National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

November 8, 2018

Office of Communications

Matthew Guariglia
59278-85699987@requests.muckrock.com

FOIA: 18-HQ-F-00801

Dear Mr. Guariglia:

Thank you for your Freedom of Information Act (FOIA) request dated and received August 13, 2018, at the NASA Headquarters FOIA Office. Your request was assigned FOIA Case Number 18-HQ-F-00801 and was for:

> Any emails, memos, letters, or communications sent or received by Administrator of the National Aeronautics and Space Administration Jim Bridenstine, that reference "Space force".

Pursuant our phone conversation of October 26, 2018, we are excluding the Daily Communications Briefings, Executive News Summaries, and a large number of emails not replied to, which resemble spam and are not from a known member of the space policy community. We have reviewed 300 pages and have made the following release determination:

13 pages are being withheld in full (WIF)
18 pages are being released in part (RIP)
254 pages are being released in full (RIF)

NASA redacted from the enclosed documents information that fell within the following FOIA Exemptions explained below.

Exemption 5, 5 U.S.C. § 552(b)(5)

FOIA Exemption 5, 5 U.S.C. § 552(b)(5), protects "inter-agency or intra-agency memorandums or letters which would not be available by law to a party other than an agency in litigation with the agency." Courts have interpreted Exemption 5 to incorporate three privileges: the attorney work-product privilege, the attorney-client privilege and the deliberative process privilege. NASA is invoking the attorney-client privilege, for the withheld records.

Exemption 5 – Deliberative Process Privilege

The deliberative process privilege is intended to protect the decision-making process of government agencies and to encourage frank discussion of legal and policy issues. The scope of the privilege covers documents reflecting advisory opinions, recommendations, and deliberations

comprising part of a process by which government decisions and policies are formulated. To qualify for the deliberative process privilege, a document must be both "pre-decisional" and "deliberative." Documents are pre-decisional when they precede an agency decision and are prepared in order to assist an agency in arriving at its decision. Documents are deliberative when they comprise part of the process by which government decisions are made

Pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10), NASA was required to develop a human exploration roadmap including a critical decision plan that identifies and defines key decisions to guide human space exploration priorities and plans that need to be made by June 30, 2020; define decisions needed to maximize efficiencies and resources for reaching the near, intermediate, and long-term goals and objectives of human space exploration; and identifies and defines timelines and milestones for a sustainable cadence of missions beginning with EM-3 for the SLS and Orion to extend human exploration from cis-lunar space to the surface of Mars. NASA released the final version of this document in September of 2018. The portions of these drafts we are withholding were not included in the final version, and unlike other sections of these drafts which differ from the final product primarily in verbiage and document flow, or would be benign to the process, these portions comprise substantive changes, and releasing these along the other withheld portions would cause harm to open, frank discussions on matters of policy between subordinates and superiors, therefore having a potential chilling effect on future deliberations with regard to the substantive inclusions of policy within future roadmaps that are required biannually by the authorizing statute. Similarly, we are also withholding portions of emails which involve deliberations regarding inclusion of language into public statements which communicate policy objectives. Also, recommendations from lower level staff regarding the NASA Administrator's decisions to calendar meetings or events are being withheld under the deliberative process privilege.

NASA has considered the foreseeable harm that would result from the release of this information and determined that its release would hinder the decision-making process, create a chilling effect on internal deliberations, lead to uninformed decision-making, and public confusion.

Exemption 6, 5 U.S.C. § 552(b)(6)

Exemption 6 allows withholding of "personnel and medical files and *similar files* the disclosure of which would constitute a clearly unwarranted invasion of personal privacy." *See* 5 U.S.C. § 552(b)(6)(emphasis added). NASA is invoking Exemption 6 to protect unpublished cell phone numbers, private email addresses, and other information where the privacy interest at stake outweighs the public interest in disclosure.

Appeal Rights

You have the right under 14 CFR §1206.700 to appeal this determination within 90 days from the date of this letter. Your appeal must be in writing and should be addressed to:

Administrator
NASA Headquarters
Executive Secretariat

MS 9R17
Washington, DC 20546
ATTN: FOIA Appeals

Your appeal should be marked "Appeal under the Freedom of Information Act" both on the envelope and the face of the letter. A copy of your initial request along with a copy of this correspondence and any other correspondence with the FOIA office must be enclosed. In order to expedite the appellate process and ensure full consideration of your appeal, your appeal should also contain a brief statement of the reasons you believe this response to be in error.

Prior to filing an appeal, you may contact NASA's Principal FOIA Officer/Chief FOIA Public Liaison, Nikki Gramian, via telephone at 202-358-0625 or via e-mail at Nikki.N.Gramian@NASA.gov to obtain further assistance or seek dispute resolution services for any aspect of your request. You may also send correspondence to Ms. Gramian at the following address:

National Aeronautics and Space Administration (NASA)
Freedom of Information Act Unit
NASA Headquarters
Attn: Nikki Gramian
Principal Agency FOIA Officer
300 E Street, S.W., 5P32
Washington D.C. 20546
(Fax) 202- 358-4332

Additionally, you may contact the Office of Government Information Services (OGIS) at the national Archives and Records Administration to inquire about the FOIA dispute resolution services it offers. The contact information for OGIS is:

Office of Government Information Services
National Archives and Records Administration
8601 Adelphi Road-OGIS
College Park, Maryland 20740-6001
Email: ogis@nara.gov
Telephone: (202) 741-5770
Toll free: 1-877-684-6448
Fax: (202) 741-5769

Important: Please note that contacting any agency official including the undersigned or NASA's Principal FOIA Officer and/or OGIS referenced above is not an alternative to filing an administrative appeal and does not stop the 90 day appeal clock.

In accordance with § 1206.804 (c), after consultation with the NASA Headquarters General Counsel Office, I am the official responsible for the denial of your request. If I can be of further assistance, please feel free to contact me at robert.s.young@nasa.gov or (202) 358-1030 or Ms. Gramian at the contact information provided above.

Sincerely,

Robert Young

Robert Young
NASA FOIA Officer
Headquarters, Office of Communications

Administrator Public / Press Activities

Upcoming

Tuesday 7/10: 1:00 PM – 1:30 PM: Administrator Interview with Bloomberg Businessweek for "Space" Issue

Reporter: Eric Roston

Proposed Topics: Conceived to be a very upbeat, positive, and science-dedicated issue, offering our million general business-savvy readers updates on how quickly many topics in space and earth-space sciences are moving. Other stories in the issue will include SpaceX (like NASA, can't have a Space issue without it), private satellite companies, the future of space travel, and possibly even an excerpt from a new science-fiction work.

Interview Format: In-person

Medium: Print

7/11 – 7/14: Administrator will travel to Israel for meetings with Israeli Space Agency officials

Interview with the Israeli Television News Company

Background: The most watched daily news program in Israel.
Reporter: Assaf Yeheskelly is a senior foreign news correspondent and the channel's space reporter. Mr. Yeheskelly has a long history covering space research, and has interviewed NASA astronauts who previously visited Israel and former NASA administrators Mr. Charles Frank Bolden, Jr. and Mr. Michael Griffin.

Interview with the Israel Hayom newspaper

Background: Largest daily circulation in Israel
Reporter: Mr. Ilan Gattegno has served as Israel Hayom's Science &Technology correspondent since the paper's establishment. He has broadly covered hi-tech, aviation and space developments.

7/14 – 7/19: Administrator will travel to London for Farnborough Air Show

TBD interviews

7/26: Administrator will tour Goddard and will be interviewed by TBD media ahead of/during visit

7/31: Administrator will tour Langley and will be interviewed by TBD media ahead of/during visit

- Possible local op-ed ahead of / following visit.

8/2: Administrator will tour Johnson and will be interviewed by TBD media ahead of/during visit

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8/4: Administrator will TBD attend Parker Solar Probe Launch (Cape Canaveral Air Force Station) and will be interviewed by TBD media ahead of/following event

8/5 – 8/8: Administrator will tour Kennedy and will be interviewed by TBD media ahead of/during visit

- Possible local op-ed ahead of / following visit.

8/8: Administrator will be at Commercial Crew Announcement (Kennedy) – TBD media

- Note: CBS This Morning doing feature

8/10: 10:30 AM – 11:30 AM: Administrator interviewed live by CSPAN Newsmakers

Contact: Leslie Burdick

Proposed Topics: NASA priorities now — a renewed focus on the moon? What's the role in humans in space? And more.

Interview Format: Live in-studio

Medium: TV

8/13 – 8/14: Administrator will tour Stennis, MAF, and Marshall (MS/LA/AL) and will be interviewed by TBD media ahead of/during visit

- Possible local op-ed ahead of / following visit.

8/23: Interview w/ Reuters TV: 11:00 AM – 12:00 PM

Reporter: Will Dunham

Proposed Topics: The future of the space program and possible missions to the moon and Mars.

Interview Format: Taped

Medium: TV

TBD Week of 8/20: Administrator Interview with USA Today for NASA Special Edition

Reporter: Ledge King

Proposed Topics: General at this point and focus on his priorities, his time at the agency, etc.

Interview Format: In-person

Medium: Print

Recent

Monday 7/9: 1:00 PM – 1:30 PM: Administrator Interview with Time Magazine

Reporter: Jeffrey Kluger

Topics Discussed:

Q: Gateway functionality

A: Gateway gives us more access to more parts of the moon… when we went to the moon before, we only explored where we landed. Gateway will give us a critical piece of infrastructure with a sustainable, reusable architecture. The goal is not to replicate Apollo. This time when we go back, we're going back to stay. It's not just beating another country, although we could do that anyway. Gateway gives us more access to more parts of the moon and gives us a better place to launch from to different places in the solar system with less launch window restrictions.

Q: Timeline – NASA historically over promises / under delivers. Timelines always slip a year or two:

A: NASA is always doing the extremely difficult. SLS is the largest rocket ever built in the history of humankind. SLS / Orion will be critical piece of national capability… Gateway is not a massive space station. It will be habitable within 3 launches. 2022/2023 we will have a human outpost around the moon. EM1 we're looking at FY 2020.

Q: Launching SLS/Orion once every 2 years seems slow:

A: We could surge if desired. Possibility we could have customer for SLS that are not just NASA. There could be 2 launches a year with DOD, International partners, etc.

Q: International Partners / ISS partner input on Gateway?

A: Have met with several ISS partners so far in my tenure and they've expressed a lot of interest. Everyone wants access – it's a good problem to have.

Q: Could budget stretch from $4 - $5 billion to upwards of $7 billion with partners?

A: If we share assets we should share costs. This is a soft power diplomacy capability.

Q: When will there be new bootprints on the moon?

A: Inside of 10 years and I've put together a NASA tiger team to determine how we can get there faster.

NOTE: Kluger recently interviewed Gerstenmaier for the same feature. Topics discussed included Gateway, astronauts going to the Moon in mid-2020s, CLPS small robotic landers on the Moon to investigate water, international / commercial interest of Gateway

Expected publication/release: TBD July / August

Interview Format: Phone Call

Medium: Print

6/27: Administrator Interview with CQ Roll Call Magazine

Reporter: Shawn Zeller

Topics Discussed: Moon, Mars, Human Exploration, Commercialization, ISS, Space Force

Podcast: https://www.rollcall.com/news/podcasts/podcast-moon-mission-mars

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Interview Format: On camera / podcast

Medium: Podcast / Print

6/27: "A Conversation with Administrator Bridenstine" hosted by Politico Space

Moderators: Bryan Bender and Jacqueline Klimas

Topics Discussed: Moon, Mars, Human Exploration, Commercialization, ISS, Space Force

Video: https://www.politico.com/live-events/2018/06/27/the-new-space-age-a-conversation-with-nasa-administrator-jim-bridenstine-640331

Interview Format: Live audience, taped, livestreamed

Medium: Online video

6/25: Administrator Interview with Axios

Reporters: Alison Snyder and Andrew Freedman

Topics Discussed: Earth Science, ISS, SLS/Orion, Human Exploration, Commercialization, Space Force

Articles: https://www.axios.com/nasa-leader-bridenstine-explains-climate-views-db6d2d13-3eae-4aac-8fa8-f361270f2585.html

https://www.axios.com/nasa-administrator-supports-trumps-space-force-7a4bba61-6184-4503-b2c3-07d158f2dbd9.html

https://www.axios.com/nasa-delays-james-webb-telescope-again-f93418cc-9a09-4250-8eb8-8a6d47209ff8.html

Interview Format: In-person

Medium: Print

6/21: CBS' The Takeout

Reporter: Major Garrett

Topics Discussed: Moon, Mars, Human Exploration, Commercialization, ISS, Space Force

Podcast: https://www.cbsnews.com/news/political-podcast-the-takeout/

Interview Format: Podcast and TV

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Topics: In-depth feature on Mars

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https://www.axios.com/nasa-administrator-supports-trumps-space-force-7a4bba61-6184-4503-b2c3-07d158f2dbd9.html

https://www.axios.com/nasa-delays-james-webb-telescope-again-f93418cc-9a09-4250-8eb8-8a6d47209ff8.html

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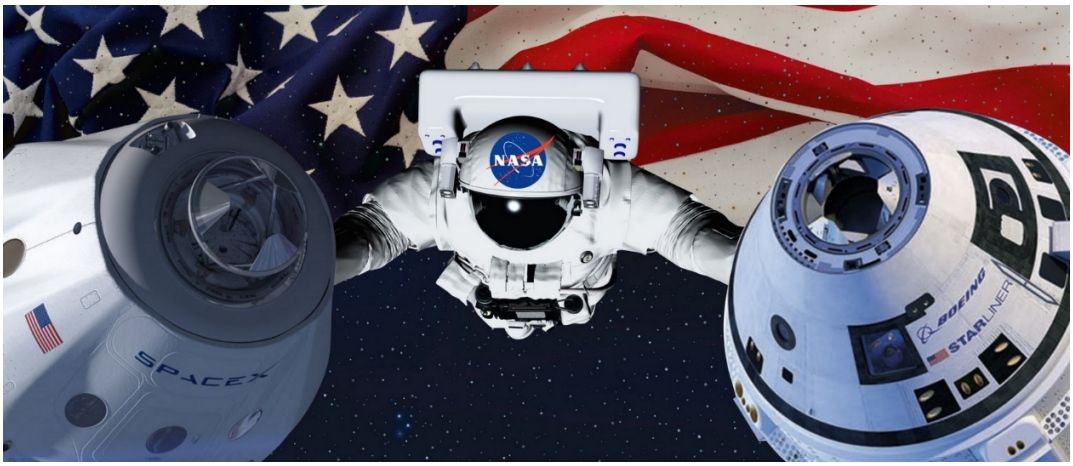
Media Outcomes Report- Commercial Crew Announcement



Announcement Date: August 3, 2018 **Prepared by: HEO PAO**

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SUMMARY

Aug. 3, NASA announced the first astronauts who will fly in SpaceX and Boeing spacecraft for the agency's Commercial Crew Program. The first crewed test flights, which will use Boeing's CST-100 Starliner and SpaceX's Crew Dragon vehicles, are currently scheduled for 2019.

NASA TV COVERAGE

Commercial Crew assignments announcement at Johnson aired on NASA TV

NASA administrator, Johnson Director Mark Geyer, and Kennedy Director Bob Cabana participation

- **11 am to noon** – Announcement and media release
- **12:30 pm to 1:30 pm** – Reddit Ask Me Anything with Commercial Crew astronauts

- **4:30 to 6:30 pm** – Media Live-shot interviews with Commercial Crew astronauts

OVERALL COMMENTS

There were nearly 1,800 media hits covered last week's Commercial Crew announcement, including previews and coverage of the event itself. Major media outlets covering included Washington Post, the New York Times, the BBC, USA Today, Yahoo news, Fox News, Scientific American, CBS News broadcast and online, NPR, NBC News, Houston Chronicle, Atlanta Journal-Constitution, Los Angeles Times, Chicago Tribune, CNBC, Associated Press, CNET, Reuters, AFP, Bloomberg, CBC News, Gizmodo, The Verge, the Atlantic.

In addition to multiple posts from the flagship, Tweets from @Space_Station and @Commercial_Crew reached audiences of over 30 million, while Facebook posts from the Space Station on the event reached from 300-500K each. Social media posts echoed the message across multiple agency accounts including Administrator Bridenstine, Dr. Thomas Zurbuchen, NASA_Astronauts and individual astronaut accounts, the International Space Station, TDRS, ISS Research, Commercial Crew, HQ Photo, and centers including but not limited to Johnson, Kennedy, JPL, and Langley. The social team updated flagship account backgrounds to feature the crew (see attached image) and promoted live Q&As on the Space Station accounts with the Boeing crew (Facebook Live) and SpaceX Crew (Periscope). Some of the coverage was dented with stories about delays from Boeing, which took a hit at the main headlines. A number of outlets' main stories were about the delays then sequentially stated the details of the announcement near the bottom.

CCP ANNOUNCEMENT KEY MESSAGES

- As this announcement shows, NASA and its U.S. commercial providers are in final preparations to launching astronauts into space from United States for the first time since 2011.
- NASA is changing the way it is doing business through commercial crew – the private sector is responsible for the development of the human space transportation systems with shared

certification responsibility. The private sector will be able to offer these transportation services to others beyond NASA.

- The Commercial Crew Program is on track to produce two, independent human space transportation systems for less than $6 billion – a significant reduction from NASA's historical experience.
- Acquiring low-Earth orbit astronaut transportation from our commercial partners frees NASA to focus on extending human presence to the Moon and eventually on to Mars.
- Boeing and SpaceX have substantial spacecraft and launch vehicle hardware in development and testing in preparation for their test flights later this year.
- NASA, Boeing and SpaceX have significant testing underway, which will ultimately lead to test missions when the systems are ready and meet NASA's safety requirements and performance requirements.
- NASA has ordered all six post-certification missions from each company.

Highlights:

The Washington Post

"NASA is about to launch astronauts into space again — and a massive business for big companies. Leading up to the ceremony at the Johnson Space Center here, NASA Administrator Jim Bridenstine said it was a historic moment for the agency: "We are going to launch American astronauts from American soil. That's a big deal."

Fox News

'"This is the stuff of dreams," said Glover, during an event at NASA's Johnson Space Center in Houston Friday.'"

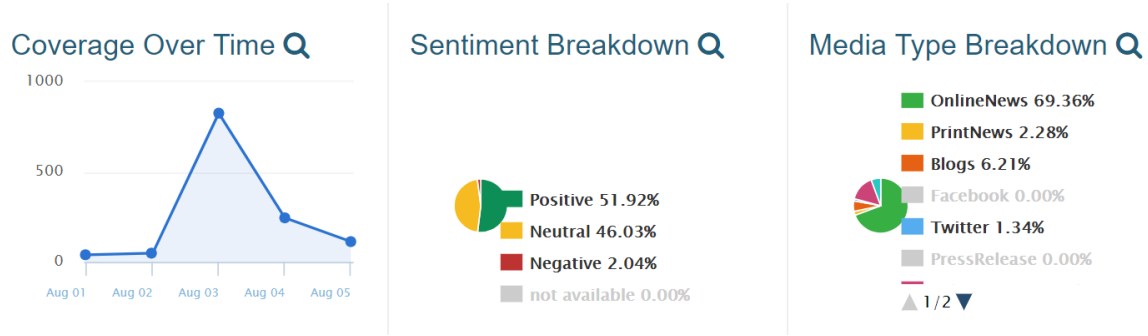
Business Insider

"The announcement is a big deal because the last American crew-carrying spacecraft — NASA's fleet of four space shuttle orbiters — retired in July 2011. Since then, NASA has been forced to rely solely on Russia's increasingly expensive Soyuz spaceships to get to the International Space Station (ISS), in which the US government has invested about $100 billion."

The New York Times

"NASA has named the astronauts chosen to fly on commercial spacecraft made by Boeing and SpaceX to and from the International Space Station, the research laboratory that orbits around Earth."

MEDIA BREAKDOWN (Agility)



NATIONAL (Pre-Announcement):

Business Insider | *NASA is naming at least 8 astronauts to fly SpaceX and Boeing's new spaceships — here's how to watch the announcement live today*

- Audience Reach: 17,885,000

The Washington Post | *NASA unveils the astronauts who will relaunch human space flights from U.S. soil*

- Audience Reach: 28,433,000

The New York Times | *NASA Names Astronauts for Boeing and SpaceX Flights to International Space Station*

- Audience Reach: 40,463,000

Space.com | *NASA Unveils First Commercial Crew Astronauts Today: How to Watch Live*

- Audience Reach: 2,175,000

Space Policy | *NASA COMMERCIAL CREW ANNOUNCEMENT, Aug 3, 2018, Kennedy Space Center, FL, 11:00 am ET (NASA TV)*

SpaceNews | *NASA confirms delays in Boeing and SpaceX commercial crew flights*

CBS News | *NASA says Boeing, SpaceX could launch astronauts next year*

Fortune | *NASA Has Finally Named a Winner in the SpaceX vs. Boeing Race to Send Astronauts Into Space*

Yahoo.com | *NASA Will Announce Commercial Crew Astronaut Picks*

Bloomberg | *SpaceX Poised to Be First With Astronaut Flights, Beating Boeing*

The Atlantic | *The Race to Launch From U.S. Soil Heats Up*

Investor's Business Daily | *Berkshire Earnings; Boeing, Space X Tune Into This, Jobs Report: Investing Action Plan*

Mirror | *Elon Musk's SpaceX will be ready to take HUMANS into space by April 2019, NASA claims*

Houston Chronicle | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

- Audience Reach: 13,860,000

Inquisitr | *NASA To Reveal Who Gets The First 'Space Taxi' Ride Aboard Boeing's And SpaceX's Crew Pods*

- Audience Reach: 3,281,000

Orlando Sentinel | *NASA to announce astronauts for SpaceX, Boeing commercial crew launches*

- Audience Reach: 1,715,000

SPACE, SCIENCE, & TECH

ULA | *United Launch Alliance Congratulates The Boeing Company on Selection for NASA Commercial Crew Integrated Capability Contract*

Next Big Future | *NASA will announce crews for SpaceX and Boeing crewed missions tomorrow*

CollectSpace | *Shuttle test pilot Bob Crippen's advice for NASA's commercial crews*

Spaceflight Now | *NASA set to announce commercial crew assignments today*

Planetary Society | *NASA names crews and dates for first U.S. commercial missions*

Geek Wire | *NASA confirms new timetable for space taxi flights; SpaceX to fly crew next April*

BGR | *NASA is ready to name the astronauts who will take the very first SpaceX and Boeing flights*

The Register Citizen | *NASA is about to announce the 8 astronauts who will fly SpaceX and Boeing's spaceships for the first time — here's who they might be*

Heavy | *NASA Commercial Crew Announcement Live Stream: Watch Online*

- Audience Reach: 4,834,000

Space Coast Daily | *Vice President Mike Pence To Visit Kennedy Space Center Aug. 3, Will Announce First NASA Commercial Crew*

Politico | *NASA to unveil first commercial astronaut crew*

Executive Gov | *Report: NASA to Announce Commercial Crew Program Astronauts in August*

Tech2 | *NASA TO SOON ANNOUNCE NAMES OF THE ASTRONAUTS ASSIGNED TO BOEING, SPACEX FLIGHTS*

Pythom | *NASA To Announce Commercial Crew Assignments on Aug. 3*

Study Idol | *NASA can Announce Commercial Crew spaceman (Astronaut) Picks*

TechGig | *NASA is naming 8 astronauts to fly SpaceX and Boeing's new spaceships - here's how to watch the announcement live*

- Audience Reach: 312,000

LOCAL:

WKMG News 6 (Orlando)| *WATCH LIVE: NASA announces first SpaceX, Boeing astronauts*

WNWO NBC 24 (Ohio) | *WATCH LIVE: NASA Commercial Crew Announcement*

Orlando Sentinel | *NASA to announce new astronaut class on Friday*

KPRC Click2Houston | *LIVE: NASA to announce new astronaut class Friday*

Chron (Houston) | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

Orlando Weekly | *Mike Pence will visit Cape Canaveral next month for a big space update*

Spectrum News (Orlando) | *NASA unveils crew test flight target dates*

Florida Today | *NASA unveils first Boeing and SpaceX astronauts for flights to ISS*

USA Today (Florida) | *NASA to announce first astronauts to fly SpaceX and Boeing ships*

Houston Chronicle | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

Associated Press | *WATCH LIVE: NASA Commercial Crew Announcement*

ABC 6
Fox 29 KABB
Fox 11 WVAH
Local 12 WKRC
Fox 44 KMEG
WTOV 9
Fox 66 WSMH
ABC 8 Tulsa
ABC 22 WKEF
NBC 16 KMTR

(MANY MORE)

POST ANNOUNCEMENT

Wired | *MEET THE ASTRONAUTS WHO WILL FLY THE FIRST PRIVATE 'SPACE TAXIS'*

- Audience Reach: 5,163,000

Business Insider | *NASA just announced the first 9 astronauts to fly SpaceX and Boeing's brand-new spaceships — here's who they are*

TIME | *These Are the Astronauts Who Will Ride the First Commercial Capsules Into Space*

- Audience Reach: 10,976,000

Daily Mail | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 37,775,000

Yahoo News | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 20,604,000

Space Daily | *NASA Assigns Crews to First Test Flights, Missions on Commercial Spacecraft*

- Audience Reach: 26,000

Engadget | *NASA announces astronauts for first Commercial Crew missions*

- Audience Reach: 6,410,000

Catch News | *Sunita Williams among 9 astronauts to fly first commercial spacecraft*

- Audience Reach: 194,000

Live Science | *Trump Hails Astronauts That Will Fly on SpaceX and Boeing Spaceships. And Space Force, Too?*

- Audience Reach: 5,428,000

Long Room | *NASA introduces its first 'Commercial Crew Astronauts'*

- Audience Reach: 25,000

CNBC | *These are the astronauts NASA assigned for SpaceX and Boeing to launch the first crews from the US since 2011*

- Audience Reach: 11,217,000

TechCrunch | *NASA names first astronauts for the inaugural commercial flights to the ISS*

- Audience Reach: 4,280,000

Fox News | *NASA names nine 'American hero' astronauts for SpaceX, Boeing missions*

Mashable | *Meet the NASA astronauts that will fly to space with*

- Audience Reach: 9,915,000

CNET | *NASA names astronauts to fly new SpaceX and Boeing spaceships*

- Audience Reach: 48,000,000

First Post | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 5,282,000

Daily Star | *NASA reveals astronauts who will take first commercial flights into space*

- Audience Reach: 3,661,000

Inquisitr | *Here Are The Astronauts Flying The First Missions Of SpaceX's Crew Dragon And Boeing's Starliner*

- Audience Reach: 3,281,000

U.S. & World Report News | *NASA Names Astronauts for First Manned U.S. Space Launches Since 2011*

- Audience Reach: 11,455,000

Reuters | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 10,826,000

Yahoo News | *NASA Introduces Nine Astronauts for First Commercial Flights*

- Audience Reach: 309,952,000

Flickr | *Crews to Fly Commercial Spacecraft Announced (NHQ201808030022)*

- Audience Reach: 22,673,000

TV:
Good Day Illinois (WCCU (Fox))
Eyewitness News This Morning (KGPE (CBS))
Good Day Colorado (KFQX (Fox))
FOX 31 Morning News at 7:00am (KDVR (Fox))
KVRR Local News at 8 (KVRR (Fox))
KTVH/KBGF Morning News (KBGFLD (NBC))
Good Day Illinois (WRSP (Fox))
Fox 8 News at 9pm (WVUE (Fox))
Ch. 7 Wknd News at 10:00 (WSVN (Fox))
Good Day Austin (KTBC (Fox))

Twitter Highlights

Trends: #NASA #Boeing #SpaceX #NASAAnnouncement #SpaceCrew #CommercialCrew #TestFlights #Astronausts #FirstAstronauts #SpaceXDragon #Crew #LIVE

https://twitter.com/Space_Station/status/1025762030681247744?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet

https://twitter.com/Commercial_Crew/status/1025489989721841664?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet

Jim Bridenstine ✓
@JimBridenstine

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With today's @Commercial_Crew announcement, we are on the brink of launching American astronauts on American rockets from American soil. Congratulations to the entire class of astronauts that were announced today. You are all American heroes. #LaunchAmerica

Commercial Crew Announcement

https://twitter.com/JimBridenstine/status/1025420629443596289

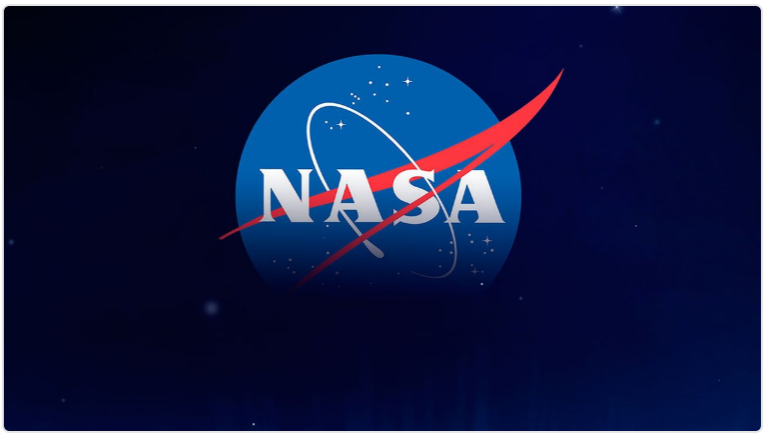
The Verge ✓ @verge · 48m
NASA announces crews for the first flights of SpaceX and Boeing's passenger spacecraft theverge.com/2018/8/3/17647...

1 24 74

https://twitter.com/verge/status/1025411838740185095

KPRC 2 Houston @KPRC2 · 2h

#LIVE **NASA announces** new class of astronauts which will be the first to man commercial space flights > kprc2.co/2vdUj7W?utm_so... #kprc2 #hounews



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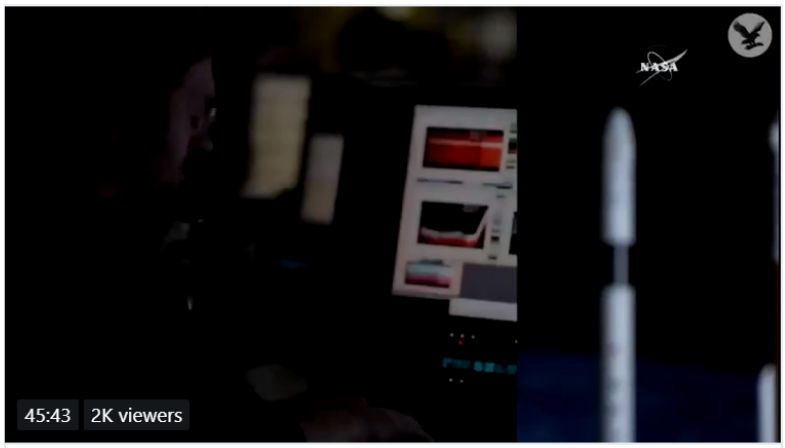
https://twitter.com/KPRC2/status/1025396479647797250

The Independent @Independent · 2h

Watch live as **NASA announces** the crews for its brand new rockets with SpaceX



Watch live as NASA announces the crews for its brand new rockets ...

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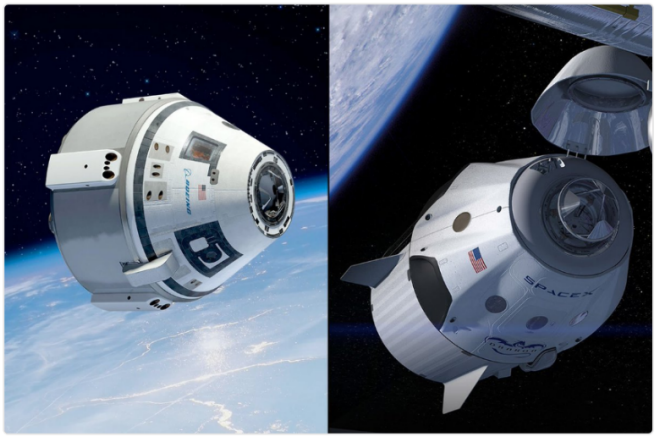
New spaceships, new astronauts - @NASA revealing the first 10 crew to fly Dragon & Starliner. Watch here live: space.com/17933-nasa-tel … @SpaceX @boeing



DRAFT – NASA INTERNAL USE ONLY

National Exploration Campaign Report

Pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1: *Forward to the Moon, Mars and Beyond*

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign laid out herein is NASA's answer to that bold call. It also directly responds to the policy objectives found in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which called upon the Agency to develop a Human Exploration Roadmap, including a critical decision plan, to expand human presence beyond low Earth orbit (LEO) to the surface of Mars and beyond, considering interim destinations such as cislunar space and the moons of Mars.

The Campaign aims to revitalize and add direction within NASA's enduring charter to build missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to increase market share and create new market. It responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the country in space. Challenges and opportunities exist in now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation, centered in part on the U.S.-led International Space Station, is today starting to unleash a new economic realm. Action, though, is needed to unleash this new commercial engine and to provide the regulatory and security environment to enable and protect this new economic zone. Further out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond comes as more countries robotically begin establish a presence in this region.

When America reaches the Moon starting early in the next decade, we will not be alone. Foreign nations are planning their own missions to send spacecraft into orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations have all stated plans or already initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013. Even out to Mars, opportunities and challenges exist. American has been the unsurpassed leader in this domain. American robotic craft have been the only ones in history to have successfully landed on Mars. Now, many Nations

are planning their own missions to Mars's surface in the coming years. China in the next decade also plans to be the first nation to bring back samples- that may show the first signs of life beyond our planet.

Opening a New Era: The Sea Beyond Calls

The overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and most importantly, the American public. It is not a return to the past or a repeat of previous efforts of the past 25 years that have sought to move beyond the near-Earth regions of space. It is not about a geo-political competition to re-do Apollo. A lot has changed – and is changing.

The Exploration Campaign builds upon the past 17 years of Americans and their partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies; and begins operations in the next few years of the first American capsule and rocket system capable of establishing the first American permanent presence and infrastructure on and around the Moon. At the same time, with rapid advances in American private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and even commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and space traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA' relationship and collaboration with other U.S. Government agencies will be expanded to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the Nation's space goals. To supplement our own well of creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call (see list of upcoming requests for information in the Appendix). We seek to engage and inspire the next generation, in particular the large number of science, technology, engineering and mathematics (STEM) professionals that support major challenges needing these skills.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create dominance beyond the littoral shores of space – out to, around and on the Moon. NASA's civil pursuit and international leadership of scientific advancement, the frontiers of human exploration, technological primacy and civilizational achievement fill in the American strategic approach to the space domain.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations, which support NASA and the needs of an emerging private sector market.

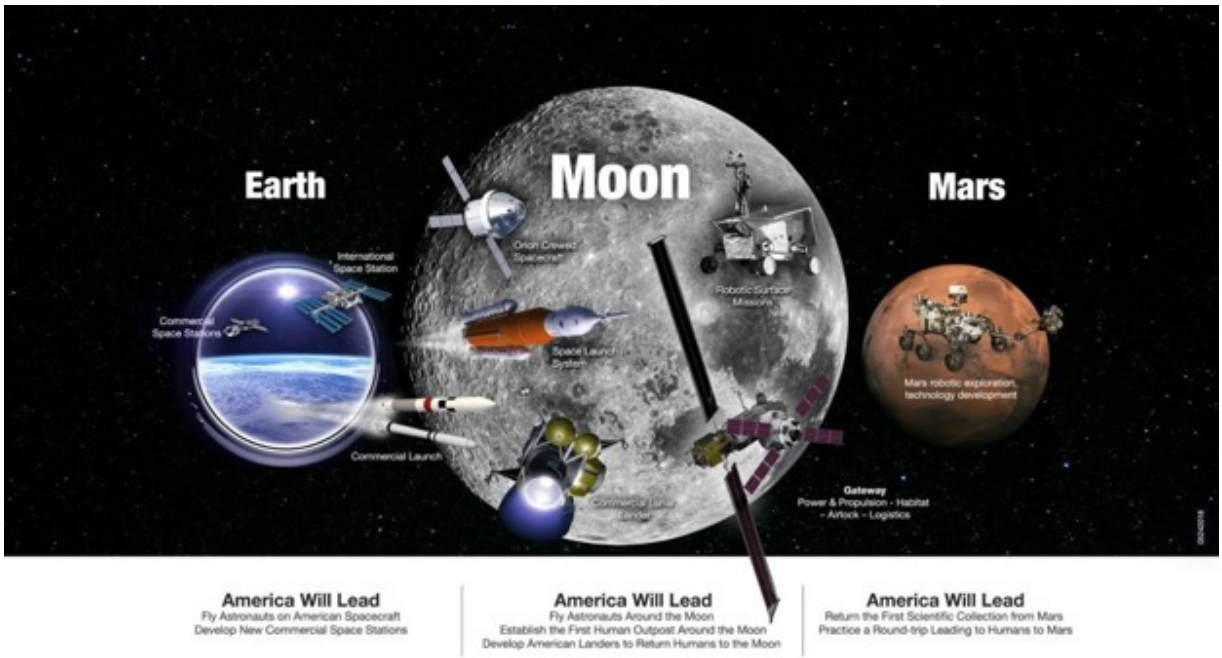
2. Lead the emplacement of capabilities in lunar orbit that support surface operations and feed forward to missions beyond cis-lunar space.

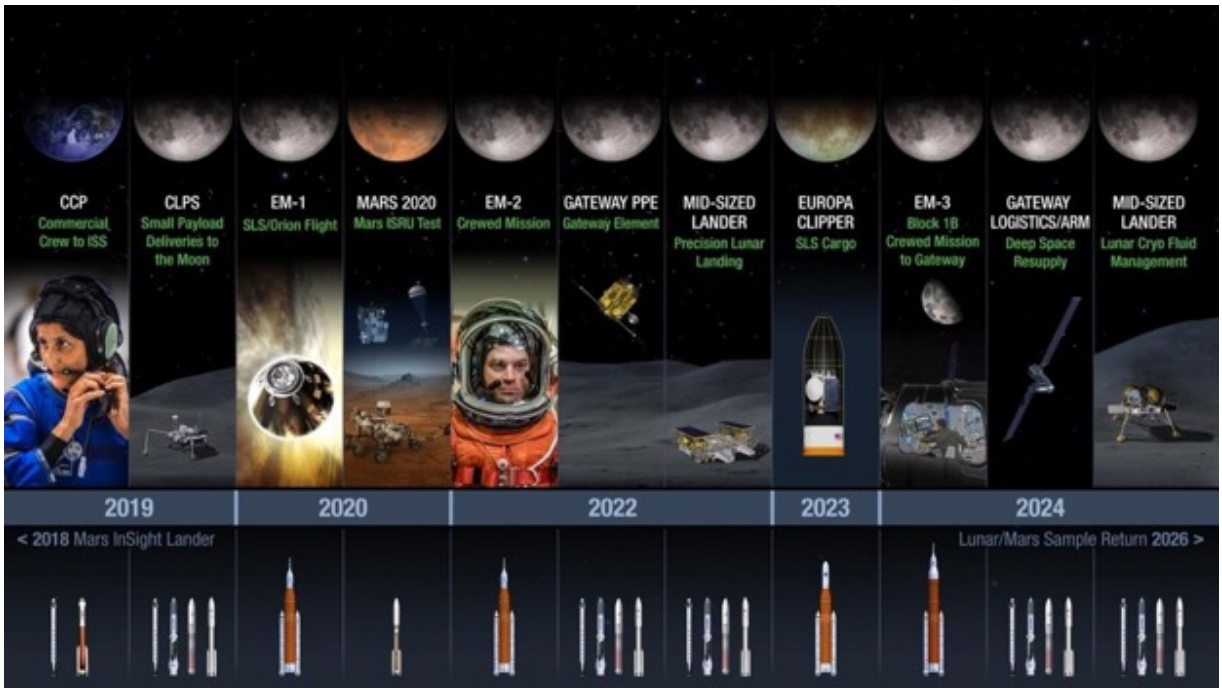
3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, the Campaign will be led by NASA as architect, mission leader, and in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. The following Report provides NASA's strategic implementation approach for "Eagle Rising."




CCP
Commercial Crew to ISS
CLPS
Small Payload Deliveries to the Moon
EM-1
SLS/Orion Flight
MARS 2020
Mars ISRU Test
EM-2
Crewed Mission
GATEWAY PPE
Gateway Element
MID-SIZED LANDER
Precision Lunar Landing
EUROPA CLIPPER
SLS Cargo
EM-3
Block 1B Crewed Mission to Gateway
GATEWAY LOGISTICS/ARM
Deep Space Resupply
MID-SIZED LANDER
Lunar Cryo Fluid Management
2019
2020
2022
2023
2024
< 2018 Mars InSight Lander
Lunar/Mars Sample Return 2026 >

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's off-shore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first placed footprints on its surface roughly 50 years ago, our explorers left only fleeting footsteps at a few sites for a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different than the past. NASA is building a plan for Americans to orbit the moon starting in 2023 and land astronauts on the surface by the late 2020s. For the majority of people alive today, this will be their first chance to witness a lunar encounter with Americans and a lunar landing – collective moments when the world holds it breath in awe and wonder. America will not stop there. A core focus of this Campaign is to bring the Moon into the nation's geo-strategic and economic sphere.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar and cosmic radiation for billions of years – left largely undisturbed, the Moon is an archive of the history of our solar system and our Sun. There are scientific mysteries locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Making the first solar chips or gallons of fuel from the regolith of the Moon, like the harnessing of fire, will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out)– Living and Working Around the Moon

The American Moon Port/Ship under development will forge U.S. leadership and presence over the region from the Moon to the Earth. This platform will host astronauts further from Earth than ever before.

A radical advancement in space technology and human life support systems, the platform will serve as a Moon Ship that will offer astronauts longer stays on the surface, easier crew return, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, we will check technologies and systems as we get ready for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the radiation and microgravity environment beyond-LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by conducting biological and biomedical studies over longer periods than ever previously possible. The Moon Ship will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub; evolving to serve as a way station for the development of refueling depots, servicing platforms, and sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship/Port is presently under construction at NASA centers across the U.S. including in Ohio, Texas and Alabama. The first element will be launched from Florida in 2022 and crews will be able to stay aboard starting in 2023. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar-electric propulsion technology, and provide the critical functionality for the rest of the Moon Ship. NASA will call upon its own workforce to build critical pieces of hardware such as the power and propulsion element and habitation module, push

industry to advance the state-of-the-art to deliver logistics modules, and utilize key contributions from international partners including additional habitat modules and a robotic arm. We will also study the effects of the deep space environment on the Moon ship and its ability to serve as a platform to assemble payloads and systems robotically or with humans that could be used for human and scientific exploration. The Ship will be incrementally built in place using the American-built Space Launch System, Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

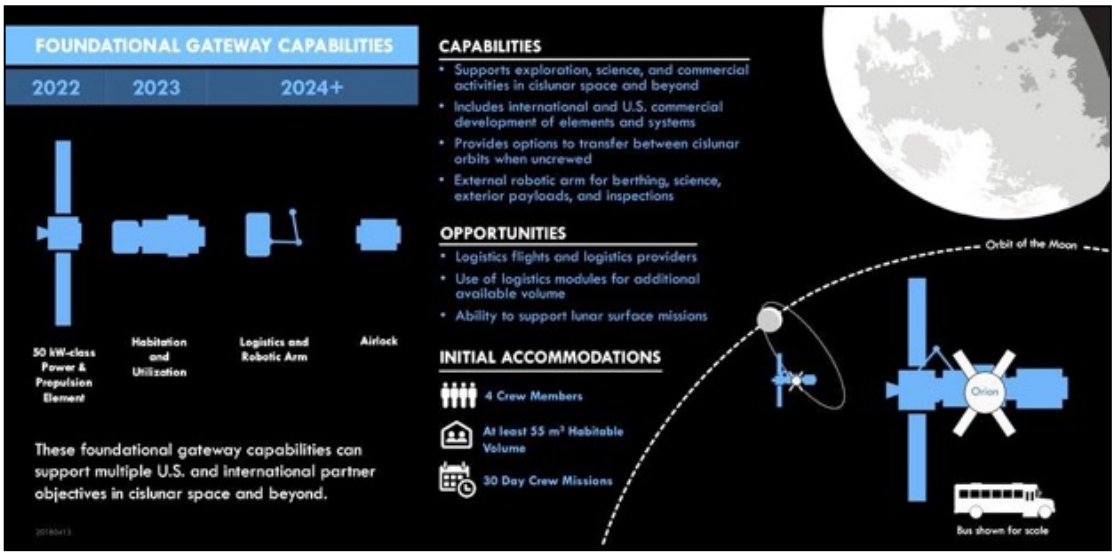


Figure 5: Gateway Development

Humans and Robots - Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, a training ground, and an off-shore continent to prepare for future human missions to Mars and other destinations. Through an innovative combination of robotic and human missions involving commercial and international partners, robotic lunar surface missions will start as early as 2019/20 focused on scientific explorations with a focus on lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in concert with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts and working in tandem with the Moon Ship/Port will expand and diversify over time, taking advantage of the Moon and cislunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far-side of the Moon for Astrophysics, focusing on Space Weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship/Port combination offers an unprecedented research platform and infrastructure. Our currently active scientific exploration missions, Lunar Reconnaissance Orbiter and ARTEMIS will be used immediately to support this increase in scientific discovery objectives.

NASA has started a program of robotic lunar missions through the Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP), including delivery of early, small payloads using emerging commercial landers through the soon-to-be-released Commercial Lunar Payload Services

(CLPS) procurement with speed and commercial partnerships as defining values. In addition, NASA will focus on continued growth of emerging commercial capabilities to further enhance human lunar lander capabilities and utilization of the Moon (including potential lunar communications networks). An assessment is underway on the best development path for an SMD-led rover capability and mid-size lander. In every case, technology and commercial sector capabilities will feed forward toward and integrated into the human exploration approaches.

While we have extensive orbital information about the lunar surface and potential resources, robotic scouts are needed on the Moon to validate prior observations and are essential to prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data – multiple landers will provide a global-scale view of the Moon and its resources. Landers will specifically be outfitted with sensor packages, while also providing lunar surface access for rovers that can explore the surface more extensively, as well as carry instruments such as *in situ resource utilization* (ISRU) experiments that will provide detailed information on extraction of usable resources such as oxygen and water. In addition to obtaining this information, robotic landers will provide critical risk reduction activities for the human-scale lander descent stage and utilization capabilities, including development of critical technologies that will enable precise and soft landings on the lunar surface.

An American human lander effort is underway within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T to advance lower-readiness-level technologies so they can be implemented in future lunar missions. A critical technology development underway involves infusing autonomous sensing, processing, guidance and navigation capabilities to enable soft, controlled landings within tens of meters of a selected target, utilizing real-time hazard detection and avoidance algorithms to ensure a safe and precise landing. In addition, long-term storage of cryogenic fluids is being developed that will enable significantly greater mid-sized and human class lander performance capability at a substantially reduced mass. A deep space engine for landers is being developed with a unique fuel mixture with a lower freezing point that will reduce the power required and lowers the system mass. NASA is also assessing the longer-term higher-power needs to surviving the lunar night and operations in shaded portions of the lunar surface by considering surface fission power that will power ISRU demonstrations and other needs. NASA is also assessing the requirements for next generation spacesuits needed for lunar exploration. In addition, planned landers and rovers provide excellent platforms to demonstrate technologies that will not only enable greater lunar surface mission capabilities but also extend beyond the moon to Mars applications.

NASA is currently assessing different trades from a mid-sized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is examining options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of on-going National need or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated that range from capability stimulation through funded Space Act Agreements to a single partner or contract approach to an international partnership model, or a NASA-led multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace – it takes about 10 years to develop a crewed system. The Apollo LEM has been the only outlier. Produced in 6 years– but at a cost of 24B at current dollars – the LEM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

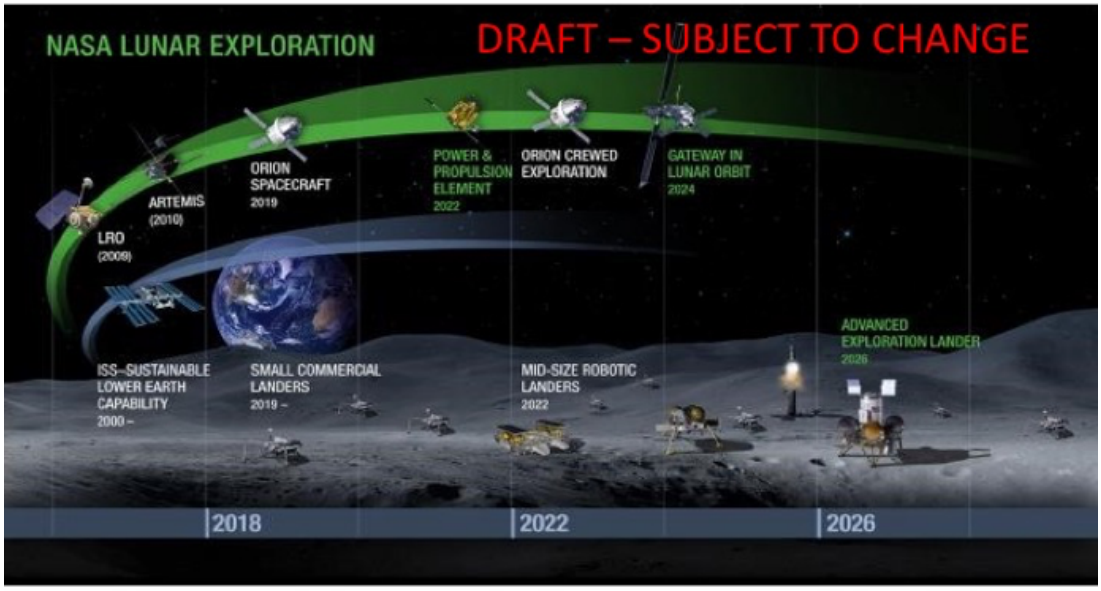
Human exploration of both the lunar surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is both building an exploration launch and crew system (the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting ground systems), and will rely on commercial launch providers to support both robotic surface and lunar orbit operations. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days with additional habitation volume and systems. New engines for Orion's Orbital Maneuvering System-E engine will need to be developed, with designs shaped by future service module development approaches and other possible applications and upgrades currently under assessment. The SLS Block 1 cargo variant will be capable of delivering 70 mT to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 mT to LEO co-manifested with Orion in the mid-to-late 2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), to be launched to lunar orbit in FY 2020 followed by the first crewed SLS/Orion mission, EM-2 no later than 2023. These SLS/Orion missions will demonstrate the capability to reach and operate safely and productively around the Moon.

Decisions related to performance, fairing volume, payload delivery mass and fairing capability evolution on SLS Block 1, 1B, and Block 2 will also need to be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing will also significantly shape the rest of the architecture. In addition, decisions to augment the SLS flight rate need to be laid out five years in advance of the added flights (such as for Europa Clipper). Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability, and cost of commercial launch options.

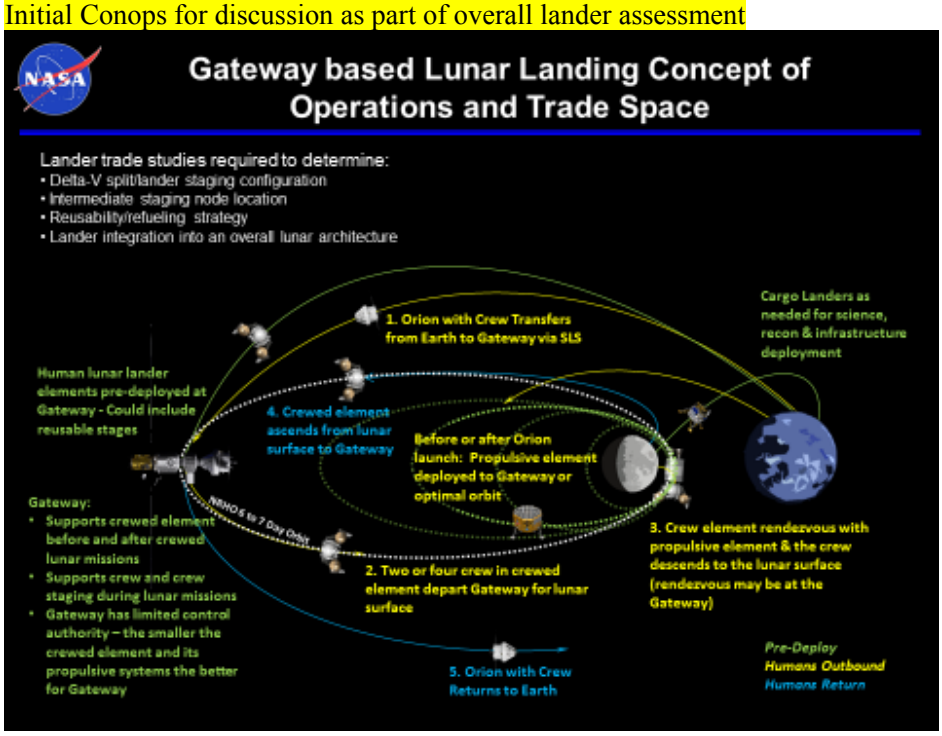
NASA's leadership evolving its current international partners involved with the ISS and opportunities to create new partnerships that add to the overall lunar orbit and surface parts of the Campaign also another National strategic dimension. While NASA is currently prohibited by law from establishing a bilateral partnership with China, we intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation. China has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to a taikonaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans. *Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing and ceding global leadership in cislunar space overall.*

Overall this Exploration Campaign is different from past attempts that could not be sustained or that never matured. With an open architecture approach, the Campaign's lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of new gained knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early-to-mid 2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)



Initial Conops for discussion as part of overall lander assessment



With our open architecture and resilient Campaign approach, NASA will allow for the evolution of its current concept of operations for human lunar surface and orbit activities. Specifically, reusability and the evolution of other architectures are being kept in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander is envisioned, as are the use of Orion systems. SLS is currently being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) Additionally, NASA is looking at other options like a stretched Orion service module and/or a co-manifested retro stage. With open architecture, on-

ramps for new and broadened commercial and international engagement, there will be other trades as the Campaign continues to innovate, adapt and grow.

As we move out with beyond Earth's shores, America will be answering critical strategic questions, such as:

Can the moon become a center for commercial enterprise? Are there significant deposits of water that could be utilized to support human settlement, or extracted for fuel on a human journey to deep space? In the long term scale of human endeavors, understanding what is possible on the moon and being the first to realize its potential could be transformational. Historically, when the explorers Lewis and Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities and they did not know what they might find. Today the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the campaign engage broader sectors of the nation? American companies will help lead this effort. Not only will they build the small landers, NASA will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a major company has experience drilling into the Earth's crust several miles under the ocean, such R&D created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign towards American and global society as a whole? Just as the ISS has spurred broader applications on Earth, America goes to the moon to extend humanity's presence in the solar system and also to improve the lives of people on Earth. The ultra-efficient use of scarce resources by humans in orbit, the production of tools and systems from extant resource off the Earth, or the extraction of water from the frozen lunar regolith are challenges that once mastered will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces and in orbit will push the technological frontier, supporting current trends in autopilot cars, trucks and trains - but with exceptional quality control and robust engineering - designed to operate in the most difficult environment known to human kind.

Nuclear Propulsion for in-Space Transportation - Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future engineering systems.

Critical Decisions and Milestones:

Lunar Surface

2018

Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019

- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020)

- Decision to develop human-class lunar lander capability for demonstration mission in 2024.

- Decision to develop and launch *Discovery*-class NASA lunar resource and science rover mission in 2022, a 500 kg-class rover mission focused on resources and other scientific discoveries, including mobility and sample return capabilities.
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Based on early results of human-class lunar lander development and on the results of the human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial lunar payload services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on results of the cost of lunar surface access, viability of higher-power systems and ISRU as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship and decision on international partnerships and Moon Port configuration. The Moon Ship will also provide broad science research and technology demonstration opportunities from cis-lunar space, including lunar surface (e.g., lunar sample return, telerobotics, etc.), astrophysics, heliophysics, and Earth science.

2020

- Uncrewed SLS/Orion first flight (Exploration Mission 1, or EM-1) in 2020 to the lunar vicinity.
- Initiation of scientific payload development for Moon Ship, by competitively assessing the most suitable and impactful scientific analysis.

- Science and industry missions flown on EM-1 using 13 co-manifested cube sats launched as secondary payloads. (Add/Highlight in earlier text).
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Based on status of launch vehicle development, decide on future Moon Port/Ship logistic resupply missions.

2022

- Conduct a crewed flight – EM-2 – sending Americans around the Moon by June of 2022.
- First element of Moonport/Moonship, the power-propulsion (including communications) element (PPE), emplaced around the Moon.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need and viability of developing and emplacing propellant depots in lunar orbit.

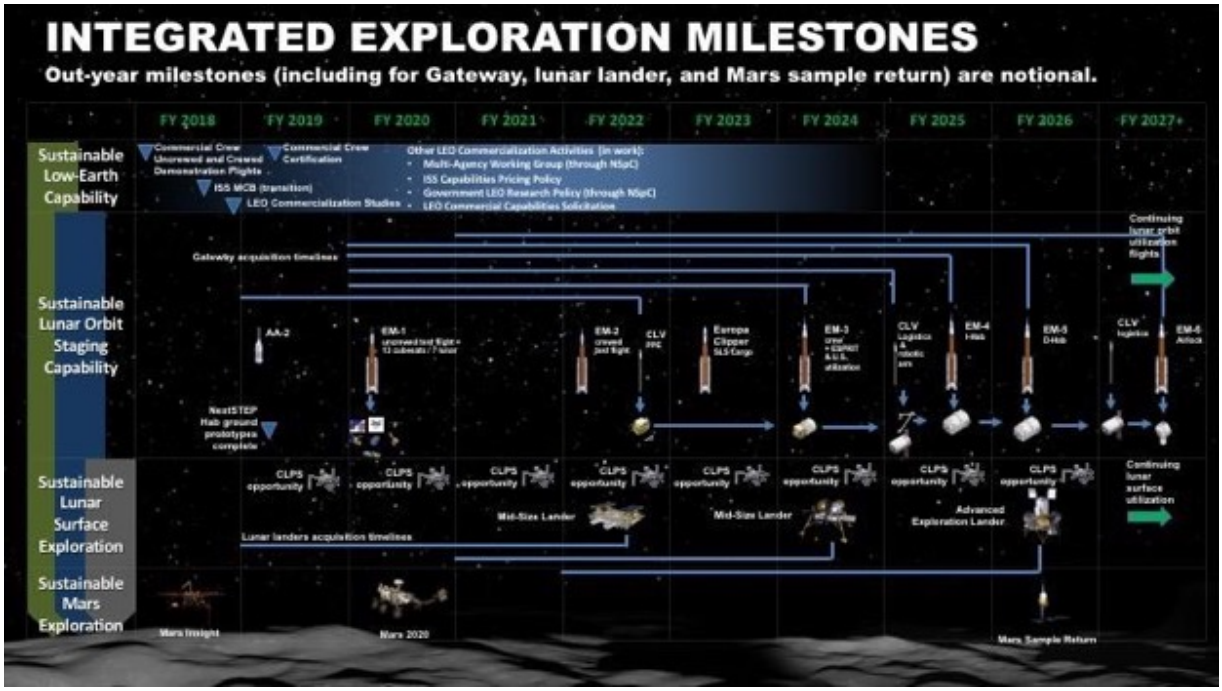


Figure 3: NASA's Exploration Campaign

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for human civilization. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon combined with continued U.S. access to commercial platform(s) in low-Earth orbit will ensure we will continue to advance American leadership in opening up the heavens to further human and scientific development.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests the advanced technologies necessary for long voyages and stays away from Earth. Long-duration exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health, and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to best address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently- crewed testbed prior to deploying these capabilities beyond low-Earth orbit (LEO).

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling discovery and development of advanced robotics, communications, medicine, agriculture, and environmental science. The Station has been an excellent platform for several Earth and space science instruments that leverage the unique infrastructure by mounting high-priority scientific investigations with strong appeal throughout the community

Ongoing operations and research on ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other Government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities. What is needed to allow a movie director to one day produce entertainment on the Station? What is needed to enable an astronaut tourist to dock to the facility and stay the night? Can biotech, materials or manufacturing companies install equipment to

produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services, but more importantly, strengthen overall demand and interest in utilizing a commercial platform in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it opens up significant new opportunities for commercial space flight. U.S. companies could become the first to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless, from tourism to training for deep space missions, it could also enable highly-trained and discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers. Specifically, nations with human spaceflight capability including Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station beginning as early as 2019. Upon completion, it will represent the extension of China's military operations onto a human habitation platform in low Earth orbit. For purposes of diplomacy and commerce, it may also offer an alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include*:*

- Expand the partnerships in LEO to include new companies and new nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including for continuing scientific exploration in low-Earth orbit.
- Pursue other efforts to enable this shift away from direct government funded support of the ISS. For a fuller assessment of the transition of LEO, please refer to the recently published *NASA ISS Transition Report*: https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY19 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development
- Work with Commerce and State, in particular, to spur greater use of ISS and interest in LEO development overall. Identify and eliminate regulatory barrier to enable more commercial activity. Identify and implement incentives for LEO efforts. Examine funding models like the Aviation Trust Fund that may aid the development of on-going non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2026 (Gerst-when is the latest date or necessary date to decide this?)

2024

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2028

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate the appropriate NASA and overall governmental support to ensure on-going NASA requirements in LEO, as well as, ensuring permanent U.S. citizen presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe for thousands of years. As part of the Exploration Campaign in response to SPD-1, this voyage will be able to occur in 2030s. Key components of this part of the Campaign are already underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit and, continuing to lead and advance the world in science missions beyond LEO, including a civilization first round-trip voyage to Mars. The U.S. will embark on the first round-trip return from another planet, Mars, launched by 2026. This mission will bring back samples with a focus on proving the existence of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes development of technologies and systems capabilities that enable a series of human and robotic lunar missions that are extensible to destinations beyond the Moon including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. The InSight mission is on its way to Mars now and will land in November to conduct research into the interior of Mars. The Mars2020 rover is continuing to make excellent progress and will be launching in July 2020. The planning for the return of samples from the Martian surface in the next decade are well under way. Research on Mars is paving the way for human exploration and utilization of the red planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

For example, Mars robotic missions have enabled the U.S. to master the incredibly complex task of entry, descent, and landing (EDL) for one-metric-ton payloads (similar to the size of a compact car), gathered data about radiation in transit and on the surface of Mars, investigated the Martian atmosphere and weather, and shown there exist significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric CO_2 while selecting and encapsulating samples for potential return to Earth. Future robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built upon the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other, and collectively build the world's knowledge base for Mars exploration. These missions have revealed a planet of diverse mineralogy indicating a water-related environment, that Mars could have supported life in its past, the massive loss of the Martian atmosphere through time, thick deposits of ice beneath Mars' surface, the presence of methane and other organics, and a still dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include:
Maintain and grow U.S. leadership at Mars with a rover in 2020, as a first step of a sample-return strategy, searching for past life and demonstrating the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent round-trip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crew Mars missions starting in the 2030s that will culminate in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the Universe and this may bode well for one day finding life on the planet. Later in 2018, NASA will land the InSight lander, a sophisticated analysis into the geology of the Red Planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest flagship priorities for future missions and is relevant to the human exploration initiative as well. Such a mission would be the first interplanetary roundtrip mission demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture; and
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning.
- Two high-visibility technology demonstrations as part of Mars2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable Oxygen from Martian's thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships, and through it assert continuing US leadership throughout, by filling a leadership void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the European Space Agency (ESA), among others. NASA and ESA recently signed a letter of intent to mutually develop a joint MSR plan and to complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked industry for inputs with regard to commercial solutions and this dialogue is ongoing. Given the expected increased data rates (for downlink) required by the science and eventual human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Critical Decisions and Milestones

2019

- Decision on Mars robotic round trip mission (Sample Return) implementation and architecture and target launch date (2026, or 2029,)
- Decision on Mars-forward technology investment R&D portfolio in ER&T
- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (on-going).
- Develop standards for human long-duration deep space transportation vehicles (on-going).

2021

- Based on results of Mars 2020, MOXIE payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T

2024

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic round trip Mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms, and Organizing to Win
OR
How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

To achieve extraordinary success, NASA must consider extraordinary changes from streamlining our organization and management to becoming even more efficient and effective. The Exploration Campaign does not assume or require Apollo levels of funding, but instead seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage and partner for up to 30% in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission – we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

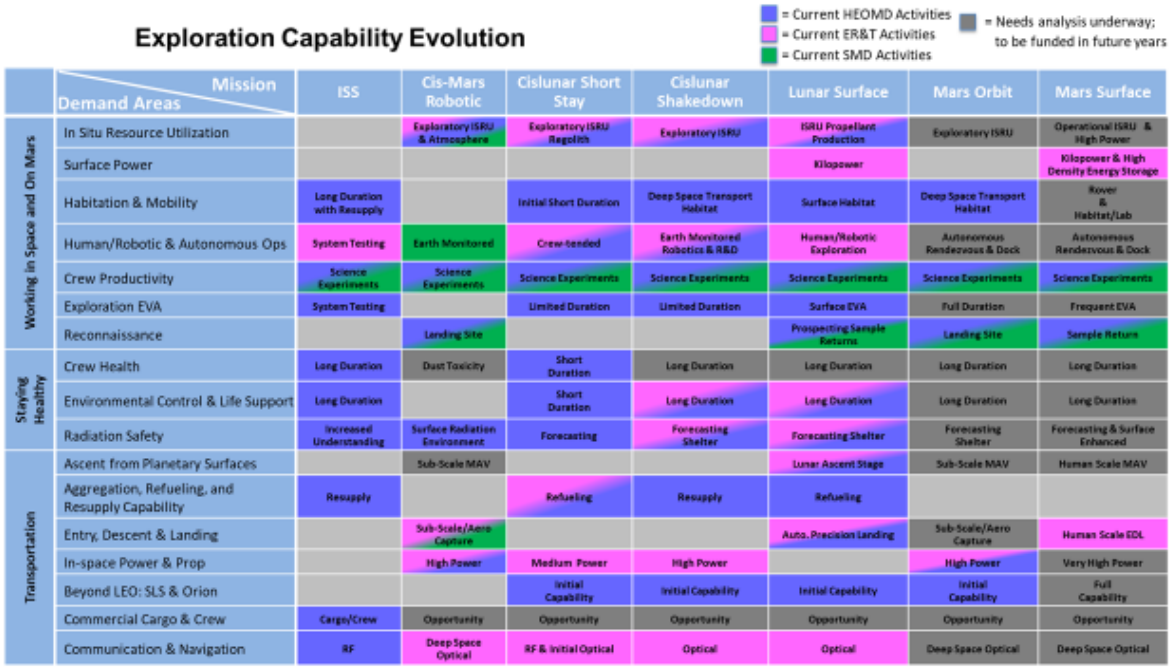
Lastly, NASA recognizes the need for SMD/HEOMD/STMD lunar exploration integration and is looking at different ways to align and focus the Campaign elements. The Agency has already initiated a federated, core Team for the lunar portion of the Exploration Campaign that consists of AA and DAA level participation working with A-suite orchestration. NASA is looking at formalizing this approach thru the establishment of a senior leadership coordination group reporting to the Administrator, Deputy Administrator, or Associate Administrator. In support of this overall Agency effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to the Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA is also examining how to most effectively organize to lead in this key Exploration Campaign initiative.

–Cross-Cutting Technologies: Focused and in Support of the Campaign

ER&T is undergoing significant organizational change to support the Exploration Campaign. The Agency is working to mature exploration technologies and systems in preparation for these cislunar Moon Ship and deep space missions. Exploration Research & Technology (ER&T) is developing advanced power and propulsion technology, including 13 kW SEP Hall thrusters, power processing units, and associated hardware supporting Moon Ship power and propulsion needs and potentially extensible to the needs of deep space architectures. ER&T is also advancing promising transformative technologies across other technology focus areas, including next-generation environmental control and life support systems; ISRU; cryogenic fluid management and long term storage; fission power systems (perhaps leading to nuclear propulsion systems for Mars); advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; EDL; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High-TRL technologies will be applied to near-term missions, while the Agency invests in low-TRL technologies to address challenges of future exploration missions. Wherever possible, these technologies are also being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities as well as Agency architecture strategies.



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National Exploration Campaign Report

Pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1: Forward to the Moon, Mars and Beyond

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign laid out herein is NASA's answer to that bold call. It also directly responds to the policy objectives in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which calls upon the Agency to develop a Human Exploration Roadmap. This Roadmap will include a critical decision plan to expand human presence beyond low Earth orbit (LEO), to the surface of Mars and beyond, considering interim destinations such as cislunar space and the Moons of Mars.

The Campaign aims to revitalize and add direction to NASA's enduring purpose to carry out human and robotic exploration missions that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, other worlds, and the cosmos as a whole; and missions that advance new technologies in aeronautics and space systems that allow American industry to increase market shares and create new markets. The Campaign also responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the nation in space. Challenges and opportunities exist now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation today, centered in part on the U.S.-led International Space Station, is starting to unleash a new economic arena. However, action is necessary to drive this new commercial engine and provide a regulatory and security environment that enables and protects this emerging economic zone. Farther out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond, comes as more countries begin to establish a presence in this region with robotic missions.

When America reaches the Moon, starting early in the next decade, we will not be alone. Other nations are planning their own missions to send spacecraft into lunar orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations all have announced plans or initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013.

Likewise, opportunities and challenges exist on our path to Mars. America has been the unsurpassed leader on the Red Planet. American robotic craft are the only ones in history to successfully land on

Mars. Now, many nations are planning their own missions to Mars's orbit and surface in the coming years. Both the U.S. and China plan, in the next decade, to bring back samples that could indicate the first signs of life beyond our planet.

Opening a New Era: The Sea Beyond Calls

NASA's overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and, most importantly, the American public. It is not a return to the past or a repeat of efforts of the past 25 years, which sought to move beyond the near-Earth regions of space. It is not a geo-political competition to repeat the Apollo era. A lot has changed, and is changing.

The Exploration Campaign builds on the last 17 years of Americans and international partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies and begins operations in the next few years, when we will see the first American capsule and rocket system capable of establishing the first permanent American presence and infrastructure on and around the Moon. At the same time, with rapid advances in America's private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out in this report align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization (ISRU), long-term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA's relationships and collaborations with other U.S. government agencies will expand to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the nation's space goals. To supplement our own creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call. We seek to engage and inspire the next generation, in particular, the vast community of science, technology, engineering and mathematics (STEM) professionals who support major challenges needing these skills.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create preeminence beyond the littoral shores of space – out to, around, and on the Moon. NASA's civil pursuit and international leadership in scientific advancement, human exploration, technological development and civilization-level advancements provides the civilian leadership component of America's strategy to open and secure the seas beyond our planet's shores.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations that support NASA and the needs of an emerging private sector market.

2. Lead the emplacement of capabilities in lunar orbit that support surface operations and facilitate missions beyond cislunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, NASA will lead the Campaign as architect, mission leader and, in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. NASA's strategic implementation approach for the Exploration Campaign follows.

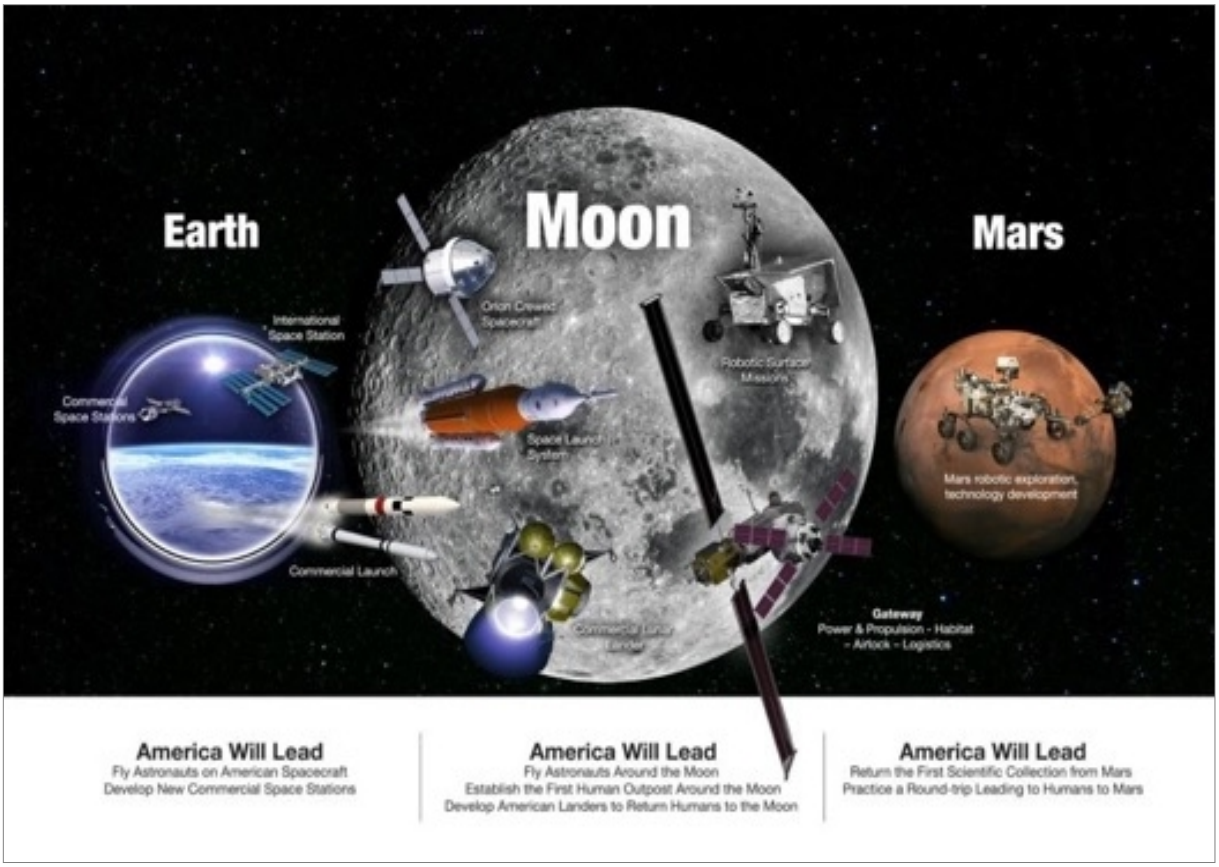


Figure 1: Platforms - From Earth, to the Moon, to Mars

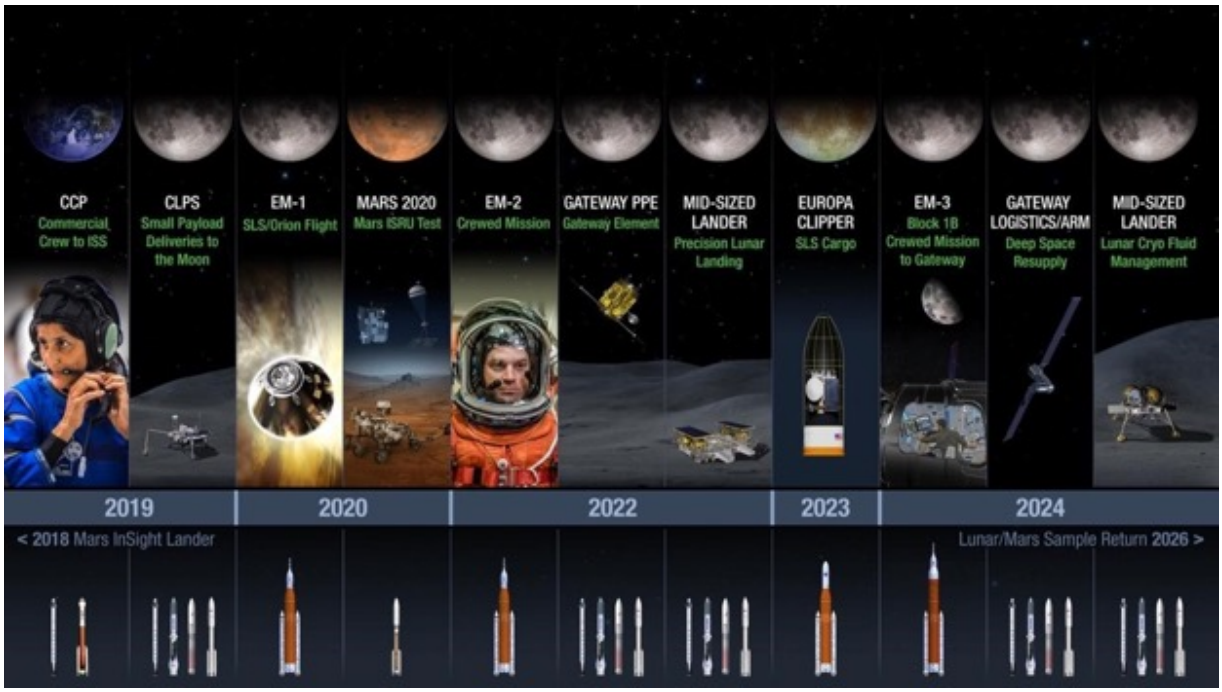


Figure 2: Moon to Mars Timeline

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's offshore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first walked on its surface roughly 50 years ago, our explorers left only fleeting footprints at a few sites, over a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different. NASA is building a plan for Americans to orbit the Moon, starting in 2023, and land astronauts on the surface by no later than the late 2020s. This will be the first chance for the majority of people alive today to witness a U.S. lunar encounter and landing – a moment when, in awe and wonder, the world holds its breath. But, America will not stop there. A core focus of this Campaign is to extend the nation's geo-strategic and economic sphere to encompass the Moon.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar and cosmic radiation for billions of years and left largely undisturbed, the Moon is a historic archive of our Sun and solar system. Scientific mysteries are locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Like the harnessing of fire, making the first solar cells or fuel from lunar regolith will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out) – Living and Working Around the Moon

The American Gateway under development will forge U.S. leadership and presence over the region between the Moon and Earth. It will serve as both a ship and a port. This platform will host astronauts farther from Earth than ever before. A radical advancement in space technology and human life support systems, the platform will offer astronauts longer stays on the lunar surface, easier crew returns, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, validating technologies and systems as we prepare for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the radiation and microgravity environment beyond LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by hosting biological and biomedical studies over longer periods than previously possible. It also will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub, evolving to serve as a way station for the development of refueling depots, servicing platforms, and a sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low-Earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship presently is under construction at NASA centers across the United States, including facilities in Ohio, Texas and Alabama. The first element will launch from Florida in 2022, and crews will be able to inhabit starting in 2023. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar electric propulsion technology, and provide critical functionality for the rest of the space vehicle. NASA will call upon its own workforce to build additional crucial pieces of hardware such as the power and propulsion element and habitation module; push industry to advance the state-of-the-art to deliver logistics modules; and utilize key contributions from international partners, including additional habitat modules and a robotic arm.

We also will study the effects of the deep space environment on the Moon Ship, and its ability to serve as a platform to assemble payloads and systems – robotically or with humans – that could be used for human and scientific exploration. The Ship will be constructed in place, incrementally, using the American-built Space Launch System (SLS), Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

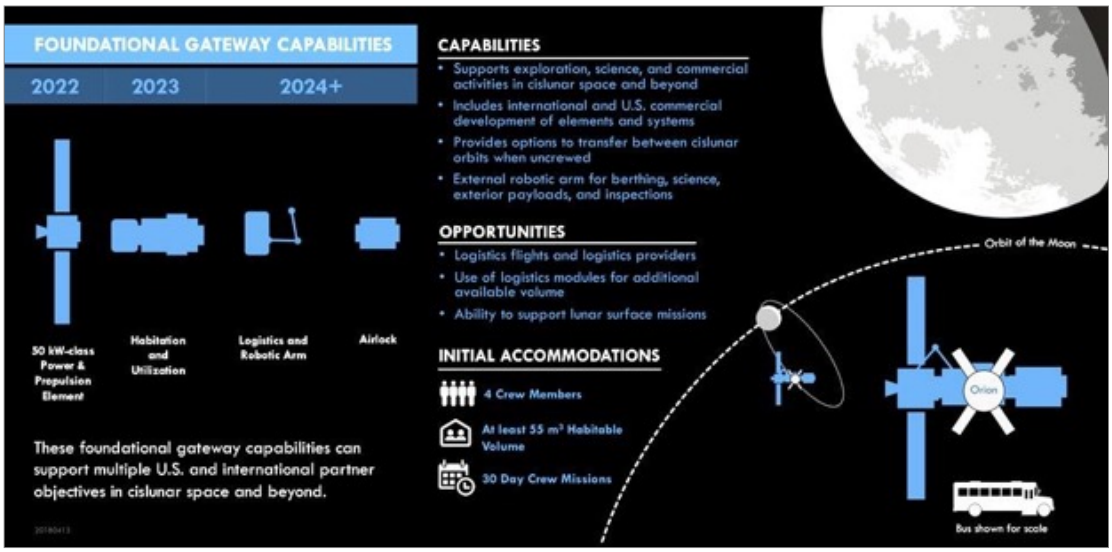


Figure 3: Foundational Gateway Capabilities

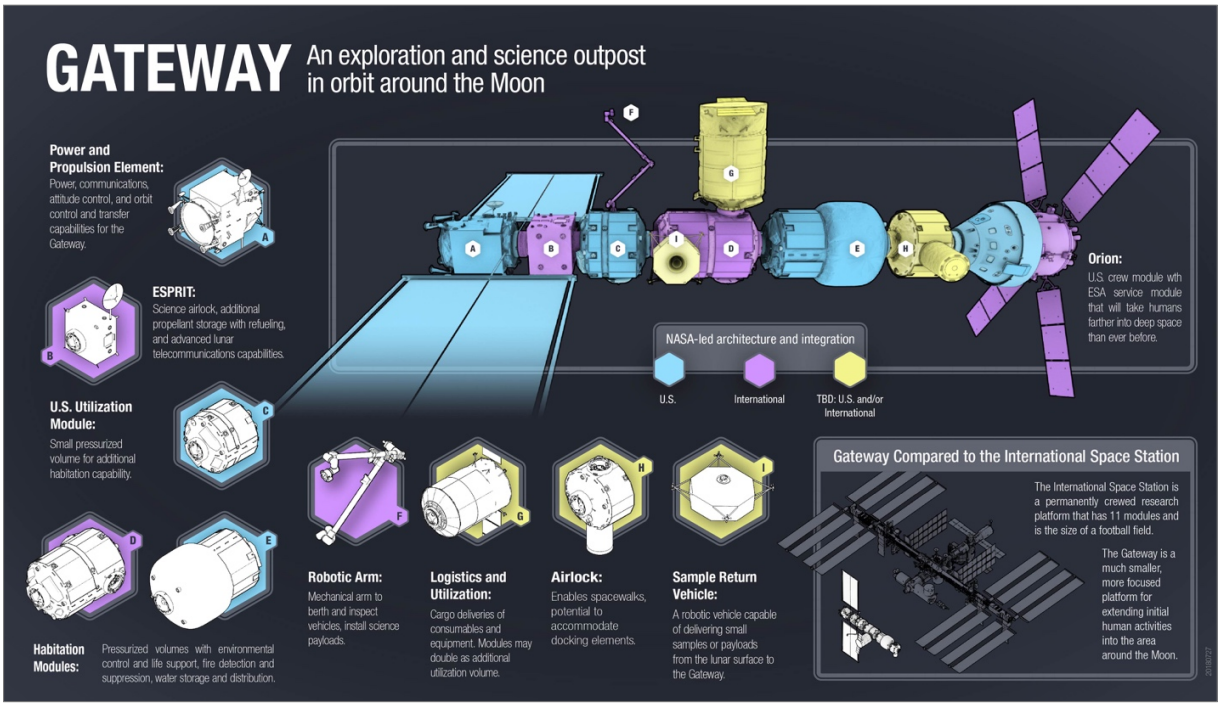


Figure 4: The Gateway

Humans and Robots: Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, training ground, and offshore continent where we will prepare for future human missions to Mars and other destinations. Through an innovative combination of missions involving commercial and international partners, robotic lunar surface missions will begin as early as 2019/20 and will focus on scientific exploration of lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in parallel with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts, in tandem with the Moon Ship, will expand and diversify over time, taking advantage of the Moon and cislunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far side of the Moon for astrophysics, focusing on space weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship combination offers unprecedented research infrastructure. Our current exploration missions, the Lunar Reconnaissance Orbiter and Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS), will be used immediately to support this increase in scientific discovery objectives.

Through the soon-to-be-released Commercial Lunar Payload Services (CLPS) procurement, NASA has started a program of robotic lunar missions overseen by its Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP) that will provide delivery of early, small payloads using emerging commercial landers – the defining values being speed and commercial partnership. In addition, NASA will focus on continued growth of emerging commercial capabilities to enhance further our human lunar lander capabilities and utilization of the Moon (including potential lunar communications networks). An assessment is underway to identify the best development path for an SMD-led rover capability and midsized lander. In every aspect, technology and commercial sector capabilities will feed forward and integrate with human exploration approaches.

While we have extensive orbital information about the lunar surface and potential resources, robotic lunar scouts are essential to validate past observations and prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data; multiple landers will provide a global-scale view of the Moon and its resources. Landers will be outfitted with sensor packages and provide critical risk-reduction activities for the human-scale lander descent stage and utilization capabilities, including development of critical technologies that will enable precise and soft landings on the lunar surface. Rovers will be used to explore the surface more extensively, carrying instruments such as ISRU experiments that will provide detailed information on the availability and extraction of usable resources, including oxygen and water.

An American human lander effort has been initiated within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T) to advance lower readiness-level technologies so they can be implemented in future lunar missions. Critical technology development underway infuses autonomous sensing, processing, guidance and navigation capabilities to enable safe, precise and controlled landings with real-time hazard detection and avoidance algorithms. In addition, long-term storage of cryogenic fluids is being developed to enable significantly greater performance capability of midsized and human-class landers at a substantially reduced mass. Also under development is a deep-space lander engine that uses a unique fuel mixture with a lower freezing point that will reduce the power required and lowers the system mass. NASA is reviewing longer-term, higher-power capabilities needed to survive lunar nights and operations in shaded portions of the lunar surface by considering surface fission power that will fuel ISRU demonstrations and other needs. NASA also is studying requirements for the next-generation spacesuits needed for lunar exploration. Planned landers

and rovers provide excellent platforms to demonstrate technologies that will enable greater lunar surface mission capabilities and have applications that extend beyond the Moon to Mars.

NASA is conducting a study to identify, and present for decision, the different trades from a midsized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is developing options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of ongoing national need, or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated and range from capability stimulation through funded Space Act Agreements to a single partner or contract approach, to an international partnership model or NASA-led, multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace; it takes about 10 years to develop a crewed system. The Apollo Lunar Module has been the only outlier. Produced in six years – but at a cost of $14.7 billion, in current dollars – the LM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

Human exploration of both the Moon's surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is building an exploration launch and crew system – the Orion spacecraft, heavy-lift SLS launch vehicle, and supporting ground systems – and will rely on commercial launch providers to support robotic lunar surface and orbit operations. The Orion spacecraft will carry up to four humans into deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days, with additional habitation volume and systems. New engines for Orion's Orbital Maneuvering System-E engine will need to be developed, with designs shaped by future service module development approaches and other possible applications and upgrades currently under assessment. The SLS Block 1 cargo variant will be capable of delivering 70 metric tons to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 metric tons to LEO, co-manifested with Orion, in the mid- to late-2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), currently scheduled to launch to lunar orbit in FY2020, followed by the first crewed SLS/Orion mission, EM-2, no later than 2023. These SLS/Orion missions will demonstrate the capability to reach, and operate safely and productively around, the Moon.

Decisions related to performance, fairing volume, payload delivery mass, and fairing capability evolution on SLS Block 1, 1B, and 2 also will need to be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing also will significantly shape the rest of the architecture. In addition, decisions to augment the SLS flight rate need to be laid out five years in advance of the added flights. Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability and cost of commercial launch options.

NASA's leadership with its current international partners involved with the ISS is shifting towards the Moon. We also are moving on new opportunities to create partnerships that add to the overall lunar orbit and surface parts of the Campaign. We intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation. In addition, China has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to a taikonaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans.

Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing, and ceding global leadership in cislunar space overall.

NASA currently is prohibited, by law, from establishing a bilateral partnership with China.

Overall, this Exploration Campaign is different from past attempts that were unsustainable or never matured. With an open architecture approach, the Campaign's lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of newly acquired knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early- to mid-2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that, as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)

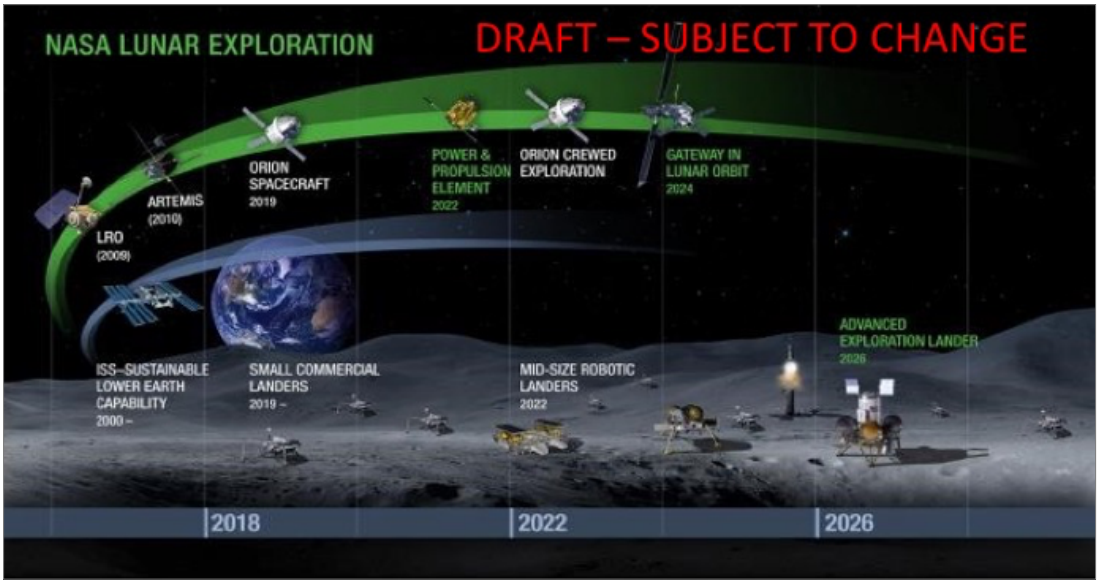


Figure 5: NASA Lunar Exploration to 2026

Initial Conops for discussion as part of overall lander assessment

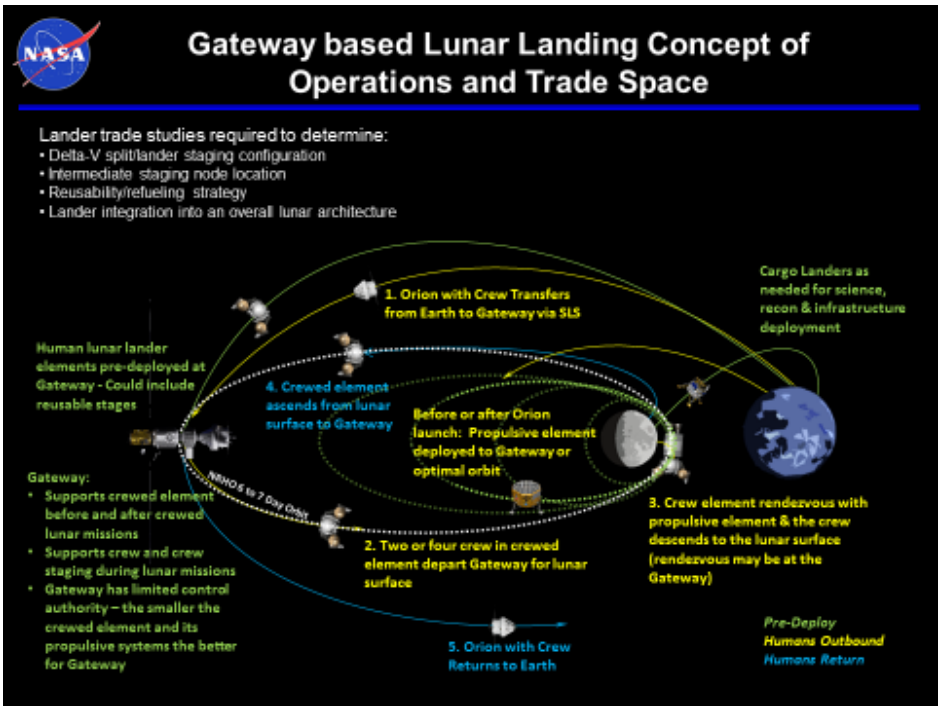


Figure 6: Lunar Landing Concept of Operations

With our resilient Campaign approach, NASA will allow, as warranted, its concept of operations for human lunar surface and orbit activities to mature. Specifically, reusability and the evolution of other architectures will remain in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander also is envisioned, as is the reuse of Orion systems. SLS currently is being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) With an open architecture, on-ramps for new and broadened commercial and international engagement, there will be other growth as the Campaign continues to innovate and adapt.

As we move beyond Earth's shores, America will be answering critical strategic questions, such as:

Can the Moon become a center for commercial enterprise? Are there significant deposits of water that can be used to support human settlement, or extracted for fuel on a human journey to deep space? In the long-term scale of human endeavors, understanding what is possible on the Moon and being the first to realize its potential could be transformational. When the explorers Meriwether Lewis and William Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities, and they did not know what they might find. Today, the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the Campaign engage broader industrial sectors in our nation? American companies will help lead this effort. Not only will they build the small landers, the U.S. government will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a company has experience drilling into the Earth's crust, several miles under the ocean, such research and development (R&D) created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign into American and global society as a whole? Just as the ISS spurred broader applications and innovations on Earth, America goes to the Moon to extend humanity's presence in the solar system and to improve the lives of people on Earth. The ultra-efficient use of scarce resources in orbit, the production of tools and systems from extant resources off the Earth, or the extraction of water from frozen lunar regolith are challenges that, once mastered, will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces, and in orbit, will push the technological frontier and support current trends in autopiloted vehicles – with exceptional quality control and robust engineering needed to design vehicles to operate in the most difficult environment known to humanity.

How will advanced propulsion play a role in opening the ocean of space for American voyagers well beyond today's limitations? For example, what role will nuclear propulsion for space transportation play? Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future systems.

Critical Decisions and Milestones:

Lunar Surface

2018

- Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019
- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020).
- Decision to develop human-class lunar lander capability for demonstration mission in 2024.
- Decision to develop and launch Discovery-class NASA lunar rover mission in 2022 – a 500 kilogram-class rover mission focused on resources and other scientific discoveries, including mobility and sample return capabilities.
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Based on early results of human-class lunar lander development and human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems and partnerships, or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on the cost of lunar surface access, viability of higher-power systems and ISRU, as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship, international partnerships, and Moon Port configuration. The Moon Ship also will provide broad science research and technology demonstration opportunities from cislunar space, in areas including lunar surface (e.g., lunar sample return, telerobotics, etc.), astrophysics, heliophysics and Earth science.

2020

- SLS/Orion first flight (EM-1), uncrewed, to the lunar vicinity.
- Initiate scientific payload development for Moon Ship by competitively assessing the most suitable and impactful scientific analysis.
- Science and industry missions flown on EM-1 using 13 co-manifested cube sats launched as secondary payloads.
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Based on status of launch vehicle development, decide on future Moon Port/Ship logistic resupply missions.

2022

- By June, conduct crewed flight, EM-2, sending Americans around the Moon.
- First element of Moon Port/Moon Ship – the power-propulsion (including communications) element (PPE) – placed in lunar orbit.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need for, and viability of, developing and placing propellant depots in lunar orbit. Assess and make appropriate decisions on Moon Ship/Port evolution requirements.

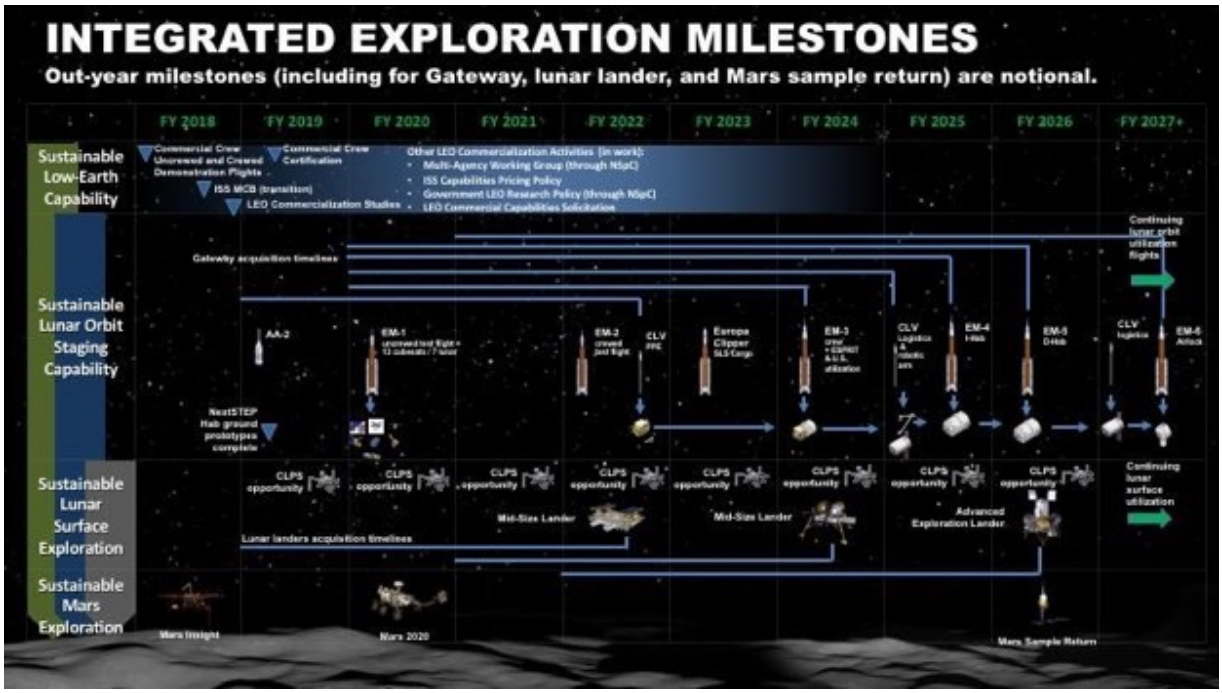


Figure 7: Integrated Exploration Milestones

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for humanity. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon, combined with continued U.S. access to commercial platform(s) in low-Earth orbit, will ensure we advance American leadership in opening up the heavens to further human and scientific development well into the future.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests on the advanced technologies necessary for long voyages and stays away from Earth. Long-duration, exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA also is using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration missions. For example, elements of ISS life support and other habitation systems will be evolved into the systems for deep space missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently-crewed testbed prior to deploying these capabilities beyond LEO.

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling the research and development of advanced robotics, communications, medicine, agriculture, and environmental science. The station's unique infrastructure has provided and unequalled platform for several Earth and space science instruments that conduct high-priority investigations with strong appeal throughout the global science community

Ongoing operations and research on the ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities to answer many forward-looking questions. How can we to allow a movie director one day to produce entertainment on the space station, or enable a tourist astronaut to dock to the facility and stay the night? Can biotechnology, materials or manufacturing

companies install equipment to produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In pursuit of a timely development and transition of commercial capabilities in LEO, where NASA envisions being one of many customers in the mid-2020s, the Administration is requesting $150 million in FY2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities that will ensure commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services and, more importantly, strengthen overall demand and interest in utilizing a commercial platform(s) in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low-Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it will open significant new opportunities for commercial space flight. U.S. companies will begin to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless – from tourism to training for deep space missions. It could also enable highly trained, discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers, specifically, nations with human spaceflight capability. Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station as soon as 2019. Upon completion, it will represent the extension of China's military operations to a human habitation platform in low-Earth orbit. For purposes of diplomacy and commerce, it also may offer a strategic alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of companies such as SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include*:*

- Expand partnerships in LEO to include new companies and nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including those that continue scientific exploration in low-Earth orbit.
- Pursue other efforts to enable the shift away from direct government-funded support of the ISS. For a full assessment on the transition of LEO, please refer to the recently published NASA ISS Transition Report at https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13 selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY2019 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development.
- Work with the U.S. Departments of Commerce and State to spur greater use of ISS and overall interest in LEO development. Identify and eliminate regulatory barriers to enable increased commercial activity. Identify and implement incentives for LEO efforts. Examine funding models, such as the Aviation Trust Fund, that may aid the development of ongoing non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether to extend ISS operations to 2026.

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate NASA and overall governmental support to ensure ongoing NASA requirements and permanent U.S. presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe far into humanity's future. As part of the Exploration Campaign, in response to SPD-1, this voyage will be able to take place in the 2030s. Key components of this part of the Campaign already are underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit, and continuing to lead and advance the world in science missions beyond LEO – including a civilization first roundtrip voyage to Mars. The U.S. will embark on this first roundtrip to another planet, Mars, in 2026. This mission will bring back samples that focus on answering the ageless question of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes the development of technologies and systems that enable a series of human and robotic lunar missions and are extensible to destinations beyond the Moon, including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. NASA's InSight mission is on its way to Mars now and will land in November to study the interior of Mars. The Mars 2020 rover is continuing to make excellent progress and is scheduled to launch in July 2020. Planning to return samples from the Martian surface is well underway. Research on Mars is paving the way for human exploration and utilization of the Red Planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

For example, Mars robotic missions have: enabled the United States to master the incredibly complex task of entry, descent and landing of one-metric-ton payloads (similar to the size of a compact car); gathered data about radiation in transit and on the surface of Mars; investigated the Martian atmosphere and weather; and shown the existence of significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric carbon dioxide while selecting and encapsulating samples for potential return to Earth. Future robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built on the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other and, collectively, build the world's knowledge base for Mars exploration. These missions have revealed that Mars has a diverse mineralogy indicative of a water-related environment; could have supported life in its past; experienced a massive loss of its atmosphere over time; has thick deposits of ice beneath its surface; holds methane and other organics; and is a dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include: Maintain and grow U.S. leadership at Mars with a rover in 2020 – as the first step of a sample-return strategy – to search for past life and demonstrate the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent roundtrip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship, and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crewed Mars missions starting in the 2030s and culminating in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the universe, and this may bode well for a future discovery of life on the planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest-priority flagship missions and is relevant to the human exploration initiative, as well. Such a mission would be the first interplanetary roundtrip mission, demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture;
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning; and
- Two high-visibility technology demonstrations, as part of Mars 2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable oxygen from Mars' thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships and assert continuing U.S. leadership by filling a void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the ESA (European Space Agency), among others. NASA and ESA recently signed a letter of intent to develop a joint MSR plan and complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked private industry for input, with regard to commercial solutions, and this dialogue is ongoing. Given the expected increase in data rates (for downlink) required by science and, in the future, human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Critical Decisions and Milestones

<u>2019</u>

- Decision on Mars robotic roundtrip mission (Mars Sample Return) implementation and architecture and target launch date (2026 or 2029).
- Decision on Mars-forward technology investment R&D portfolio in ER&T.

- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (ongoing).
- Develop standards for human long-duration deep space transportation vehicles (ongoing).

2021

- Based on results of Mars 2020, the Mars Oxygen ISRU Experiment (MOXIE) payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T.

2024

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic roundtrip mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms and Organizing to Win
OR
How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

To achieve extraordinary success, NASA must consider extraordinary changes, from streamlining our organization and management to becoming even more efficient and effective. The Exploration Campaign does not assume or require Apollo levels of funding but, instead, seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage partnerships for up to 30 percent in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission, and we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

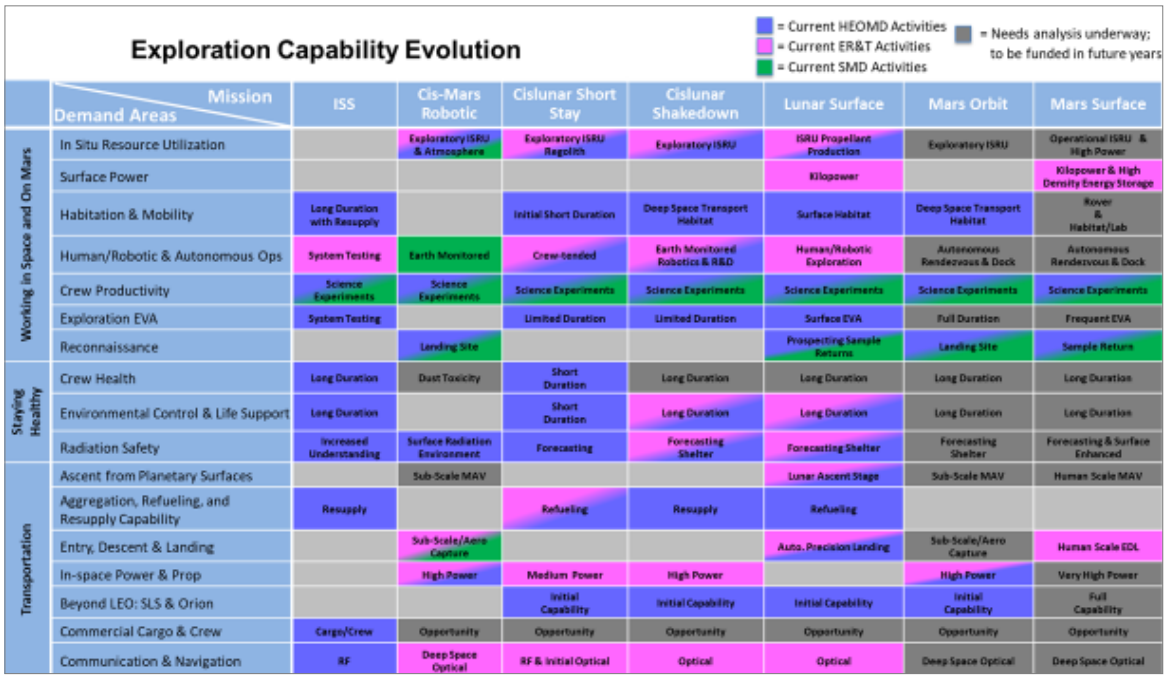
Lastly, NASA recognizes the need for lunar exploration integration between its Science, Human Exploration and Operations, and Space Technology Mission Directorates, and is looking at different ways to align and focus the Campaign elements. The Agency already has initiated a federated core team for the lunar portion of the Exploration Campaign that is orchestrated by the Agency Administrator with day to day support by his direct, front-office staff. r. NASA is looking at formalizing this approach through the establishment of a senior leadership coordination group reporting to the Administrator, and Associate Administrator. In support of this effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA also is examining how to most effectively organize to lead in this key Exploration Campaign initiative.

–Cross-Cutting Technologies: Focused On and in Support of the Campaign

Exploration Research & Technology (ER&T) is undergoing significant organizational change to support the Exploration Campaign. The Agency is working to mature exploration technologies and systems in preparation for cislunar Moon Ship and deep space missions. ER&T is developing advanced power and propulsion technology – including 13-kilowatt solar electric propulsion Hall thrusters, power processing units, and associated hardware – to support Moon Ship power and propulsion needs and, potentially, extend to meet the needs of deep space architectures. ER&T also is advancing promising transformative technologies across other technology focus areas, including: next-generation environmental control and life support systems; ISRU; cryogenic fluid management and long-term storage; fission power systems (perhaps leading to nuclear propulsion systems for Mars); advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; entry, descent and landing; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High readiness-level technologies will be applied to near-term missions, while the Agency invests in low readiness-level technologies to address challenges of future exploration missions. Wherever possible, these technologies also are being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities, as well as Agency architecture strategies.



Exploration Capability Evolution

= Current HEOMD Activities
= Current ER&T Activities
= Current SMD Activities
= Needs analysis underway; to be funded in future years

	Mission / Demand Areas	ISS	Cis-Mars Robotic	Cislunar Short Stay	Cislunar Shakedown	Lunar Surface	Mars Orbit	Mars Surface
Working in Space and On Mars	In Situ Resource Utilization		Exploratory ISRU & Atmosphere	Exploratory ISRU Regolith	Exploratory ISRU	ISRU Propellant Production	Exploratory ISRU	Operational ISRU & High Power
	Surface Power					Kilopower		Kilopower & High Density Energy Storage
	Habitation & Mobility	Long Duration with Resupply		Initial Short Duration	Deep Space Transport Habitat	Surface Habitat	Deep Space Transport Habitat	Rover & Habitat/Lab
	Human/Robotic & Autonomous Ops	System Testing	Earth Monitored	Crew-tended	Earth Monitored Robotics & R&D	Human/Robotic Exploration	Autonomous Rendezvous & Dock	Autonomous Rendezvous & Dock
	Crew Productivity	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments
	Exploration EVA	System Testing		Limited Duration	Limited Duration	Surface EVA	Full Duration	Frequent EVA
	Reconnaissance		Landing Site			Prospecting Sample Returns	Landing Site	Sample Return
Staying Healthy	Crew Health	Long Duration	Dust Toxicity	Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Environmental Control & Life Support	Long Duration		Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Radiation Safety	Increased Understanding	Surface Radiation Environment	Forecasting	Forecasting Shelter	Forecasting Shelter	Forecasting Shelter	Forecasting & Surface Enhanced
Transportation	Ascent from Planetary Surfaces		Sub-Scale MAV			Lunar Ascent Stage	Sub-Scale MAV	Human Scale MAV
	Aggregation, Refueling, and Resupply Capability	Resupply		Refueling	Resupply	Refueling		
	Entry, Descent & Landing		Sub-Scale/Aero Capture			Auto. Precision Landing	Sub-Scale/Aero Capture	Human Scale EDL
	In-space Power & Prop		High Power	Medium Power	High Power		High Power	Very High Power
	Beyond LEO: SLS & Orion			Initial Capability	Initial Capability	Initial Capability	Initial Capability	Full Capability
	Commercial Cargo & Crew	Cargo/Crew	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity
	Communication & Navigation	RF	Deep Space Optical	RF & Initial Optical	Optical	Optical	Deep Space Optical	Deep Space Optical

Figure 8: Exploration Capability Evolution

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Framing the Week Ahead - Office of Communications - June 22

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Framing the Week Ahead

FOR INTERNAL USE ONLY

This week we look forward to the next commercial resupply mission to the International Space Station with the launch of SpaceX Dragon CRS-15 on Friday. We're also planning to host an update on the James Webb Space Telescope. Throughout the week, students from across the U.S. will participate in three live events with astronauts aboard the International Space Station. The events serve as question-and-answer sessions and are hosted as part of NASA's Year of Education on Station.

Administrator's Activities

On June 25, Jim speaks on a panel at the White House State-Federal STEM Summit about the Importance of STEM and the role of our agency in promoting it. He also speaks at the HQ Fitness Center Awards that day. On June 27, he talks about the Future of Exploration at the White House Youth Summit. He'll also be interviewed by Politico during the public event: "The New Space Age: A Conversation with NASA Administrator Jim Bridenstine" from 7-8 p.m. EDT.

Media Teleconference on James Webb Space Telescope

On June 27, NASA is planning to host a media teleconference at 1 p.m. EDT, to provide an update on the agency's James Webb Space Telescope – what will be the world's premier space observatory and the biggest astronomical space science telescope ever built. The most technically demanding and powerful space observatory ever developed, Webb will solve mysteries of our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Audio of the call will stream live on NASA's website along with associated report and other materials.

Launch of SpaceX Dragon CRS-15 Mission to ISS

On June 29, NASA commercial cargo provider SpaceX is targeting launch of its 15th resupply mission to the space station for no earlier than 5:42 a.m. EDT. Packed with more than 5,900 pounds of research, crew supplies and hardware, the SpaceX Dragon spacecraft will launch on a Falcon 9 rocket from the Cape Canaveral Air Force Station in Florida for a 3-day trip to the station. Live coverage begins on NASA Television and the agency's website <https://www.nasa.gov/nasalive> Thursday, June 28, with prelaunch events, including a What's On Board Science Briefing at 11 a.m. EDT followed by a Prelaunch News Conference at 12:45 p.m. EDT. Launch day coverage begins at 5:15 a.m. A Postlaunch news conference is scheduled for8 a.m.

International Space Station Activities

Students in New York, Washington, DC, and California talk to astronauts on orbit during three downlink events. Coverage airs live on NASA Television and the agency's website.

On June 25, at 11:15 a.m. EDT, students at the Spruce Street School in New York will speak with NASA's Ricky Arnold who is onboard the space station.

On June 27 at 11:05 a.m. EDT, NASA’s Serena M. Auñón-Chancellor talks with students at the Smithsonian’s National Air and Space Museum in Washington. Attendees will include 300-400 middle school students from the greater D.C. metro area. Future Engineers, an online K-12 educational platform, is partnering with the Smithsonian and including its national design challenge winners.

On June 28 at 1:40 p.m. EDT, NASA’s Auñón-Chancellor speaks with students at Armstrong Flight Research Center in California during the center’s first-ever ISS downlink event. The event is part of Armstrong’s Bring Your Child to Work Day. Several local scout groups and summer camps will make up an audience of about 200 students.

METRICS

• The June 18 Space Council meeting and signing of Space Policy Directive-3 was the busiest day in the news this week. There were about 300 media hits (in Agility) mentioning Space Council+NASA, with stories noting comments by former astronauts serving on the council, pickups of the NASA press release with the Administrator's statement and preview content carried by newswires and NPR affiliates mentioning plans to tackle issues of orbital debris. Our best-performing Tweet for this event featured a video clip of Administrator Bridenstine talking about returning to the Moon, while our best-performing Facebook post <https://www.facebook.com/NASA/photos/a.67899501771.69169.54971236771/10156344498856772/?type=3> reached 457K people and asked them to tune in to watch the event.

• There were over 1,300 media hits from June 18-19 for the "space force" proposal, including coverage in major outlets: Washington Post, Yahoo news, NPR, Fox News, CNET, Forbes, the New York Times, Axios, Bloomberg, The Week, Atlanta Journal-Constitution, Philadelphia Inquirer, Popular Science, CNBC, the Verge, VOX. The majority of these stories (about 1,100) did not mention NASA. Google Trends found over 500K Google searches for June 18 for "space force,” making it #4 on the list of breakout top search topics for the entire day of June 18 in the United States. Search queries most used by the public for this topic associate it with branches of the military and terms like "enlistment" or "recruitment," or with pop culture references.

• The NASA and FEMA teleconference focusing on the near-Earth object preparedness plan release drew around 150 media hits this week, the majority of which (65%) were radio news bulletins from stations around the country. There was a steady audience though not a large one for the teleconference itself, peaking at 257 simultaneous listeners and a total of 882 unique listeners tuning in. The web feature had about 9.5K pageviews.

• An unexpected traffic spike on NASA.gov came at the end of the week, thanks to a question from the public (on Reddit) - a Space Station Research web page outlining the Aquatic Habitat experiment on the station received over 65K pageviews in a day, when a user on the /askScience message board posted the question, "How would having a fish in the ISS work? <https://www.reddit.com/r/askscience/comments/8syf6g/how_would_having_a_fish_in_the_iss_work/>" and others responded with a link to the NASA.gov page <https://www.nasa.gov/mission_pages/station/research/experiments/221.html>.

• For the past week, Mars was once again the most popular content on NASA.gov as well as in social media conversations related to NASA, with the "perfect storm" web feature <https://www.nasa.gov/feature/jpl/nasa-encounters-the-perfect-storm-for-science> on Opportunity ranking as the most-viewed, followed by an image from the Mars Reconnaissance Orbiter <https://www.nasa.gov/image-feature/jpl/bang-and-whoosh/>, and the organic materials news release from Curiosity, which continues to draw traffic and now has over 520K pageviews total for the year. @NASA’s most popular tweet <https://twitter.com/NASA/status/1009590475840466944> was a different Mars Reconnaissance Orbiter image of a “blue dune” on Mars, which was posted as NASA's Image of the Day on June 20 and shared to our flagship social media accounts. It was retweeted 3,691 times and achieved a reach of 61.8 million. Elon Musk retweeted <https://twitter.com/elonmusk/status/1009605123117670400> this post, and this retweet became the second most retweeted NASA-related tweet this week.

• NASA was one of the first brands to roll out vertical video on Instagram - IGTV - when the company announced the product update earlier this week. We have two longer form videos on our channel: one showing Earth views from the Space Station and the "What's Up for June" video. In less than 24 hours, the What's Up video has garnered 680k views and the Earth views video has 218k views. We were as high as the #17 most popular video on launch day, and eventually moved up to #10.

• On Facebook, the top post this week <https://www.facebook.com/NASA/posts/10156345125156772> highlighted the anniversary of Sally Ride's historic flight on STS-7, using the text and images from a web feature posted by Johnson Space Center. This post reached nearly 1.1 million people and drew over 14.5K engagements (shares, comments, and reactions). An aurora image from the SOFIA mission was our top NASA Instagram post <https://www.instagram.com/p/BkLl_PCA4nP/> of the week.

• NASA's popular Spot the Station <https://spotthestation.nasa.gov/> website continues to grow in traffic. The site’s unique visitor count increased 40% from last month and 33% from last year. The United States still leads in the number of visits to the site (800,046), followed by the United Kingdom (103,315) and Brazil (72,160). The top 3 domestic sighting opportunity pages are Seattle, WA, Indianapolis, Ind. and Phoenix, Ariz. Spot The Station ranks the 3rd most popular website in the NASA.gov domain for the month of May; the same place as the last two months.

FULL SCHEDULE OF ACTIVITIES AND PRODUCTS

Saturday, June 23

Activities

• Arroyo Seco Weekend festival, Pasadena, California

• Trenton Summer Festival, Trenton, Michigan

Products

• JPL Exhibit, Social Media Activity: Arroyo Seco Weekend festival

Sunday, June 24

Activities

• NASA Innovative Advanced Concepts at the Philadelphia Maker Faire

• Arroyo Seco Weekend festival, Pasadena, California

• Trenton Summer Festival, Trenton, Michigan

Products

• JPL Exhibit, Social Media Activity: Arroyo Seco Weekend festival

Annual Events

• Birthday: Late Astronaut Ellison Onizuka (STS-51C, 51L) birthday

Monday, June 25

Activities

• Bridenstine speaks at the White House State-Federal STEM Summit

• Bridenstine speaks at the HQ Fitness Center Awards

• ISS: Year of Education on Station (YES) Downlink with Spruce Street School in New York City

• ISS: Downlink Message for Orlando STEM Conference

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

• JSC: Suni Williams and Bob Behnken with Space City Films

Products

• Aero: AFRC Media Release, NASA HQ Social Media Activity: Landing Gear Noise Research Reduction

• Earth: LARC Web Article: Long Island Sound Ozone Study

• Earth, ISS: JPL Web Article, NASA HQ Social Media Activity: ECOSTRESS Observes Plants' Day-Night Cycle

• ISS: JSC Blog Post, Image/Video, Social Media Activity: YES Downlink with Spruce Street School in New York City

• ISS: NASA HQ Web Article: NASA Selects 15 Research Opportunities in Space Biology

• Mars: KSC Image/Video: Aeroshell arrival for Orion Ascent Abort-2 pathfinding operation

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: JPL Web Article, NASA HQ Social Media Activity: Exoplanet atmospheres web feature

• Solar System and Beyond: JPL Web Article: New summer dates for Mars Insight Roadshow

• Solar System and Beyond: NASA HQ Media Release, Web Article: Scientists Developing Strategies to Search for Life on Exoplanets

• Solar System and Beyond: GSFC Image/Video, Web Article: NASA's James Webb Space Telescope Targets Jupiter's Great Red Spot

• Space Tech: LARC Media Advisory: Testing of Commercial Infrastructure for Robotic Assembly and Services

Annual Events

• Anniversary: Progress-Mir Collision (1997)

Tuesday, June 26

Activities

• The White House State-Federal STEM Summit

• National Park Service Online Media Briefing for Space Pup, 11 a.m. – noon EDT

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: ARC Web Article: SpaceX CRS-15 Science: Electric Possibilities for Bacteria in Space

• LARC Blog Post: LGBT Pride Month: "Sex, Gender and Reaching New Heights with the Science of Nonconformance"

• Mars: KSC Other, NASA HQ Social Media Activity: Rocket Ranch Podcast Episode 1

• Mars, Space Tech: JSC Image/Video, Web Article, Social Media Activity: Next Step Habitat Media Op

• Solar System and Beyond: NASA HQ Media Advisory: Media advisory for Webb media teleconference

• Solar System and Beyond: GSFC Web Article: Hubble Messier Catalog Update (3 new images)

• Solar System and Beyond: NET JPL Web Article: What Else Looks Like Ceres?

Annual Events

• Anniversary: 40th Anniversary: SeaSat A launch (1978)

Wednesday, June 27

Activities

• Bridenstine speaks at the White House Youth Summit

• Event with Jim Bridenstine: A Conversation with Politico at The Willard Hotel, 7 – 8 p.m. EDT

• Webb media teleconference

• ISS: NASA Future Engineers In-Space Manufacturing Event/Downlink at NASM

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

• Interview: Dr. Grace Douglas, JSC Food Lab, with New York Academy of Sciences Magazine

• Interview: Tracy Caldwell Dyson with Psychology Today (JSC)

Products

• Aero: NASA HQ Web Article: Sonic Booms and How They're Created

• Earth: LARC Image/Video: TEMPO Thermal Vacuum Testing

• Earth, ISS: JPL Web Article: Four Things ECOSTRESS Can See from Space

• GRC (Local) Media Release: NASA, astronaut to appear at Medina Bicentennial Celebration

• ISS: KSC Web Article: Students Select Crops for ISS

• ISS, Mars: NASA HQ Blog Post, Image/Video, Social Media Activity: NASA Future Engineers In-Space Manufacturing Event/Downlink at National Air and Space Museum

• Mars: NASA HQ Image/Video, Web Article: NET: NASA Provides Update on Gateway Configuration, Partnerships

• Mars: JSC Image/Video, Social Media Activity, Web Article: Next Step Hab Gateway-oriented imagery

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: NASA HQ Image/Video; Media Release; Social Media Activity: Webb media teleconference

• Solar System and Beyond: NASA HQ Image/Video, Media Release: NASA Report to Congress: Webb LRD / IRB Assessment

• Solar System and Beyond: NASA HQ Image/Video, Media Release, Social Media Activity: Interstellar Visitor Gets An Unexpected Boost In Speed -Oumuamua

Annual Events

• 5th Anniversary: IRIS Solar Observatory Launch (2013)

Thursday, June 28

Activities

• SpaceX CRS-15 Prelaunch News Conference, 12:45 a.m. EDT

• SpaceX CRS-15 What's On Board Briefing, 11 a.m. EDT

• ISS Downlink: Serena Auñón-Chancellor with AFRC

• Media Event: Commercial Infrastructure for Robotic Assembly and Services Testing, LARC

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: AFRC Blog Post, Image/Video, Media Release: NASA Armstrong ISS Downlink

• ISS: JSC Blog Post, Image/Video, Social Media Activity: Serena Auñón-Chancellor with AFRC

• LARC Social Media Activity, Web Article: NASA Langley Teams with Local Small Businesses to Advance Technology

• Solar System and Beyond: JPL Image/Video: JunoCam image of the week

• Solar System and Beyond: JPL Web Article: (NET) "We Fly Kepler" timeline & profiles

• Solar System and Beyond: GSFC Image/Video, Web Article: Parker Solar Probe Gets Its HeatShield

• Space Tech: GSFC Web Article: Interns Create Viz of Space Comm Resources

Annual Events

• Hubble discovers 4th moon of Pluto (2011)

Friday, June 29

Activities

• ISS: SpaceX Dragon CRS-15 Launch from Cape Canaveral, Fla., 5:42 a.m. EDT

• SpaceX CRS-15 Post Launch News Conference, 8 a.m. EDT

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: KSC Blog Post, Image/Video, Media Release, Social Media Activity: SpaceX/Dragon CRS-15 Launch from Cape Canaveral, Fla.

• ISS: JSC Image/Video, Media Release: Astronaut Dan Burbank retirement release

ISS: JSC Blog Post, Image/Video, Social Media Activity, Media advisory on YES event w/Eisenhower Museum

• ISS, Aeronautics: Image/Video, Podcast: Houston We Have a Podcast “Airspace”

• Mars: MSFC Web Article: Web Feature: Space Launch System Forward Skirt Complete

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: GSFC Image/Video: Hubble Friday image and caption

• Solar System and Beyond: JPL Web Article: (NET) Exoplanet atmospheres feature

• Solar System and Beyond: JPL Web Article: (NET) Stellar Quakes feature

Annual Events

• Launch of 1st nuclear powered satellite (Transit 4A) (1961)

Saturday, June 30

Activities

• 2018 Hampton Roads Pride Fest

Products

• LARC Exhibit, Image/Video, Social Media Activity: 2018 Hampton Roads Pride Fest

• Solar System and Beyond: NASA HQ Image/Video: World Asteroid Day

FYI: Space Force OpEd WaPo

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Sent:	August 24, 2018 9:04:28 AM EDT
Received:	August 24, 2018 9:04:29 AM EDT

I was an astronaut. We need a Space Force.

Terry Virts, a retired U.S. Air Force colonel, is a former astronaut who served as commander of the International Space Station. He is a special adviser to Govini, a data and analytics firm based in Arlington.

Space has been a hotly contested domain for decades. I can personally attest to this: While I wascommander of the International Space Station in 2015, we had to maneuver our spaceship to avoid debris left over from a 2007 Chinese anti-satellite missile demonstration.

The threat, however, is only going to get worse. The United States must proactively ensure its ability to operate and defend itself in space — which is why Congress needs to act to finalize the U.S. Space Force as a sixth independent branch of our armed forces.

It’s hard to overstate the importance of space in our military operations and civilian life. Though the United States is the world’s leader in space, China and Russia have made it clear they are not willing to accept the status quo. They already have access to weapons that threaten our assets in space, either by destroying them in orbit or by crippling ground control through cyberattacks or radio jamming.

Since the Trump administration’s recent announcement of plans to create a Space Force, there has been a fair amount of criticism stemming from a lack of understanding about what such a force would be. It wouldn’t, of course, be a collection of “Star Wars” troops fighting battles in outer space. We cannot even call it a militarization of space — which already occurred in the 1950s when the Soviet army launched Sputnik and the U.S. Navy launched Vanguard.

But the Space Force could address serious shortcomings in how effectively our military is organized. As the administration laid out this month <https://www.washingtonpost.com/business/economy/pence-details-plan-for-creation-of-space-force-in-what-would-be-the-sixth-branch-of-the-military/2018/08/09/0b40b8d0-9bdc-11e8-8d5e-c6c594024954_story.html?utm_term=.d2d31bb704db>, the first steps toward creating a Space Force would include creating a subunified Space Command, a Space Operations Force that would initially recruit from the ranks of current military members and a Space Development Agency tasked with procuring space hardware.

Though these steps can be taken without major congressional legislation, the final and most important step in creating the Space Force would require legislators to rewrite Title 10 <https://www.defensenews.com/space/2018/06/20/space-force-will-require-legislation-and-a-lot-of-detail-planning-says-mattis/> of the U.S. Code, which outlines the role of armed forces. The last major rewrite was undertaken when the Air Force was created after World War II.

Why should Congress make the Space Force a reality? Because space is important and unique enough to deserve its own place at the Defense Department table to ensure rightful allocation of budget resources and power.

Our military uses a principle known as “multidomain warfare,” meaning that when tasked with combat, different services all work jointly across the five domains — air, sea, land, space and cyber. However, in peacetime, the Army, Navy, Air Force, Marine Corps and Coast Guard only “organize, train and equip” by their specific domain.

Space as a domain is now mature enough to stand alone. Today, there are officers who “grew up” in Air Force Space Command, beginning as second lieutenants and making their way through the ranks to four-star general. It simply defies logic to keep that domain in the Air Force — akin to having the infantry in the Navy. Air and space are completely unrelated domains, and the equipment, techniques and culture required to operate airplanes are entirely different from those required to launch and operate in space.

Though creating a Space Force makes sense from a theoretical point of view, there are legitimate practical concerns. The president wants a Space Force by 2020, a very ambitious timeline. However, the tight deadline serves to light a fire under the sprawling Pentagon bureaucracy, helping to prevent this initiative from floundering over a longer period. There would also be significant initial costs to standing up a new Space Force. In the long run, however, it would become more efficient as duplication across services was reduced.

The devil is in the details. What exactly would the Space Force entail? I recommend that such a branch consolidate missions that launch and control satellites in orbit; that develop and procure space-related equipment; and that maintain our land-based nuclear missiles as well as our land-based missile-defense system (for example, to protect us from North Korean missiles). I would also consolidate cyberforces into the Space Force. Though cyber is also its own domain, it is not yet mature enough to warrant a separate Cyber Force. This would also be a sound decision from both an organizational efficiency and a cultural point of view.

The 21st century will present continuous challenges to the United States, and we must realize that there is no “manifest destiny” that guarantees our status as world leader. Now is the time to show leadership and vision by properly realigning our military with the reality that space is an essential and unique domain of modern warfare.

https://www.washingtonpost.com/opinions/i-was-an-astronaut-we-need-a-space-force/2018/08/23/637667e6-a6fb-11e8-b76b-d513a40042f6_story.html?utm_term=.8df7bc9d5e4c

Best,
Megan

Megan Powers
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Gateway rebrand

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Did you see the full page on B2 in the Post today? It starts to merge Space Force and a Space Ship. While I have concerns(deeply) of too overtly overlapping them, there is a real opportunity to rebrand Gateway in September- in a powerful, meaningful way. Look forward to continuing to work it.

Tom

National Space Council
User's Advisory Group

June 19, 2018
NASA Headquarters
Washington, DC

MEETING MINUTES

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

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Mr. Brandon Eden, Executive Secretary

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Meeting Report prepared by
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Tuesday, June 19, 2018

Call to Order, Announcements

Mr. Brandon Eden, Executive Secretary of the National Space Council (NSpC) Users' Advisory Group (UAG), introduced himself and welcomed the meeting participants. NASA sponsors UAG, which exists to ensure that industry and other stakeholders are adequately represented in the Space Council. This was an open Federal Advisory Committee Act (FACA) meeting, formal minutes were being taken for the public record, and all discussions were on the record. Each UAG member had been appointed by the NASA Administrator, Mr. James Bridenstine, as either representatives of specific entities, or as Special Government Employees (SGEs). All SGEs were required to recuse themselves whenever they might have a conflict of interest.

Opening Remarks by Chair, UAG

Admiral James Ellis welcomed the UAG members, other participants, and listeners. This was the inaugural session of UAG, and the purpose of the day's meeting was to address organization and structure. The UAG was enabled by legislation enacted decades ago, but it had only now been formed after 25 years of dormancy. UAG is to function as a think tank for the NSpC, in addition to advising the Council. UAG has many opportunities and few constraints. It will be a conduit for new ideas and will work to identify obstacles that can be quickly removed. This is both a challenge and an opportunity.

The organization is for all users of space, and so there will be continued outreach to those who were not present. UAG members are free to shape the Group as they deem appropriate. They can innovate to facilitate the goals of the NSpC, and they can expect NSpC tasking. In turn, NSpC expects UAG to take the initiative. Therefore, it is important to understand the NSpC priorities. While NASA is overseeing implementation, facilitation, and other aspects of the NSpC mission, additional organizations are involved. UAG should collect inputs from all space stakeholders. The Department of Defense (DOD), industry, and the science community are also users to which UAG must reach out. Through individual members and/or subcommittees, UAG will co-locate with existing venues, like the National Space Symposium, the Universities Space Research Association (USRA), and others. UAG will meet with NSpC annually, but otherwise will be able to hold its meetings independently.

Adm. Ellis invited the UAG members to review the charter, objectives, and scope, which are broad. UAG duties include: ensuring the interests of industry and other non-federal entities involved in aeronautical and space activities are represented on NSpC; providing subject matter expertise to the Council; submitting reports; conducting studies, reviews, etc., requested by NSpC; and reporting to the Council.

Adm. Ellis then presented a proposal for UAG subcommittees, with distinguished advisors as chairs:

- Exploration and Discovery – Gen. Lester Lyles, Chair
- National Security Space – Adm. Ellis
- Economic Development and Industrial Base – Dr. Mary Lynne Dittmar and Mr. Eric Stallmer
- Technology and Innovation – Ms. Pamela Melroy
- Outreach and Education – Ms. Eileen Collins
- Space Policy and International Engagement – Dr. David Wolf

The Executive Committee will comprise the subcommittee chairs.

Opening Remarks by NSpC Executive Secretary

Dr. Scott Pace, Executive Secretary of NSpC, began by noting that this is the third incarnation of the Space Council. The first was during the space race of the 1960s, and the second was during the

administration of President George H. W. Bush. The latter dealt with the aftermath of the Cold War and addressed cross-cutting issues like international partnerships and other areas beyond the scope of an individual agency. The current space environment includes many public and private sector actors, along with intense globalization. Not all of the international entities are fully engaged in all activities, but are all interested in what space activities can do for their people. The new private sector involvement has raised questions about how to innovate at less cost. The second NSpC reached out to the national labs for innovation, but now that role is now filled by industry and others outside the Federal government. The NSpC priority is a unity of effort, so that stakeholders can proceed in roughly the same direction. There are already directions provided from the Decadal Surveys (DSes), the NASA Advisory Council (NAC), and others, but the NSpC is the only place where it all comes together. It provides the larger perspective that is needed at this time.

Dr. Pace said that the NSpC is mindful of UAG member time, and therefore wants members to leverage their existing schedules to use their networks and other resources. However, they should also take a step further to connect with larger communities. None of this happens without public support, and the public trust must be earned. NSpC has embraced exploration because it is highly visible. While the White House and Congress are very supportive of ambitious directions, public support is crucial. There needs to be growth in international investments in order to expand the sector, and that requires being indispensable from the commercial standpoint.

There is a process here. In terms of reinvigorating the NSpC, it is to work through the differences among the various players. It is not to take over the Federal agencies. When problems occur in programs that have national impact, NSpC will be involved. The process is a cycle, which Dr. Pace described. The President directs the top level tone and direction, to grow the economy and sector. He also wants faster growth, not just for the sake of speed, but for rapid feedback as well. He wants to have smart people in the right places. NSpC tries to set up framework agreements and set up boundaries with agencies. The Interagency Working Group addresses what it can, but these are not easy issues. A lot of staff work is involved in shaping this effort in terms of principles.

Dr. Pace next turned to space exploration priorities. While other countries rejected the previous administration's plan for human exploration of Mars, they can envision going to the moon. Similarly, commercial companies saw no benefit from human exploration of Mars but did see a case for a return to the moon. The focus on Mars drove international partners away instead of aligning them with the United States. Space Policy Directive 1 corrects this and redirects NASA to the moon, with commercial and international partners. The United States is doing this because it is in our best interests and that of our allies. This is bigger than projects and hardware and astronauts.

In order to address commercial space priorities, the United States must retain its lead, and that means streamlining the regulatory system. National security space priorities are rooted in the fact that space is now recognized as a war-fighting domain. The United States' adversaries have weapons that threaten our space assets, which are considerable. The United States needs to dominate in space, as the nation is extremely reliant on it. Therefore, we need to make our space systems more resilient and less vulnerable to attack. The White House seeks to ensure that this happens. Space Policy Directive 2 provides more details in this area.

Transportation is a Federal Aviation Administration (FAA) responsibility, under Title 49. Other activities are under the Commerce Department. There is also a need to have a specific voice for commercial spectrum issues within the Federal Communications Commission, and this must be addressed from a space perspective. Space Policy Directive 3, signed just the day before, addresses space traffic management and will provide a broader civil interface through the Commerce Department.

Adm. Ellis asked about priorities that UAG might address. Dr. Pace replied that there is a need to strengthen public engagement with space, first. Next, the United States must increase commercial activities in low-Earth orbit (LEO), and shift from owning the International Space Station (ISS) to leasing portions of it. This will not be easy, as the nation does not want to lose the gains from LEO, nor the international partnerships involved. It is important to preserve the capabilities, if not the facilities. He is interested in determining where people can make money in space. The third priority is accelerating the return to the moon. Program management is a consideration – where are the necessary people who have a sense of urgency? Fourth is where the country competes and where it cooperates internationally, including the countries with which there is some friction. The success in keeping ISS out of geopolitics has taken a huge effort, which requires examination. Finally, there is a need for exploration-enabled science and science-enabled exploration. There is a relationship between the two, as they create opportunities for each other. There should be more geologists on the moon, for example. Science, technology development, and the science community are crucial.

Mr. Salvatore Bruno noted that commercial entities have had opportunities in LEO. He wondered if UAG might also consider cis-lunar space opportunities. Dr. Pace said that that was absolutely the case. Not only are there research needs, there is also a national security aspect – it is an integrated whole. Mr. Wes Bush observed that UAG meetings are public, but that is not always possible in the national security space. Dr. Pace replied that the National Space Strategy lays out priorities, and NSpC works closely with the National Security Council. In areas of overlap, NSpC will probably take the lead. Acquisition reform is a big concern. There are various organizational approaches that were considered, but this is being resolved. Adm. Ellis added that technology can drive things as well, and much of that will be in the classified area.

Ms. Marillyn Hewson asked how UAG might contribute to the space force. Dr. Pace answered that there is a need to speed up acquisition, identify capabilities where the effort can succeed, get right the people with hands-on experience, and obtain sufficient resources. It is also necessary to see the context regarding the major threats that exist. This should all take place as soon as practical, ideally starting with the Fiscal Year 2020 (FY20) budget. The Honorable Harrison Schmitt pointed out that the nuclear Navy has managed to stay young, which could be a model. NASA is not that young. Dr. Pace thought it was a matter of how to attract young people, by giving them something interesting to do. They want tacit, hands-on experience. The military gives responsibility to young people. Hon. Schmitt noted that that will require Congressional action and a restructuring of the civil service system.

Mr. Fatih Ozmen expressed concern about stove-piping and asked if it would make sense to have a group examine the committees and subcommittees that might contribute to that. Adm. Ellis said that he was open to that in the discussion of the groups. The elements will get worked out in the subcommittees, and the plenary group will make the recommendations. The process is designed to pull it together at this level. Dr. Pace added that sometimes issues have to go to the principals. This is why all final recommendations must go through the plenary group in a FACA environment. Where consensus does not exist, the discussion will be public. It is not required to have consensus.

Mr. Dennis Muilenburg pointed out that there will be a need to think differently about sectors and government agencies. For example, frequency management is beyond the purview of a U.S. agency, as it is international. Similarly, space use at the edge of the atmosphere will no longer make sense. Trends for the future are becoming apparent. There will be commercialization of space and there are other international agencies with requirements. The nature of commercializing space calls for stakeholders to think differently. Dr. Pace said that he was hopeful that the space and frequency issues would work in favor of the United States, noting that U.S. space interests often did well at the International Telecommunication Union (ITU) because our needs and interests in space aligned well with those of the developing countries. The biggest areas of problems he had internationally were countries that had narrow interests. Regarding the seamlessness of hypersonic vehicles and air traffic management, there are

fundamental legal and practical considerations about flying over sovereign air space, as well as overflight in space. However, there is also a need for international traffic management and interfaces.

Deregulation and Space Traffic Management Initiatives

Mr. James Uthmeier of the Department of Commerce (DOC), explained that the Trump Administration has established requirements to reduce rules, especially when implementing new ones. Mr. Uthmeier is focused on the deregulation of space. DOC hopes to enable more commercial success in space, and to that end is also addressing the entire supply chain. The Department also wants to determine how to continue government research and growth while better developing a market. DOC is creating a single interface for companies, a "one-stop shop." The right organization must be in place to ensure that everyone is working on the same page. When a company meets with DOC about space, the Department will have the right people at the table. As part of this effort, DOC has submitted a reprogramming plan to Congress, to establish a space office at Commerce and to take on mission support services.

To be clear, DOD will continue collecting data, and DOC will be the interface supporting companies to launch successfully and obtain their own data. Right now, for example, the Federal government provides raw weather data, which should go over to the commercial side. The appropriators in the House of Representatives approved the re-organization and discussions are ongoing with the Senate. DOC hopes to establish the right infrastructure and streamlining process to move into the future. At present, companies go overseas when they do not receive Federal support, so industry has been invited to discuss definitions in order to enable flexibility, and to explain what they need from DOC. A new rule will be issued later this year. In addition, DOC will convene discussions among the big lending institutions and NASA. Finally, in the area of Space Situational Awareness and Space Traffic Management (SSASTM), the current requirement is to work through the Department of State. However, there will be more initiatives to protect U.S. businesses and assets.

Adm. Ellis asked for a list of DOC priorities. Mr. Uthmeier replied that getting the new office stood up to have a true advocate for industry is first. The second priority is cutting red tape. Third is establishing creative ways to help businesses, enable space-oriented infrastructure, and address the frequency of launches. Fourth is to expose our ideas for investment overseas. Finally, the Federal government must work together in a cross-agency approach that can move quickly, keeping in mind the needs and constraints of national security.

Ms. Collins urged including the minimization of orbital debris as a priority, as it is an international issue that constitutes a major threat. This is also a technology problem. Mr. Uthmeier agreed, noting that this is above and beyond what he does, but Commerce is working hard to look at this. Ms. Collins explained that she had wanted to get it on the record because it is an important issue that calls for an international effort. Dr. Pace added that there is a strategy on debris in the works. Guidelines are going through the United Nations (UN) into nations' laws and regulations. However, it is important to avoid a top-down, centralized approach. Regarding export control, NSpC has been hearing from companies about the problems of dealing with antiquated, non-user-friendly IT systems. There may also be friction in terms of what happens commercially on ISS. As the nation transitions to a different use model of ISS, there will need to be more government-to-government dialogues about trade and impact, and DOC can help with that.

Mr. Stuart Witt asked what DOC might do about past contracting practices. This is not a one-size-fits-all issue, but he would like to see a review of what does and does not work, and what might work in the future. Hon. Schmitt noted that international forums work out some of the issues mentioned, and they operate on consensus. He wondered if those would be reviewed as well. Mr. Uthmeier said that the reviews are under consideration. Dr. Pace urged caution in creating new international organizations, though he was initially a skeptic of the consensus required in ITU and is now a fan. That organization has

turned out to protect U.S. interests and is helpful overall. It is easy for leading countries to find themselves isolated or outnumbered, but finding our way forward with like-minded countries is probably the best hope for the United States. Hon. Schmitt said that his experience was that it was important to have the U.S. commercial sector deeply involved. It helped illustrate to other countries the value of our technologies. Dr. Pace added that one of the most impressive things was the breadth and diversity of the U.S. delegation. Other countries did not always have that, and it is something to build on.

Mr. Uthmeier closed by stating that the DOC Secretary, Mr. Wilbur Ross, will come to the next UAG meeting.

Space Exploration Priorities; ISS Transition and Lunar Exploration Roadmap

Mr. Bridenstine thanked the meeting participants, stating that UAG can be effective in moving the country forward. He sees NSpC and UAG as key in the interagency space area. When he served on the House Armed Services Committee, he identified communications architectures that need to be brought together. It is notable that commercial interests jump in to act while DOD takes 2 years to do an analysis that is already obsolete upon publication. The issues then become how to develop a low-latency capability for bandwidth, how might the United States best take advantage of it, how do Federal agencies work together to maximize that capability, what does DOD need and how does it get out in front on that, and are we communicating it early enough to have the capabilities?

NASA plays a role in the robotic servicing piece, because the Agency has thousands of satellites in LEO. The congestion is a massive challenge that is only growing with greater launch cadences. The prediction is that collisions will occur at a rate of one every 4 to 9 years. That raises the issue of how to prevent this congested, contested environment in LEO. NASA's role could be the robotic element. In addition, the Restore-L mission addresses the issue, though it does not go far enough. NASA can make the investments that industry does not where there is no commercial payoff. However, NASA can also license those activities to companies.

Mr. Bridenstine explained that when he was in Congress, tornadoes occasionally killed some of his constituents. At the same time, there were delays in the weather models and missions that ought to protect his constituents. He therefore worked on developing commercial activities to mitigate the gaps in data delivery. The companies had problems due to the fact that the data had to be given away free internationally, however. The United States needs to think about its capabilities. While we receive a lot of our data from the international community, we might try to find a way to license companies so that the data do not have to be given away. The global public good is not a global public good if the framework prevents it from being created to begin with. Our international obligations constrain us and prevent the government from keeping up. Mr. Bridenstine hopes UAG can help in this area. The transformational things happening in space are critical, and the government must be responsive to that.

Mr. Stallmer asked if Mr. Bridenstine had any insight or thoughts about the space force that had been announced the day before. Mr. Bridenstine replied that as a member of the House Armed Services Committee, he voted to support the space corps the three times it came up. This is not an easy thing, but it is an idea whose time has come. The United States faces unprecedented challenges in space and has been contested in space. It is become a very dangerous environment. His Navy experience showed that two things matter: how good your commerce is, and how good your defense of that commerce is. The same is true in space. Commerce is critical for space, which is a major industry and an element of our international export strategy. The commerce is there right now, but the defense of that commerce is not. Therefore, the White House is moving forward on that. Mr. Bridenstine gave the example of General Billy Mitchel, who after WWI was vocal about the need for an air force with a bombing ability. While his advice was ignored for many years, WWII proved him to be right, and the U.S. Air Force (USAF) was created as a result. The space force is an idea whose time has come, though it is not yet clear what it will

look like. Military services organize, train, and equip. A space force within the military would come out of USAF, and it could take many different forms. There is a lot of work to be done.

Mr. Bruno asked about whether the government might be a customer in LEO and cis-lunar space. Mr. Bridenstine said that it will be, and there are international consortia interested in taking ISS over commercially. These are serious conversations currently underway. It is important to not have a gap in LEO; rather, there should be a permanent human presence there. ISS is a government function that could transition to where the government is a tenant alongside private industry tenants. Following that, the government could be the anchor customer for lunar capabilities with payloads from various sources. There is a lot that can be done, but he supports being a customer. The Federal government should lead where the commercial side is not yet ready, or take over where industry cannot operate.

Mr. Muilenburg observed that UAG is eager to help strengthen public advocacy for space exploration and asked how that might best occur. Mr. Bridenstine replied that a recent Pew Research Center poll found that 72 percent of Americans think the United States should be a leader in space. That is an enormous level of agreement. In addition, 80 percent of Americans believe ISS has been a good investment for the U.S. taxpayer. This says that NASA has communicated well how ISS establishes U.S. leadership. The poll shows that 65 percent of Americans believe the United States should lead in the use of space to understand Earth, and to track objects that could be a threat to Earth. However, he was surprised to see that the exploration of the moon and Mars was at the 15-20 percent approval level. This means there is a need to change that narrative.

NASA excels at transdisciplinary thought. When the Agency does human exploration, it conducts science that helps our own planet. He gave the example of Mars losing its oceans and atmosphere, which scientists need to understand. The United States must be the first nation to discover life on another world, not the second. That is why exploration is important. However, astronauts returning to Earth face significant health problems and deficits. For example, it takes an astronaut up to 60 days just to be able to touch his or her nose with a finger. This illustrates why there are issues with sending them on a 6-month journey to Mars, where they will have to do the hardest work they have done in their lives. This is the kind of thing that must be tested and addressed.

NASA operates in a different environment from that of the Apollo era. The level of redundancy is an example. There must be a sustainable lunar architecture, and the sustainability element is key. This shows the need to communicate to the American people why it is important to go to the moon. It is good that Americans see the importance of studying Earth from space, but they also need to understand the importance of studying other planets and bodies.

Hon. Schmitt cited the geopolitical context in going back to the moon and on to Mars. Mr. Bridenstine said that the United States has the opportunity to open dialogues with Russia due to our ISS collaboration, as long as the United States leads. Hon. Schmitt pointed out that China wants to lead, too. Mr. Bridenstine said that he thinks the United States can do this. We are the only nation that has successfully landed on Mars, for example, having done it seven times and preparing for an eighth. He believes our leadership position is sustainable.

Ms. Hewson asked what the U.S. government should own to support U.S. businesses in space. Mr. Bridenstine replied that the Lunar Gateway provides an opportunity to take advantage of commercial partnerships in a new way. The United States is going to the moon, and the Gateway will provide even greater access to the moon rather than diminishing that access. With Apollo, NASA missed a lot of science – the ice being an example - by going to a single spot on the moon. The United States wants to do more science on the moon and will use the Gateway to do so. The country needs a station orbiting the

moon that enables other travel in the solar system as well. The Gateway will provide this kind of broad access. This is the United States' opportunity to prove those technologies and lead internationally.

Mr. Buzz Aldrin said that the Chinese will have a halo orbit around L2, with the capability of a landing on the dark side of the moon. The United States denied the Chinese the opportunity to go to the ISS. If the Chinese launch as planned, they can launch to larger inclinations than what is planned by the United States. We denied them something, and they can deny us something and encourage other international partners to join them. Therefore, we should attract other nations with compelling inclinations. The country needs an organization and a plan that international partners would like to have. Mr. Bridenstine offered to discuss this further.

Formation of Work Plan and UAG Subcommittees

Adm. Ellis explained that his list of proposed subcommittees was a draft, though each subcommittee was the result of a specific conversation with Vice President Pence on the topic of the NSpC charge. UAG was free to reorganize the subcommittees as long as the issues are covered. He asked each member to communicate to Mr. Eden about a couple of committees of interest to them. There may need to be some shuffling around in order to achieve balance. Adm. Ellis's initial choices for chairs might change as well.

He elaborated on what some of the subcommittees might cover. In Exploration and Discovery, the "discovery" element addresses science. The National Security Space subcommittee might be best for people with active security clearances. Economic Development and Industrial Base addresses a major NSpC focus. Outreach and Education is important and will address making the case for support of space exploration. Space Policy and International Engagement is an area in which technology has outpaced both policy and international agreements.

Gen. Lyles pointed out that the subcommittees are broad, and he wanted to know about the subsets and specificity under each. Adm. Ellis said that aside from Dr. Pace's top five priorities, this is an ongoing dialogue. The subcommittee chairs will help prioritize, which will involve tradeoffs. He wants to increase the pace and sustain the work going forward, and would prefer to decide on a few things for focus rather than be spread too thin. That was also advice from Vice President Pence. It is important to identify the issues to work on quickly rather than seek complete solutions. UAG will learn the NSpC priorities as they evolve.

Mr. Aldrin asked if UAG should look at the education pipeline. He also stated that there are disadvantages to international cooperation. Adm. Ellis thought that while the pipeline might be beyond UAG, they need to point it out and note the linkage to space. International bodies share interests, which can lead to some issues over who gets what. The commercialization of LEO falls under the Economic Development and Industrial Base Subcommittee. Ms. Collins asked why UAG did not include any members of the active duty military. Adm. Ellis said that there was some thought that the retired military members could serve that function. DOD is also a constituent of UAG, and there will be outreach to that department in order to facilitate addressing their needs.

Dr. Wolf asked what license UAG has to investigate some of these issues. Adm. Ellis replied that in regard to "third rails," sensitive areas, etc., there are none. UAG needs to emphasize what is important within its charge, and there is nothing to stop them from following up on their priorities. Dr. Wolf observed that those they talk to might not agree. Adm. Ellis said that while that is true, they work for the Vice President and are almost obligated to think broadly about where the important issues lie. Most of what the subcommittees focus on should be welcome.

He turned to the schedule. The UAG charter says they should meet three times per year, and at least once with NSpC. Other than the joint meeting, the UAG sessions will be decoupled from NSpC. Members will

have other obligations resulting in conflicting schedules, so he wanted to get a sense of the number of meetings they wanted to hold. Gen. Lyles pointed out that the NAC subcommittees meet right before the NAC meetings, which is one way to structure it. Hon. Schmitt advised quarterly meetings. Mr. Fred Klipsch said that the subcommittees will need to meet in order to organize. Adm. Ellis said that he envisioned an organizational teleconference for the subcommittees, with their meetings before the UAG meeting. Ms. Mandy Vaughn said that much of what they will want to do will be cross-cutting more than strictly in the purview of any one subcommittee.

Dr. Dittmar asked if the subcommittees will need to take findings and recommendations to the Executive Committee and then to the UAG. Adm. Ellis thought that was the way they would do it, though there might be quorum concerns. At the same time, they will need to work through concepts before they go public. He could see UAG holding meetings at NASA facilities outside of Washington. They have already been invited to both Huntsville, Alabama, and the Johnson Space Center (JSC), for example. As for field hearings, they might be able to put panels together at other events so that they are listening as well as speaking. This will likely be in the form of small groups. People are curious about this effort and UAG wants their input. The subcommittees and UAG as a whole can also request briefings. There is a lot of interest in addressing this group. If members need something broader and more in-depth, they should tell him and Mr. Eden. He has had international partners express interest. There are many opportunities, but they need to make sure they advance the issues.

Adm. Ellis asked the industry representatives which meetings they considered to have the most impact, both national and worldwide. Mr. Ozmen said that they might consider whether to have a website and social media presence. This can be hard to manage and would require a budget, but it could broaden the base. Adm. Ellis said that he would like to float a NASA-designed website up to NSpC, but he advised caution with social media. He would investigate further. Hon. Schmitt said that on the science side, there are annual meetings of groups with which NASA is loosely affiliated. The Lunar Exploration Analysis Group (LEAG) is one. USRA also hosts a group. The Solar System Exploration Research Virtual Institute (SSERVI) meets at the NASA Ames Research Center (ARC) each year. In addition, there are conferences for the broader community, such as the American Geophysical Union (AGU); every discipline has its annual meetings. UAG cannot appear at all of them, but there are many from which to choose. Adm. Ellis said that he would like Hon. Schmitt's help in capturing those communities without becoming too specialized. UAG does not have unlimited time or funds, so would he would rather find opportunities where some of the members are already involved, then pull in one or two more members. He added that the legal pieces of some of the security policies are huge, with a great deal of uncertainty. There needs to be that understanding. Hon. Schmitt noted that a lot of non-space-faring nations would like to see the policies change, which he considered inadvisable. Adm. Ellis said he would like to talk with these groups, agreeing that they should not dictate policy.

He would like the subcommittees to be aligned by July 1. He asked that as UAG members volunteered for subcommittees, they also submit their priorities and questions. He would then have a teleconference of the Executive Committee to address this, the schedule, and the priorities. He would like to have a couple of issues to take forward to the next NSpC meeting, which would mean having another UAG meeting before then. It is important to emphasize UAG's expertise and collective insights. He would like to have the subcommittees to bring forward six or seven important recommendations that the Executive Committee could take to UAG and then to NSpC. Within the FACA guidelines, UAG can do pretty much whatever the members want, so they need to determine how to add value and make progress.

Adm. Ellis asked that each UAG member volunteer to be on at least two subcommittees, ideally as many as they feel they could be part of and have time for. Dr. Robert Smith said that it would be helpful to have criteria for the recommendations, for example placing an emphasis on something that could be implemented and is economically feasible. The direction would be helpful so they do not spend too much

time arguing about outcomes. Adm. Ellis agreed and asked for UAG member thoughts on this. He promised to put together some guidelines on the qualities a recommendation should have. He added that there are things that do not make economic sense and have no business case but still need to be done.

Public Input
Adm. Ellis opened the microphones for public comment.

Mr. Joseph Gillen, affiliated with a small consulting group, said that he believed he was speaking for a larger community of the many individuals who are retired or left the industry and who are chomping at the bit to use their talents and passions to become involved in this effort. This included public outreach and specialty areas. He asked if there might be any way that UAG could use their help. Adm. Ellis thanked Mr. Gillen and said that UAG will find ways to fully engage and communicate.

Ms. Stephanie Wan introduced herself as the former chair of the Space Generation Advisory Council, which is affiliated with the UN and provides a youth perspective on space policy. The Council has an observer with the UN Committee on the Peaceful Uses of Outer Space. She said that the workforce, the younger generation, is a great community for UAG to work with. Adm. Ellis praised Ms. Wan's initiative, thanked her, and said that he is familiar with her organization. It will be important in outreach.

Mr. Keith Cowing of Nasawatch.com stated that UAG appeared to have only one person under the age of 50. He also stated that the panel seemed to be largely made up of big aerospace representatives. He asked if the lack of younger people was deliberate. Mr. Stallmer said that there were some younger people in the room, Ms. Vaughn stated that she was younger, and Ms. Gwynne Shotwell said she represented many younger individuals. Dr. Wolf said that he has mentored younger astronauts and was still in frequent contact with many of them, but he welcomed anything Mr. Cowing could do to help with connections.

Mr. Asian Zuckery thanked the UAG members for their service and said he would be happy to help.

Mr. Gary Barnhart of Extraordinary Innovative Space Partnerships said that it is important that UAG be involved in LEO commercialization, as the attention paid now will make a tremendous difference. There is interest from a number of groups, such as the Planetary Society, as well as the broader entrepreneurial community. An example of the latter is a ULA initiative that now has over 160 participants. He suggested that UAG seek out such groups.

Mr. Keith Catterfelt asked about the best way for younger people to get involved in the effort. Adm. Ellis said that he appreciates this kind of support. Committee membership is limited to UAG participants, but there are generational or space organizations with which young people can associate. The interest in space is a passion we all share, and he advised interested individuals to make their presence and views known with the other organizations.

Roundtable Discussion and Final Wrap-Up
Adm. Ellis asked the UAG members for their thoughts at the end of the meeting. Mr. David Thompson thanked Adm. Ellis and the other UAG members. Mr. Witt thought that they have a short-term opportunity in which to be bold. Mr. Aldrin explained that he is establishing a human spaceflight institute for academic judgment of innovative, game-changing ideas, located in Houston. Ms. Collins said that it is an honor to chair the outreach subcommittee and members had sent ideas to her already. She is a member of many of the organizations mentioned and wants to hear from the public. Speaking for Mr. Muilenburg, who had had to leave, Mr. James Hughes said that Mr. Muilenburg was grateful for the privilege of serving. Mr. Klipsch appreciated the opportunity. He suggested that the process for output and what it might look like be a future topic. Ms. Vaughn said that this was a good opportunity to make a real impact.

Gen. Lyles also appreciated the opportunity. He pointed out that the UAG charter refers to both aeronautics and space, and yet there was nothing in UAG related to aeronautics. He asked how it might be addressed. Adm. Ellis replied that there will be no spin-off group, but there was a lots of aeronautics representation on UAG. There are both legal boundaries and other boundaries that are blurring. If they need specificity, that will be addressed. Mr. Stallmer and Dr. Dittmar both said that it was an honor to be present. The Honorable Kay Ivey said she was thrilled to have a vision of the United States as a leader in space again and looked forward to working with this group.

Mr. Bruno said that they will be bold. Dr. Pamela Vaughan said she was proud and honored to be there. Dr. Smith thanked Adm. Ellis, and Ms. Shotwell urged UAG to get the work done. Dr. Wolf compared this to his first astronaut class, and said he was feeling again that this is a great opportunity. A spokeswoman for Ms. Hewson thanked the group and took note of the diversity of the people in the room. Mr. Ozmen was grateful for the leadership and said that this is a time to take advantage of the opportunities. Mr. Bush called it a unique moment. Mr. Tim Ellis said that in regard to public outreach, they share the dream of going to the moon and Mars, which calls for bold, inspirational ideas.

Adm. Ellis thanked everyone for being part of this. Space is daunting in many ways. There is now an opportunity to do things differently. How we differentiate ourselves will be hugely important. They will find the things to which they can uniquely add value.

Adjournment
The meeting was adjourned at 1:53 p.m.

Appendix A
Attendees

UAG Membership
James Ellis, *UAG Chair*
Brandon T. Eden, *UAG Executive Secretary*
Buzz Aldrin
Salvatore Bruno
Wes Bush
Eileen Collins
Mary Lynne Dittmar
Tim Ellis
Marillyn Hewson
Kay Ivey
Fred Klipsch
Lesley Lyles
Dennis Muilenburg
Fatih Ozmen
Harrison Schmitt
Gwynne Shotwell
Robert Smith
Eric Stallmer
David Thompson
Pamela Vaughan
Mandy Vaughn
Stuart Witt
David Wolf

Other attendees
Barbara Adde
William Beckman
Cindy Brennan
Sandy Coleman
Mat Dun
Martin Frederick
Rebecca Gilchrist
Newt Gingrich
Marchel Holk
Tim Hughes
Teddy Jonston
Cody Knipfe
Doug Lauren
Alex MacDonald
Mark Mozem
Scott Pace
Ben Preugh

Alex Rodriguez
Robbie Sabathier
Tommy Sanford
Elizabeth Sheley
Jared Staut
James Uthmeier
Stephanie Wan

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

Wes Bush
CEO of Northrop Grumman

Dean Cheng
Scholar at the Heritage Foundation

Eileen Collins
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

Kay Ivey
Governor of Alabama

Fred Klipsch
Founder and Chairman of Hoosiers for Quality Education

Les Lyles
Retired 4-star Air Force General and member of the NASA Advisory Council

Pamela Melroy
Three-time Shuttle astronaut and former Deputy Director of the Tactical Technology Office at the Defense Advanced Research Projects Agency

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

Jack Schmitt
Apollo 17 Astronaut and former Senator

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
Agenda

National Space Council Users' Advisory Group
First meeting

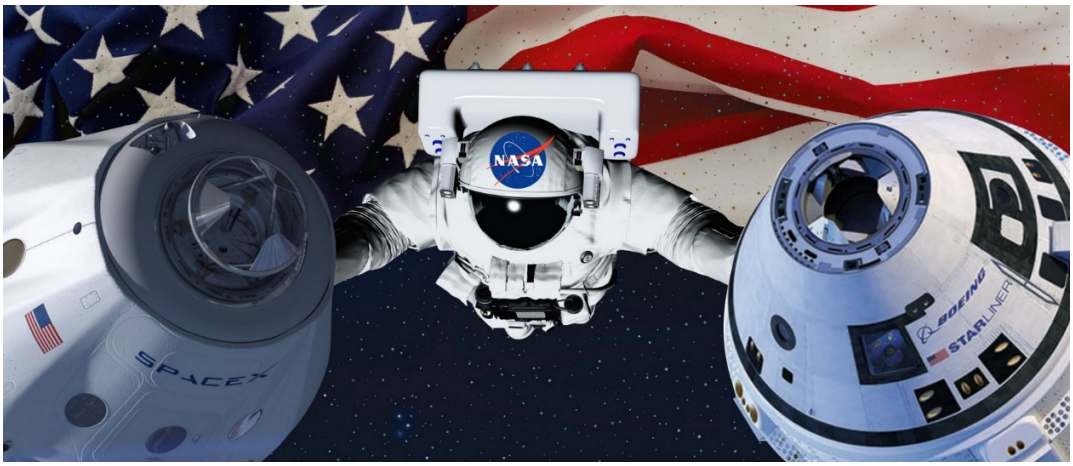
Tuesday, June 19, 2018
9:00 a.m. to 2:00 p.m.

NASA Headquarters
Executive Conference Center, Room 8Q40B
300 E Street, SW
Washington, DC 20546

Public Agenda

9:00 a.m.	Call to Order, Announcements	Mr. Brandon Eden Executive Secretary Users' Advisory Group
9:03 a.m.	Opening Remarks by Chair Users' Advisory Group (UAG)	Admiral James Ellis *(USN Ret.)* Chair Users' Advisory Group
9:10 a.m.	Opening Remarks by Executive Secretary National Space Council	Dr. Scott Pace Executive Secretary National Space Council
9:20 a.m.	Candidate Topics for UAG Review	Dr. Pace
10:00 a.m.	Deregulation and Space Traffic Management Initiatives	Mr. James Uthmeier Department of Commerce
10:45 a.m.	Space Exploration Priorities; ISS Transition and Lunar Exploration Roadmap	Mr. James Bridenstine NASA Administrator
11:30 a.m.	Lunch	
12:30 p.m.	Formation of Work Plan and UAG Subcommittees	All
1:30 p.m.	Public Input	
1:40 p.m.	Roundtable Discussion and Final Wrap-Up	All
2:00 p.m.	Adjournment	

Media Outcomes Report- Commercial Crew Announcement



Announcement Date: August 3, 2018 **Prepared by: HEO PAO**

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SUMMARY

Aug. 3, NASA announced the first astronauts who will fly in SpaceX and Boeing spacecraft for the agency's Commercial Crew Program. The first crewed test flights, which will use Boeing's CST-100 Starliner and SpaceX's Crew Dragon vehicles, are currently scheduled for 2019.

NASA TV COVERAGE

Commercial Crew assignments announcement at Johnson aired on NASA TV

NASA administrator, Johnson Director Mark Geyer, and Kennedy Director Bob Cabana participation

- **11 am to noon** – Announcement and media release
- **12:30 pm to 1:30 pm** – Reddit Ask Me Anything with Commercial Crew astronauts

- **4:30 to 6:30 pm** – Media Live-shot interviews with Commercial Crew astronauts

OVERALL COMMENTS

There were nearly 1,800 media hits covered last week's Commercial Crew announcement, including previews and coverage of the event itself. Major media outlets covering included Washington Post, the New York Times, the BBC, USA Today, Yahoo news, Fox News, Scientific American, CBS News broadcast and online, NPR, NBC News, Houston Chronicle, Atlanta Journal-Constitution, Los Angeles Times, Chicago Tribune, CNBC, Associated Press, CNET, Reuters, AFP, Bloomberg, CBC News, Gizmodo, The Verge, the Atlantic.

In addition to multiple posts from the flagship, Tweets from @Space_Station and @Commercial_Crew reached audiences of over 30 million, while Facebook posts from the Space Station on the event reached from 300-500K each. Social media posts echoed the message across multiple agency accounts including Administrator Bridenstine, Dr. Thomas Zurbuchen, NASA_Astronauts and individual astronaut accounts, the International Space Station, TDRS, ISS Research, Commercial Crew, HQ Photo, and centers including but not limited to Johnson, Kennedy, JPL, and Langley. The social team updated flagship account backgrounds to feature the crew (see attached image) and promoted live Q&As on the Space Station accounts with the Boeing crew (Facebook Live) and SpaceX Crew (Periscope). Some of the coverage was dented with stories about delays from Boeing, which took a hit at the main headlines. A number of outlets' main stories were about the delays then sequentially stated the details of the announcement near the bottom.

CCP ANNOUNCEMENT KEY MESSAGES

- As this announcement shows, NASA and its U.S. commercial providers are in final preparations to launching astronauts into space from United States for the first time since 2011.
- NASA is changing the way it is doing business through commercial crew – the private sector is responsible for the development of the human space transportation systems with shared

certification responsibility. The private sector will be able to offer these transportation services to others beyond NASA.

- The Commercial Crew Program is on track to produce two, independent human space transportation systems for less than $6 billion – a significant reduction from NASA's historical experience.
- Acquiring low-Earth orbit astronaut transportation from our commercial partners frees NASA to focus on extending human presence to the Moon and eventually on to Mars.
- Boeing and SpaceX have substantial spacecraft and launch vehicle hardware in development and testing in preparation for their test flights later this year.
- NASA, Boeing and SpaceX have significant testing underway, which will ultimately lead to test missions when the systems are ready and meet NASA's safety requirements and performance requirements.
- NASA has ordered all six post-certification missions from each company.

Highlights:

The Washington Post

"NASA is about to launch astronauts into space again — and a massive business for big companies. Leading up to the ceremony at the Johnson Space Center here, NASA Administrator Jim Bridenstine said it was a historic moment for the agency: "We are going to launch American astronauts from American soil. That's a big deal."

Fox News

'"This is the stuff of dreams," said Glover, during an event at NASA's Johnson Space Center in Houston Friday.'"

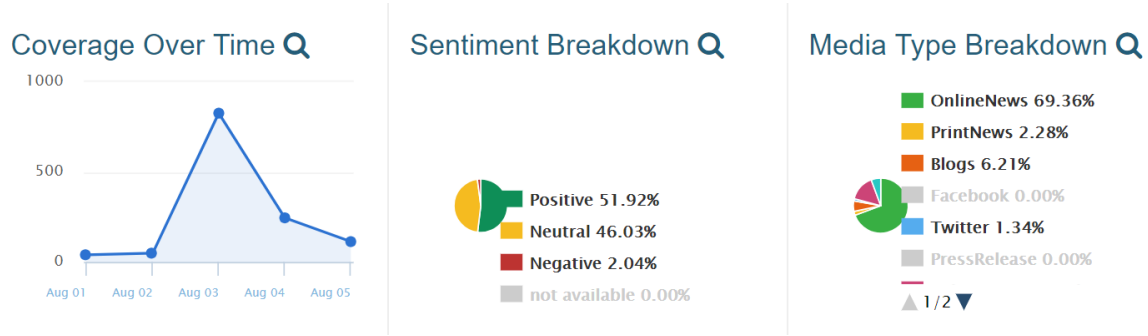
Business Insider

"The announcement is a big deal because the last American crew-carrying spacecraft — NASA's fleet of four space shuttle orbiters — retired in July 2011. Since then, NASA has been forced to rely solely on Russia's increasingly expensive Soyuz spaceships to get to the International Space Station (ISS), in which the US government has invested about $100 billion."

The New York Times

"NASA has named the astronauts chosen to fly on commercial spacecraft made by Boeing and SpaceX to and from the International Space Station, the research laboratory that orbits around Earth."

MEDIA BREAKDOWN (Agility)



NATIONAL (Pre-Announcement):

Business Insider | *NASA is naming at least 8 astronauts to fly SpaceX and Boeing's new spaceships — here's how to watch the announcement live today*

- Audience Reach: 17,885,000

The Washington Post | *NASA unveils the astronauts who will relaunch human space flights from U.S. soil*

- Audience Reach: 28,433,000

The New York Times | *NASA Names Astronauts for Boeing and SpaceX Flights to International Space Station*

- Audience Reach: 40,463,000

Space.com | *NASA Unveils First Commercial Crew Astronauts Today: How to Watch Live*

- Audience Reach: 2,175,000

Space Policy | *NASA COMMERCIAL CREW ANNOUNCEMENT, Aug 3, 2018, Kennedy Space Center, FL, 11:00 am ET (NASA TV)*

SpaceNews | *NASA confirms delays in Boeing and SpaceX commercial crew flights*

CBS News | *NASA says Boeing, SpaceX could launch astronauts next year*

Fortune | *NASA Has Finally Named a Winner in the SpaceX vs. Boeing Race to Send Astronauts Into Space*

Yahoo.com | *NASA Will Announce Commercial Crew Astronaut Picks*

Bloomberg | *SpaceX Poised to Be First With Astronaut Flights, Beating Boeing*

The Atlantic | *The Race to Launch From U.S. Soil Heats Up*

Investor's Business Daily | *Berkshire Earnings; Boeing, Space X Tune Into This, Jobs Report: Investing Action Plan*

Mirror | *Elon Musk's SpaceX will be ready to take HUMANS into space by April 2019, NASA claims*

Houston Chronicle | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

- Audience Reach: 13,860,000

Inquisitr | *NASA To Reveal Who Gets The First 'Space Taxi' Ride Aboard Boeing's And SpaceX's Crew Pods*

- Audience Reach: 3,281,000

Orlando Sentinel | *NASA to announce astronauts for SpaceX, Boeing commercial crew launches*

- Audience Reach: 1,715,000

SPACE, SCIENCE, & TECH

ULA | *United Launch Alliance Congratulates The Boeing Company on Selection for NASA Commercial Crew Integrated Capability Contract*

Next Big Future | *NASA will announce crews for SpaceX and Boeing crewed missions tomorrow*

CollectSpace | *Shuttle test pilot Bob Crippen's advice for NASA's commercial crews*

Spaceflight Now | *NASA set to announce commercial crew assignments today*

Planetary Society | *NASA names crews and dates for first U.S. commercial missions*

Geek Wire | *NASA confirms new timetable for space taxi flights; SpaceX to fly crew next April*

BGR | *NASA is ready to name the astronauts who will take the very first SpaceX and Boeing flights*

The Register Citizen | *NASA is about to announce the 8 astronauts who will fly SpaceX and Boeing's spaceships for the first time — here's who they might be*

Heavy | *NASA Commercial Crew Announcement Live Stream: Watch Online*

- Audience Reach: 4,834,000

Space Coast Daily | *Vice President Mike Pence To Visit Kennedy Space Center Aug. 3, Will Announce First NASA Commercial Crew*

Politico | *NASA to unveil first commercial astronaut crew*

Executive Gov | *Report: NASA to Announce Commercial Crew Program Astronauts in August*

Tech2 | *NASA TO SOON ANNOUNCE NAMES OF THE ASTRONAUTS ASSIGNED TO BOEING, SPACEX FLIGHTS*

Pythom | *NASA To Announce Commercial Crew Assignments on Aug. 3*

Study Idol | *NASA can Announce Commercial Crew spaceman (Astronaut) Picks*

TechGig | *NASA is naming 8 astronauts to fly SpaceX and Boeing's new spaceships - here's how to watch the announcement live*

- Audience Reach: 312,000

LOCAL:

WKMG News 6 (Orlando)| *WATCH LIVE: NASA announces first SpaceX, Boeing astronauts*

WNWO NBC 24 (Ohio) | *WATCH LIVE: NASA Commercial Crew Announcement*

Orlando Sentinel | *NASA to announce new astronaut class on Friday*

KPRC Click2Houston | *LIVE: NASA to announce new astronaut class Friday*

Chron (Houston) | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

Orlando Weekly | *Mike Pence will visit Cape Canaveral next month for a big space update*

Spectrum News (Orlando) | *NASA unveils crew test flight target dates*

Florida Today | *NASA unveils first Boeing and SpaceX astronauts for flights to ISS*

USA Today (Florida) | *NASA to announce first astronauts to fly SpaceX and Boeing ships*

Houston Chronicle | *NASA Administrator Jim Bridenstine announcing commercial crew in Houston*

Associated Press | *WATCH LIVE: NASA Commercial Crew Announcement*

ABC 6
Fox 29 KABB
Fox 11 WVAH
Local 12 WKRC
Fox 44 KMEG
WTOV 9
Fox 66 WSMH
ABC 8 Tulsa
ABC 22 WKEF
NBC 16 KMTR

(MANY MORE)

POST ANNOUNCEMENT

Wired | *MEET THE ASTRONAUTS WHO WILL FLY THE FIRST PRIVATE 'SPACE TAXIS'*

- Audience Reach: 5,163,000

Business Insider | *NASA just announced the first 9 astronauts to fly SpaceX and Boeing's brand-new spaceships — here's who they are*

TIME | *These Are the Astronauts Who Will Ride the First Commercial Capsules Into Space*

- Audience Reach: 10,976,000

Daily Mail | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 37,775,000

Yahoo News | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 20,604,000

Space Daily | *NASA Assigns Crews to First Test Flights, Missions on Commercial Spacecraft*

- Audience Reach: 26,000

Engadget | *NASA announces astronauts for first Commercial Crew missions*

- Audience Reach: 6,410,000

Catch News | *Sunita Williams among 9 astronauts to fly first commercial spacecraft*

- Audience Reach: 194,000

Live Science | *Trump Hails Astronauts That Will Fly on SpaceX and Boeing Spaceships. And Space Force, Too?*

- Audience Reach: 5,428,000

Long Room | *NASA introduces its first 'Commercial Crew Astronauts'*

- Audience Reach: 25,000

CNBC | *These are the astronauts NASA assigned for SpaceX and Boeing to launch the first crews from the US since 2011*

- Audience Reach: 11,217,000

TechCrunch | *NASA names first astronauts for the inaugural commercial flights to the ISS*

- Audience Reach: 4,280,000

Fox News | *NASA names nine 'American hero' astronauts for SpaceX, Boeing missions*

Mashable | *Meet the NASA astronauts that will fly to space with*

- Audience Reach: 9,915,000

CNET | *NASA names astronauts to fly new SpaceX and Boeing spaceships*

- Audience Reach: 48,000,000

First Post | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 5,282,000

Daily Star | *NASA reveals astronauts who will take first commercial flights into space*

- Audience Reach: 3,661,000

Inquisitr | *Here Are The Astronauts Flying The First Missions Of SpaceX's Crew Dragon And Boeing's Starliner*

- Audience Reach: 3,281,000

U.S. & World Report News | *NASA Names Astronauts for First Manned U.S. Space Launches Since 2011*

- Audience Reach: 11,455,000

Reuters | *NASA names astronauts for first manned U.S. space launches since 2011*

- Audience Reach: 10,826,000

Yahoo News | *NASA Introduces Nine Astronauts for First Commercial Flights*

- Audience Reach: 309,952,000

Flickr | *Crews to Fly Commercial Spacecraft Announced (NHQ201808030022)*

- Audience Reach: 22,673,000

TV:
Good Day Illinois (WCCU (Fox))
Eyewitness News This Morning (KGPE (CBS))
Good Day Colorado (KFQX (Fox))
FOX 31 Morning News at 7:00am (KDVR (Fox))
KVRR Local News at 8 (KVRR (Fox))
KTVH/KBGF Morning News (KBGFLD (NBC))
Good Day Illinois (WRSP (Fox))
Fox 8 News at 9pm (WVUE (Fox))
Ch. 7 Wknd News at 10:00 (WSVN (Fox))
Good Day Austin (KTBC (Fox))

Twitter Highlights

Trends: #NASA #Boeing #SpaceX #NASAAnnouncement #SpaceCrew #CommercialCrew #TestFlights #Astronausts #FirstAstronauts #SpaceXDragon #Crew #LIVE

https://twitter.com/Space_Station/status/1025762030681247744?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet

https://twitter.com/Commercial_Crew/status/1025489989721841664?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet

Jim Bridenstine ✓
@JimBridenstine

Follow

With today's @Commercial_Crew announcement, we are on the brink of launching American astronauts on American rockets from American soil. Congratulations to the entire class of astronauts that were announced today. You are all American heroes. #LaunchAmerica

Commercial Crew Announcement

https://twitter.com/JimBridenstine/status/1025420629443596289

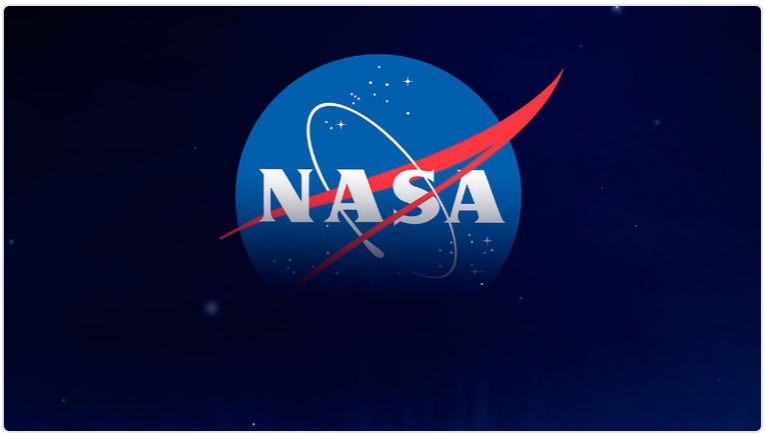
The Verge ✓ @verge · 48m
NASA announces crews for the first flights of SpaceX and Boeing's passenger spacecraft theverge.com/2018/8/3/17647...

1 24 74

https://twitter.com/verge/status/1025411838740185095

KPRC 2 Houston @KPRC2 · 2h

#LIVE **NASA announces** new class of astronauts which will be the first to man commercial space flights > kprc2.co/2vdUj7W?utm_so... #kprc2 #hounews



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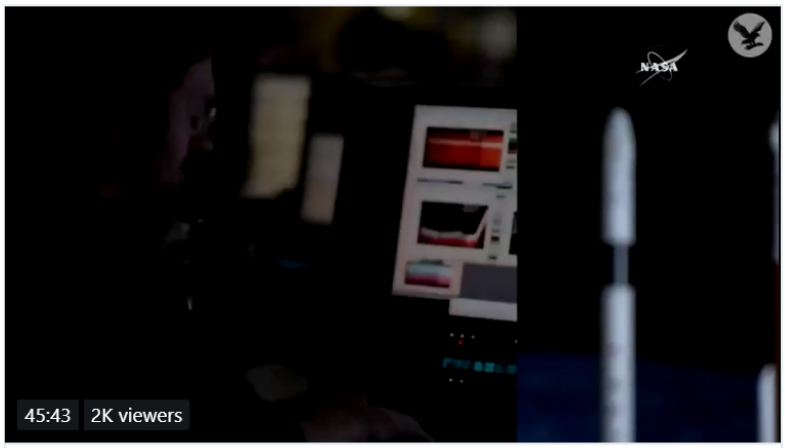
https://twitter.com/KPRC2/status/1025396479647797250

The Independent @Independent · 2h

Watch live as **NASA announces** the crews for its brand new rockets with SpaceX



Watch live as NASA announces the crews for its brand new rockets ...

The Independent @Independent

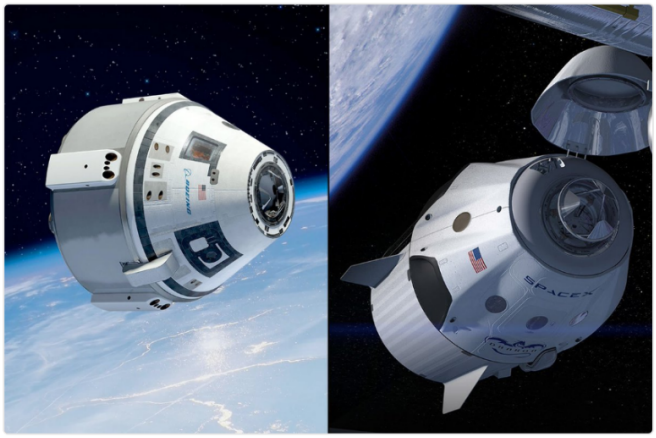
1 10 11

https://twitter.com/Independent/status/1025396144564649984

Chris Hadfield
@Cmdr_Hadfield

Follow

New spaceships, new astronauts - @NASA revealing the first 10 crew to fly Dragon & Starliner. Watch here live: space.com/17933-nasa-tel … @SpaceX @boeing



DRAFT – NASA INTERNAL USE ONLY

National Exploration Campaign Report

Pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1
Forward to the Moon, Mars and Beyond

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Americans on the Lunar Surface and in Lunar Orbit

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Living in Space Prepared America for this Moment: A Key Inflection Point

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Vistas of Unending Opportunity and Discovery - Mars and Beyond

Section 5
Enabling Initiatives, Reforms, and Organizing to Win OR How NASA Will Change to Achieve Mission Success

Section 1: *Forward to the Moon, Mars and Beyond*

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign laid out herein is NASA's answer to that bold call. It also directly responds to the policy objectives found in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which called upon the Agency to develop a Human Exploration Roadmap, including a critical decision plan, to expand human presence beyond low Earth orbit (LEO) to the surface of Mars and beyond, considering interim destinations such as cislunar space and the moons of Mars.

The Campaign aims to revitalize and add direction within NASA's enduring charter to build missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to increase market share and create new market. It responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the country in space. Challenges and opportunities exist in now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation, centered in part on the U.S.-led International Space Station, is today starting to unleash a new economic realm. Action, though, is needed to unleash this new commercial engine and to provide the regulatory and security environment to enable and protect this new economic zone. Further out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond comes as more countries robotically begin establish a presence in this region.

When America reaches the Moon starting early in the next decade, we will not be alone. Foreign nations are planning their own missions to send spacecraft into orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations have all stated plans or already initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013. Even out to Mars, opportunities and challenges exist. American has been the unsurpassed leader in this domain. American robotic craft have been the only ones in history to have successfully landed on Mars. Now, many Nations

are planning their own missions to Mars's surface in the coming years. China in the next decade also plans to be the first nation to bring back samples- that may show the first signs of life beyond our planet.

Opening a New Era: The Sea Beyond Calls

The overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and most importantly, the American public. It is not a return to the past or a repeat of previous efforts of the past 25 years that have sought to move beyond the near-Earth regions of space. It is not about a geo-political competition to re-do Apollo. A lot has changed – and is changing.

The Exploration Campaign builds upon the past 17 years of Americans and their partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies; and begins operations in the next few years of the first American capsule and rocket system capable of establishing the first American permanent presence and infrastructure on and around the Moon. At the same time, with rapid advances in American private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and even commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and space traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA' relationship and collaboration with other U.S. Government agencies will be expanded to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the Nation's space goals. To supplement our own well of creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call (see list of upcoming requests for information in the Appendix). We seek to engage and inspire the next generation, in particular the large number of science, technology, engineering and mathematics (STEM) professionals that support major challenges needing these skills.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create dominance beyond the littoral shores of space – out to, around and on the Moon. NASA's civil pursuit and international leadership of scientific advancement, the frontiers of human exploration, technological primacy and civilizational achievement fill in the American strategic approach to the space domain.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations, which support NASA and the needs of an emerging private sector market.

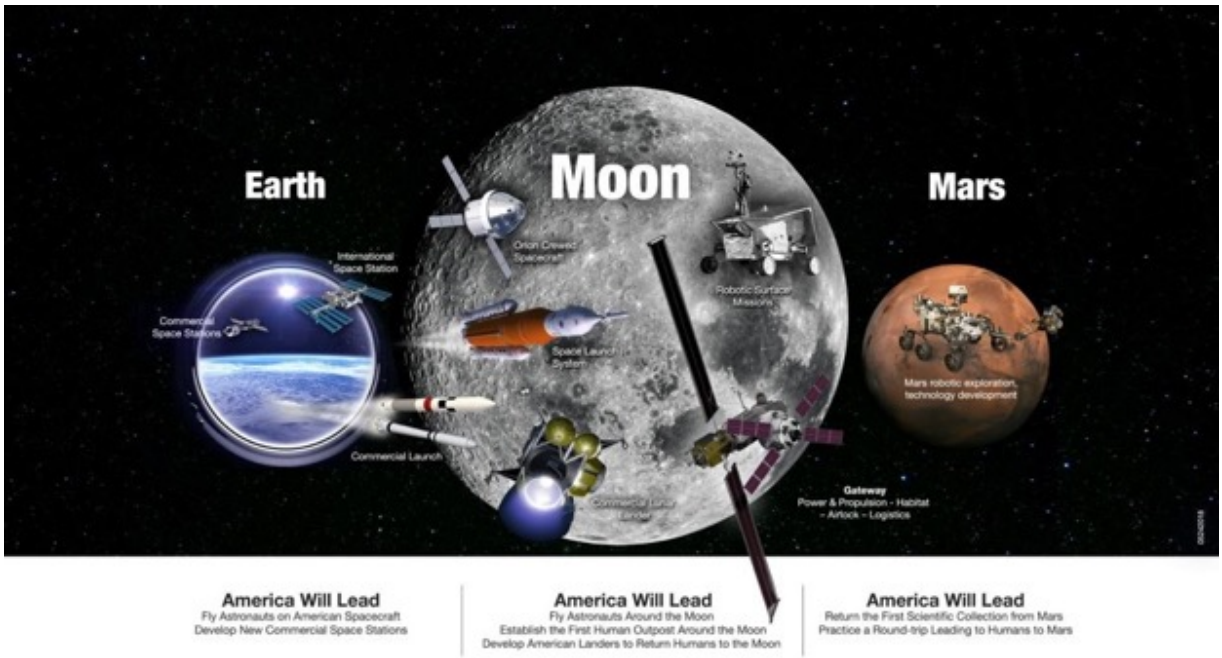
2. Lead the emplacement of capabilities in lunar orbit that support surface operations and feed forward to missions beyond cis-lunar space.

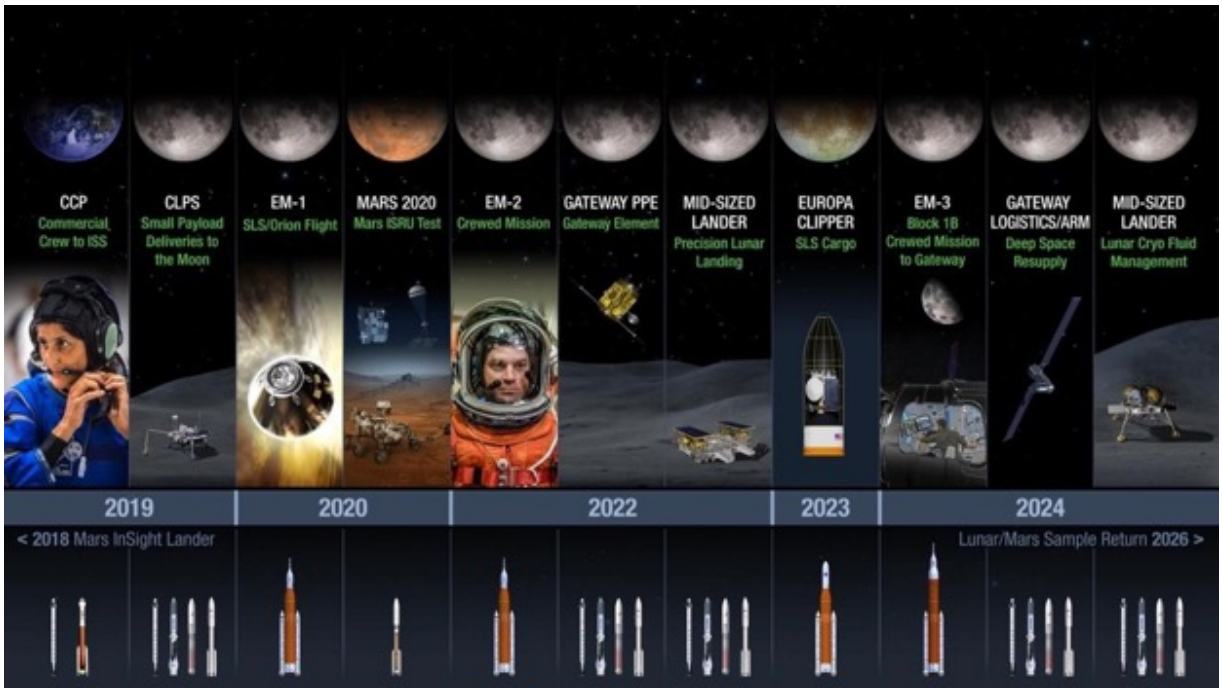
3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, the Campaign will be led by NASA as architect, mission leader, and in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. The following Report provides NASA's strategic implementation approach for "Eagle Rising."




CCP
Commercial Crew to ISS
CLPS
Small Payload Deliveries to the Moon
EM-1
SLS/Orion Flight
MARS 2020
Mars ISRU Test
EM-2
Crewed Mission
GATEWAY PPE
Gateway Element
MID-SIZED LANDER
Precision Lunar Landing
EUROPA CLIPPER
SLS Cargo
EM-3
Block 1B Crewed Mission to Gateway
GATEWAY LOGISTICS/ARM
Deep Space Resupply
MID-SIZED LANDER
Lunar Cryo Fluid Management
2019
2020
2022
2023
2024
< 2018 Mars InSight Lander
Lunar/Mars Sample Return 2026 >

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's off-shore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first placed footprints on its surface roughly 50 years ago, our explorers left only fleeting footsteps at a few sites for a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different than the past. NASA is building a plan for Americans to orbit the moon starting in 2023 and land astronauts on the surface by the late 2020s. For the majority of people alive today, this will be their first chance to witness a lunar encounter with Americans and a lunar landing – collective moments when the world holds it breath in awe and wonder. America will not stop there. A core focus of this Campaign is to bring the Moon into the nation's geo-strategic and economic sphere.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar and cosmic radiation for billions of years – left largely undisturbed, the Moon is an archive of the history of our solar system and our Sun. There are scientific mysteries locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Making the first solar chips or gallons of fuel from the regolith of the Moon, like the harnessing of fire, will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out)– Living and Working Around the Moon

The American Moon Port/Ship under development will forge U.S. leadership and presence over the region from the Moon to the Earth. This platform will host astronauts further from Earth than ever before.

A radical advancement in space technology and human life support systems, the platform will serve as a Moon Ship that will offer astronauts longer stays on the surface, easier crew return, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, we will check technologies and systems as we get ready for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the radiation and microgravity environment beyond-LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by conducting biological and biomedical studies over longer periods than ever previously possible. The Moon Ship will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub; evolving to serve as a way station for the development of refueling depots, servicing platforms, and sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship/Port is presently under construction at NASA centers across the U.S. including in Ohio, Texas and Alabama. The first element will be launched from Florida in 2022 and crews will be able to stay aboard starting in 2023. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar-electric propulsion technology, and provide the critical functionality for the rest of the Moon Ship. NASA will call upon its own workforce to build critical pieces of hardware such as the power and propulsion element and habitation module, push

industry to advance the state-of-the-art to deliver logistics modules, and utilize key contributions from international partners including additional habitat modules and a robotic arm. We will also study the effects of the deep space environment on the Moon ship and its ability to serve as a platform to assemble payloads and systems robotically or with humans that could be used for human and scientific exploration. The Ship will be incrementally built in place using the American-built Space Launch System, Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

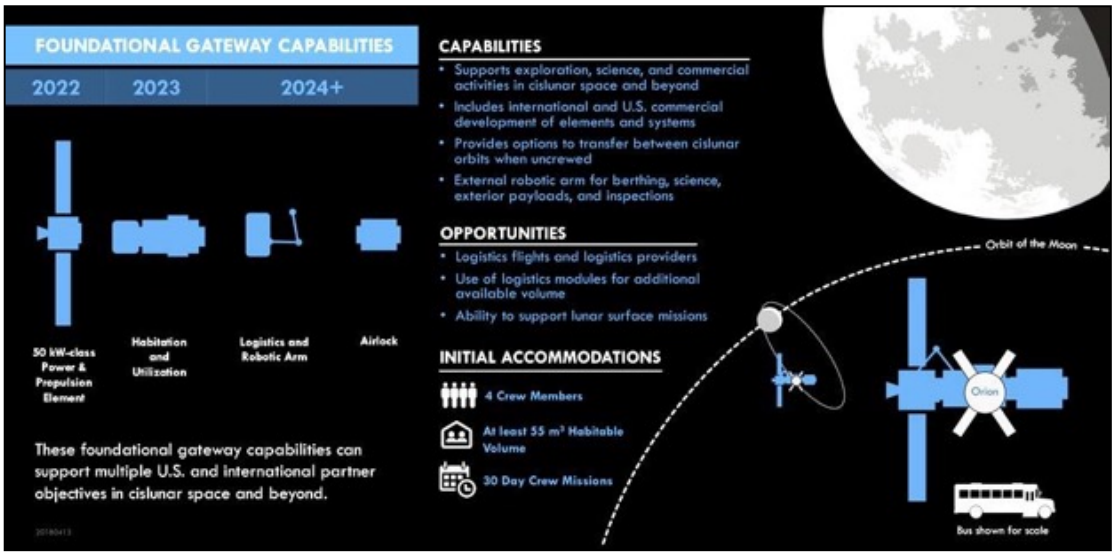


Figure 5: Gateway Development

Humans and Robots - Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, a training ground, and an off-shore continent to prepare for future human missions to Mars and other destinations. Through an innovative combination of robotic and human missions involving commercial and international partners, robotic lunar surface missions will start as early as 2019/20 focused on scientific explorations with a focus on lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in concert with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts and working in tandem with the Moon Ship/Port will expand and diversify over time, taking advantage of the Moon and cislunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far-side of the Moon for Astrophysics, focusing on Space Weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship/Port combination offers an unprecedented research platform and infrastructure. Our currently active scientific exploration missions, Lunar Reconnaissance Orbiter and ARTEMIS will be used immediately to support this increase in scientific discovery objectives.

NASA has started a program of robotic lunar missions through the Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP), including delivery of early, small payloads using emerging commercial landers through the soon-to-be-released Commercial Lunar Payload Services

(CLPS) procurement with speed and commercial partnerships as defining values. In addition, NASA will focus on continued growth of emerging commercial capabilities to further enhance human lunar lander capabilities and utilization of the Moon (including potential lunar communications networks). An assessment is underway on the best development path for an SMD-led rover capability and mid-size lander. In every case, technology and commercial sector capabilities will feed forward toward and integrated into the human exploration approaches.

While we have extensive orbital information about the lunar surface and potential resources, robotic scouts are needed on the Moon to validate prior observations and are essential to prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data – multiple landers will provide a global-scale view of the Moon and its resources. Landers will specifically be outfitted with sensor packages, while also providing lunar surface access for rovers that can explore the surface more extensively, as well as carry instruments such as *in situ resource utilization* (ISRU) experiments that will provide detailed information on extraction of usable resources such as oxygen and water. In addition to obtaining this information, robotic landers will provide critical risk reduction activities for the human-scale lander descent stage and utilization capabilities, including development of critical technologies that will enable precise and soft landings on the lunar surface.

An American human lander effort is underway within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T to advance lower-readiness-level technologies so they can be implemented in future lunar missions. A critical technology development underway involves infusing autonomous sensing, processing, guidance and navigation capabilities to enable soft, controlled landings within tens of meters of a selected target, utilizing real-time hazard detection and avoidance algorithms to ensure a safe and precise landing. In addition, long-term storage of cryogenic fluids is being developed that will enable significantly greater mid-sized and human class lander performance capability at a substantially reduced mass. A deep space engine for landers is being developed with a unique fuel mixture with a lower freezing point that will reduce the power required and lowers the system mass. NASA is also assessing the longer-term higher-power needs to surviving the lunar night and operations in shaded portions of the lunar surface by considering surface fission power that will power ISRU demonstrations and other needs. NASA is also assessing the requirements for next generation spacesuits needed for lunar exploration. In addition, planned landers and rovers provide excellent platforms to demonstrate technologies that will not only enable greater lunar surface mission capabilities but also extend beyond the moon to Mars applications.

NASA is currently assessing different trades from a mid-sized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is examining options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of on-going National need or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated that range from capability stimulation through funded Space Act Agreements to a single partner or contract approach to an international partnership model, or a NASA-led multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace – it takes about 10 years to develop a crewed system. The Apollo LEM has been the only outlier. Produced in 6 years– but at a cost of 24B at current dollars – the LEM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

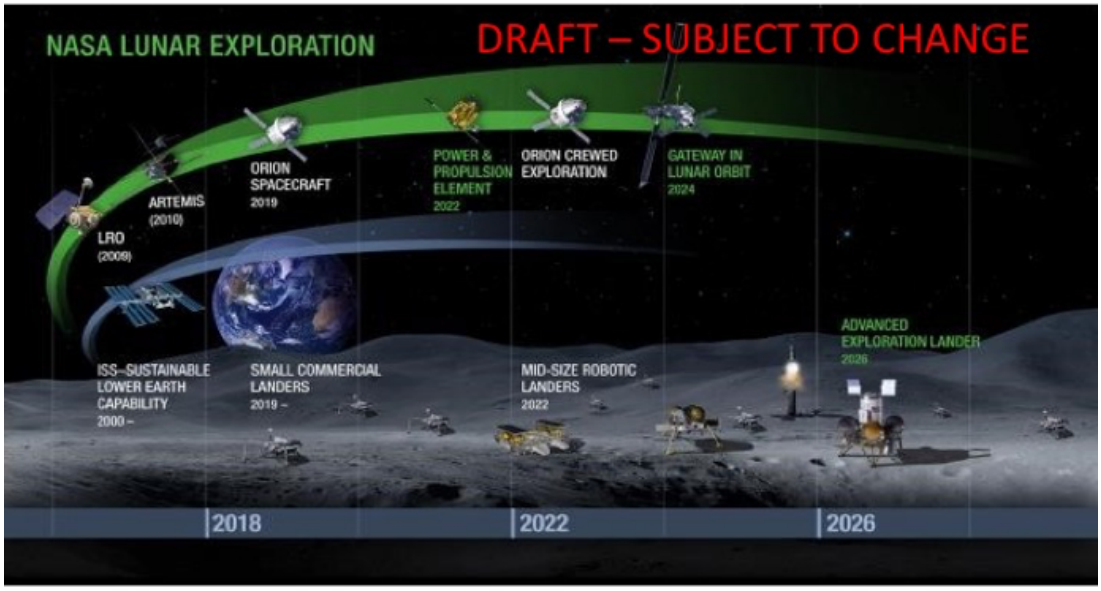
Human exploration of both the lunar surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is both building an exploration launch and crew system (the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting ground systems), and will rely on commercial launch providers to support both robotic surface and lunar orbit operations. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days with additional habitation volume and systems. New engines for Orion's Orbital Maneuvering System-E engine will need to be developed, with designs shaped by future service module development approaches and other possible applications and upgrades currently under assessment. The SLS Block 1 cargo variant will be capable of delivering 70 mT to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 mT to LEO co-manifested with Orion in the mid-to-late 2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), to be launched to lunar orbit in FY 2020 followed by the first crewed SLS/Orion mission, EM-2 no later than 2023. These SLS/Orion missions will demonstrate the capability to reach and operate safely and productively around the Moon.

Decisions related to performance, fairing volume, payload delivery mass and fairing capability evolution on SLS Block 1, 1B, and Block 2 will also need to be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing will also significantly shape the rest of the architecture. In addition, decisions to augment the SLS flight rate need to be laid out five years in advance of the added flights (such as for Europa Clipper). Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability, and cost of commercial launch options.

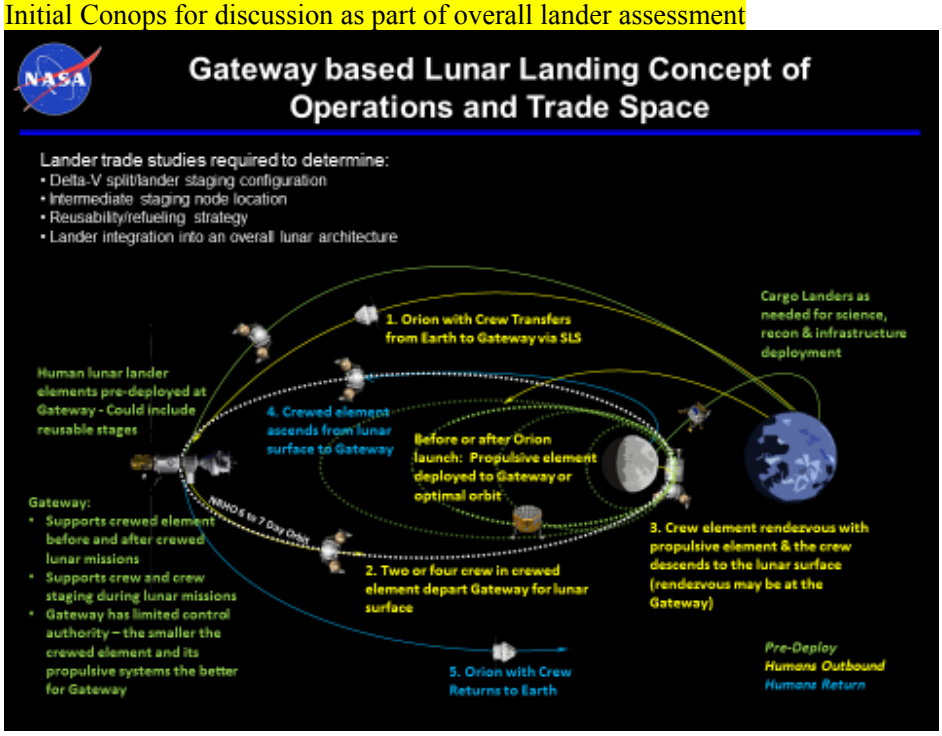
NASA's leadership evolving its current international partners involved with the ISS and opportunities to create new partnerships that add to the overall lunar orbit and surface parts of the Campaign also another National strategic dimension. While NASA is currently prohibited by law from establishing a bilateral partnership with China, we intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation. China has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to a taikonaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans. *Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing and ceding global leadership in cislunar space overall.*

Overall this Exploration Campaign is different from past attempts that could not be sustained or that never matured. With an open architecture approach, the Campaign's lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of new gained knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early-to-mid 2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)



Initial Conops for discussion as part of overall lander assessment



With our open architecture and resilient Campaign approach, NASA will allow for the evolution of its current concept of operations for human lunar surface and orbit activities. Specifically, reusability and the evolution of other architectures are being kept in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander is envisioned, as are the use of Orion systems. SLS is currently being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) Additionally, NASA is looking at other options like a stretched Orion service module and/or a co-manifested retro stage. With open architecture, on-

ramps for new and broadened commercial and international engagement, there will be other trades as the Campaign continues to innovate, adapt and grow.

As we move out with beyond Earth's shores, America will be answering critical strategic questions, such as:

Can the moon become a center for commercial enterprise? Are there significant deposits of water that could be utilized to support human settlement, or extracted for fuel on a human journey to deep space? In the long term scale of human endeavors, understanding what is possible on the moon and being the first to realize its potential could be transformational. Historically, when the explorers Lewis and Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities and they did not know what they might find. Today the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the campaign engage broader sectors of the nation? American companies will help lead this effort. Not only will they build the small landers, NASA will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a major company has experience drilling into the Earth's crust several miles under the ocean, such R&D created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign towards American and global society as a whole? Just as the ISS has spurred broader applications on Earth, America goes to the moon to extend humanity's presence in the solar system and also to improve the lives of people on Earth. The ultra-efficient use of scarce resources by humans in orbit, the production of tools and systems from extant resource off the Earth, or the extraction of water from the frozen lunar regolith are challenges that once mastered will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces and in orbit will push the technological frontier, supporting current trends in autopilot cars, trucks and trains - but with exceptional quality control and robust engineering - designed to operate in the most difficult environment known to human kind.

Nuclear Propulsion for in-Space Transportation - Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future engineering systems.

Critical Decisions and Milestones:

Lunar Surface

2018

Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019

- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020)

- Decision to develop human-class lunar lander capability for demonstration mission in 2024.

- Decision to develop and launch *Discovery*-class NASA lunar resource and science rover mission in 2022, a 500 kg-class rover mission focused on resources and other scientific discoveries, including mobility and sample return capabilities.
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Based on early results of human-class lunar lander development and on the results of the human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial lunar payload services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on results of the cost of lunar surface access, viability of higher-power systems and ISRU as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship and decision on international partnerships and Moon Port configuration. The Moon Ship will also provide broad science research and technology demonstration opportunities from cis-lunar space, including lunar surface (e.g., lunar sample return, telerobotics, etc.), astrophysics, heliophysics, and Earth science.

2020

- Uncrewed SLS/Orion first flight (Exploration Mission 1, or EM-1) in 2020 to the lunar vicinity.
- Initiation of scientific payload development for Moon Ship, by competitively assessing the most suitable and impactful scientific analysis.

- Science and industry missions flown on EM-1 using 13 co-manifested cube sats launched as secondary payloads. (Add/Highlight in earlier text).
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Based on status of launch vehicle development, decide on future Moon Port/Ship logistic resupply missions.

2022

- Conduct a crewed flight – EM-2 – sending Americans around the Moon by June of 2022.
- First element of Moonport/Moonship, the power-propulsion (including communications) element (PPE), emplaced around the Moon.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need and viability of developing and emplacing propellant depots in lunar orbit.

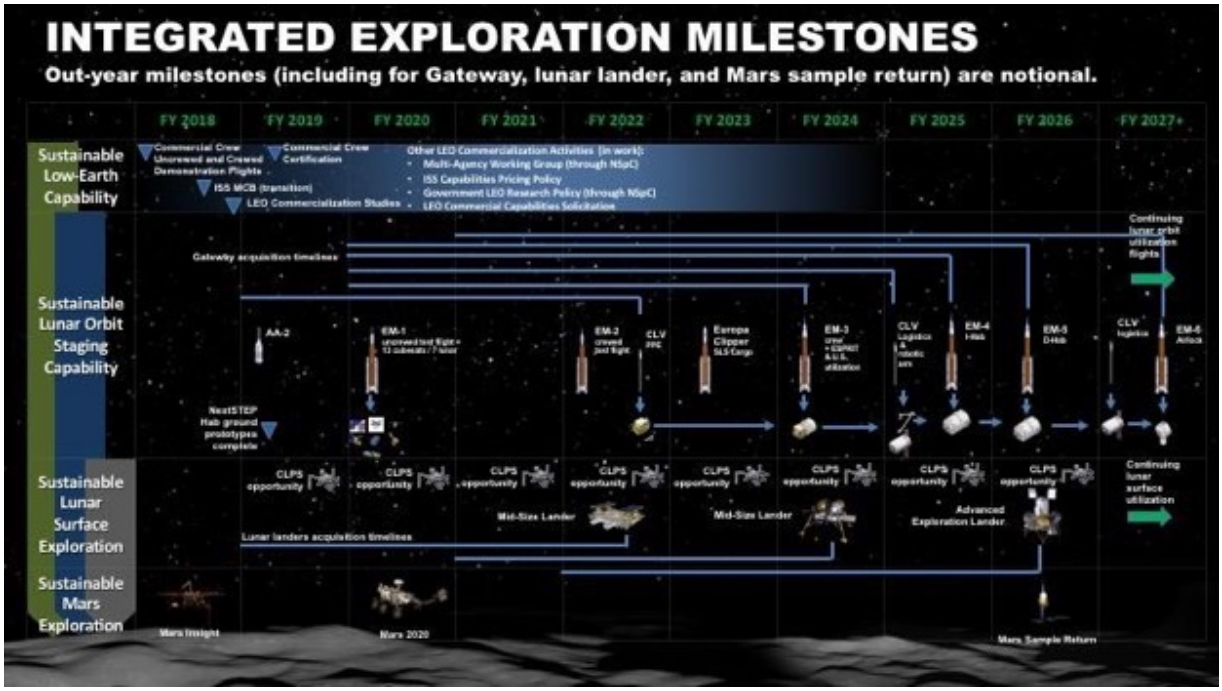


Figure 3: NASA's Exploration Campaign

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for human civilization. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon combined with continued U.S. access to commercial platform(s) in low-Earth orbit will ensure we will continue to advance American leadership in opening up the heavens to further human and scientific development.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests the advanced technologies necessary for long voyages and stays away from Earth. Long-duration exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health, and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to best address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently- crewed testbed prior to deploying these capabilities beyond low-Earth orbit (LEO).

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling discovery and development of advanced robotics, communications, medicine, agriculture, and environmental science. The Station has been an excellent platform for several Earth and space science instruments that leverage the unique infrastructure by mounting high-priority scientific investigations with strong appeal throughout the community

Ongoing operations and research on ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other Government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities. What is needed to allow a movie director to one day produce entertainment on the Station? What is needed to enable an astronaut tourist to dock to the facility and stay the night? Can biotech, materials or manufacturing companies install equipment to

produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services, but more importantly, strengthen overall demand and interest in utilizing a commercial platform in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it opens up significant new opportunities for commercial space flight. U.S. companies could become the first to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless, from tourism to training for deep space missions, it could also enable highly-trained and discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers. Specifically, nations with human spaceflight capability including Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station beginning as early as 2019. Upon completion, it will represent the extension of China's military operations onto a human habitation platform in low Earth orbit. For purposes of diplomacy and commerce, it may also offer an alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include*:*

- Expand the partnerships in LEO to include new companies and new nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including for continuing scientific exploration in low-Earth orbit.
- Pursue other efforts to enable this shift away from direct government funded support of the ISS. For a fuller assessment of the transition of LEO, please refer to the recently published *NASA ISS Transition Report*: https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY19 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development
- Work with Commerce and State, in particular, to spur greater use of ISS and interest in LEO development overall. Identify and eliminate regulatory barrier to enable more commercial activity. Identify and implement incentives for LEO efforts. Examine funding models like the Aviation Trust Fund that may aid the development of on-going non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2026 (Gerst-when is the latest date or necessary date to decide this?)

2024

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2028

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate the appropriate NASA and overall governmental support to ensure on-going NASA requirements in LEO, as well as, ensuring permanent U.S. citizen presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe for thousands of years. As part of the Exploration Campaign in response to SPD-1, this voyage will be able to occur in 2030s. Key components of this part of the Campaign are already underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit and, continuing to lead and advance the world in science missions beyond LEO, including a civilization first round-trip voyage to Mars. The U.S. will embark on the first round-trip return from another planet, Mars, launched by 2026. This mission will bring back samples with a focus on proving the existence of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes development of technologies and systems capabilities that enable a series of human and robotic lunar missions that are extensible to destinations beyond the Moon including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. The InSight mission is on its way to Mars now and will land in November to conduct research into the interior of Mars. The Mars2020 rover is continuing to make excellent progress and will be launching in July 2020. The planning for the return of samples from the Martian surface in the next decade are well under way. Research on Mars is paving the way for human exploration and utilization of the red planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

For example, Mars robotic missions have enabled the U.S. to master the incredibly complex task of entry, descent, and landing (EDL) for one-metric-ton payloads (similar to the size of a compact car), gathered data about radiation in transit and on the surface of Mars, investigated the Martian atmosphere and weather, and shown there exist significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric CO_2 while selecting and encapsulating samples for potential return to Earth. Future robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built upon the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other, and collectively build the world's knowledge base for Mars exploration. These missions have revealed a planet of diverse mineralogy indicating a water-related environment, that Mars could have supported life in its past, the massive loss of the Martian atmosphere through time, thick deposits of ice beneath Mars' surface, the presence of methane and other organics, and a still dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include:
Maintain and grow U.S. leadership at Mars with a rover in 2020, as a first step of a sample-return strategy, searching for past life and demonstrating the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent round-trip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crew Mars missions starting in the 2030s that will culminate in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the Universe and this may bode well for one day finding life on the planet. Later in 2018, NASA will land the InSight lander, a sophisticated analysis into the geology of the Red Planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest flagship priorities for future missions and is relevant to the human exploration initiative as well. Such a mission would be the first interplanetary roundtrip mission demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture; and
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning.
- Two high-visibility technology demonstrations as part of Mars2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable Oxygen from Martian's thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships, and through it assert continuing US leadership throughout, by filling a leadership void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the European Space Agency (ESA), among others. NASA and ESA recently signed a letter of intent to mutually develop a joint MSR plan and to complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked industry for inputs with regard to commercial solutions and this dialogue is ongoing. Given the expected increased data rates (for downlink) required by the science and eventual human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Critical Decisions and Milestones

2019

- Decision on Mars robotic round trip mission (Sample Return) implementation and architecture and target launch date (2026, or 2029,)
- Decision on Mars-forward technology investment R&D portfolio in ER&T
- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (on-going).
- Develop standards for human long-duration deep space transportation vehicles (on-going).

2021

- Based on results of Mars 2020, MOXIE payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T

2024

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic round trip Mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms, and Organizing to Win
OR
How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

To achieve extraordinary success, NASA must consider extraordinary changes from streamlining our organization and management to becoming even more efficient and effective. The Exploration Campaign does not assume or require Apollo levels of funding, but instead seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage and partner for up to 30% in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission – we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

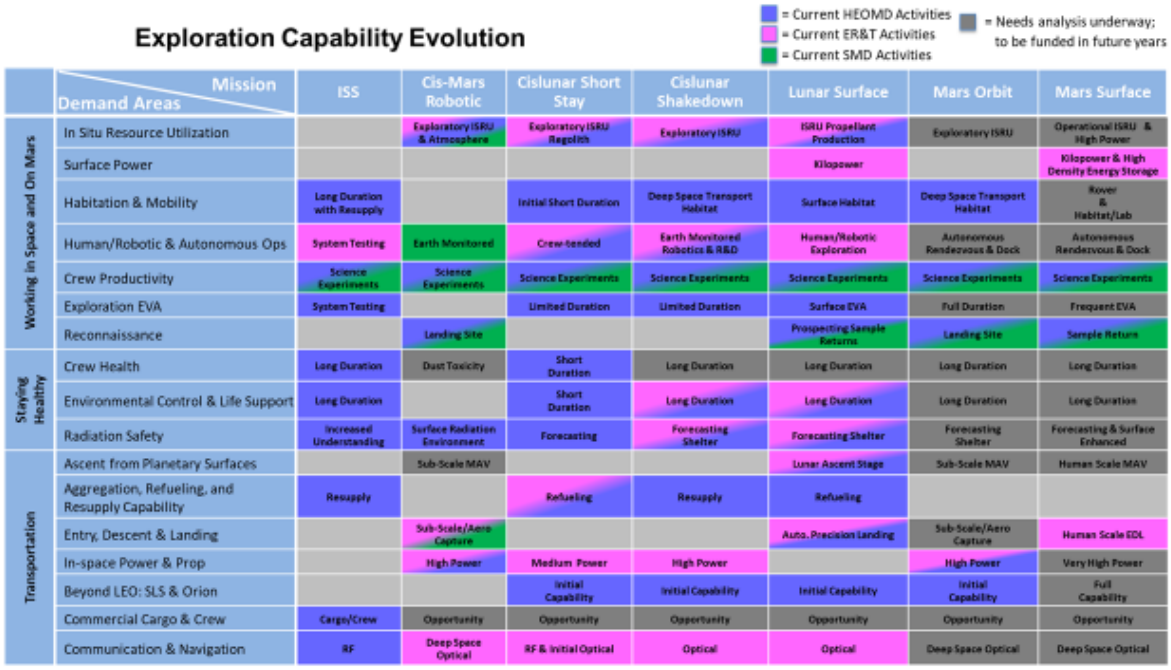
Lastly, NASA recognizes the need for SMD/HEOMD/STMD lunar exploration integration and is looking at different ways to align and focus the Campaign elements. The Agency has already initiated a federated, core Team for the lunar portion of the Exploration Campaign that consists of AA and DAA level participation working with A-suite orchestration. NASA is looking at formalizing this approach thru the establishment of a senior leadership coordination group reporting to the Administrator, Deputy Administrator, or Associate Administrator. In support of this overall Agency effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to the Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA is also examining how to most effectively organize to lead in this key Exploration Campaign initiative.

–Cross-Cutting Technologies: Focused and in Support of the Campaign

ER&T is undergoing significant organizational change to support the Exploration Campaign. The Agency is working to mature exploration technologies and systems in preparation for these cislunar Moon Ship and deep space missions. Exploration Research & Technology (ER&T) is developing advanced power and propulsion technology, including 13 kW SEP Hall thrusters, power processing units, and associated hardware supporting Moon Ship power and propulsion needs and potentially extensible to the needs of deep space architectures. ER&T is also advancing promising transformative technologies across other technology focus areas, including next-generation environmental control and life support systems; ISRU; cryogenic fluid management and long term storage; fission power systems (perhaps leading to nuclear propulsion systems for Mars); advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; EDL; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High-TRL technologies will be applied to near-term missions, while the Agency invests in low-TRL technologies to address challenges of future exploration missions. Wherever possible, these technologies are also being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities as well as Agency architecture strategies.



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National Exploration Campaign Report

Pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1: Forward to the Moon, Mars and Beyond

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign laid out herein is NASA's answer to that bold call. It also directly responds to the policy objectives in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which calls upon the Agency to develop a Human Exploration Roadmap. This Roadmap will include a critical decision plan to expand human presence beyond low Earth orbit (LEO), to the surface of Mars and beyond, considering interim destinations such as cislunar space and the Moons of Mars.

The Campaign aims to revitalize and add direction to NASA's enduring purpose to carry out human and robotic exploration missions that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, other worlds, and the cosmos as a whole; and missions that advance new technologies in aeronautics and space systems that allow American industry to increase market shares and create new markets. The Campaign also responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the nation in space. Challenges and opportunities exist now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation today, centered in part on the U.S.-led International Space Station, is starting to unleash a new economic arena. However, action is necessary to drive this new commercial engine and provide a regulatory and security environment that enables and protects this emerging economic zone. Farther out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond, comes as more countries begin to establish a presence in this region with robotic missions.

When America reaches the Moon, starting early in the next decade, we will not be alone. Other nations are planning their own missions to send spacecraft into lunar orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations all have announced plans or initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013.

Likewise, opportunities and challenges exist on our path to Mars. America has been the unsurpassed leader on the Red Planet. American robotic craft are the only ones in history to successfully land on

Mars. Now, many nations are planning their own missions to Mars's orbit and surface in the coming years. Both the U.S. and China plan, in the next decade, to bring back samples that could indicate the first signs of life beyond our planet.

Opening a New Era: The Sea Beyond Calls

NASA's overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and, most importantly, the American public. It is not a return to the past or a repeat of efforts of the past 25 years, which sought to move beyond the near-Earth regions of space. It is not a geo-political competition to repeat the Apollo era. A lot has changed, and is changing.

The Exploration Campaign builds on the last 17 years of Americans and international partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies and begins operations in the next few years, when we will see the first American capsule and rocket system capable of establishing the first permanent American presence and infrastructure on and around the Moon. At the same time, with rapid advances in America's private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out in this report align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization (ISRU), long-term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA's relationships and collaborations with other U.S. government agencies will expand to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the nation's space goals. To supplement our own creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call. We seek to engage and inspire the next generation, in particular, the vast community of science, technology, engineering and mathematics (STEM) professionals who support major challenges needing these skills.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create preeminence beyond the littoral shores of space – out to, around, and on the Moon. NASA's civil pursuit and international leadership in scientific advancement, human exploration, technological development and civilization-level advancements provides the civilian leadership component of America's strategy to open and secure the seas beyond our planet's shores.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations that support NASA and the needs of an emerging private sector market.

2. Lead the emplacement of capabilities in lunar orbit that support surface operations and facilitate missions beyond cislunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, NASA will lead the Campaign as architect, mission leader and, in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. NASA's strategic implementation approach for the Exploration Campaign follows.

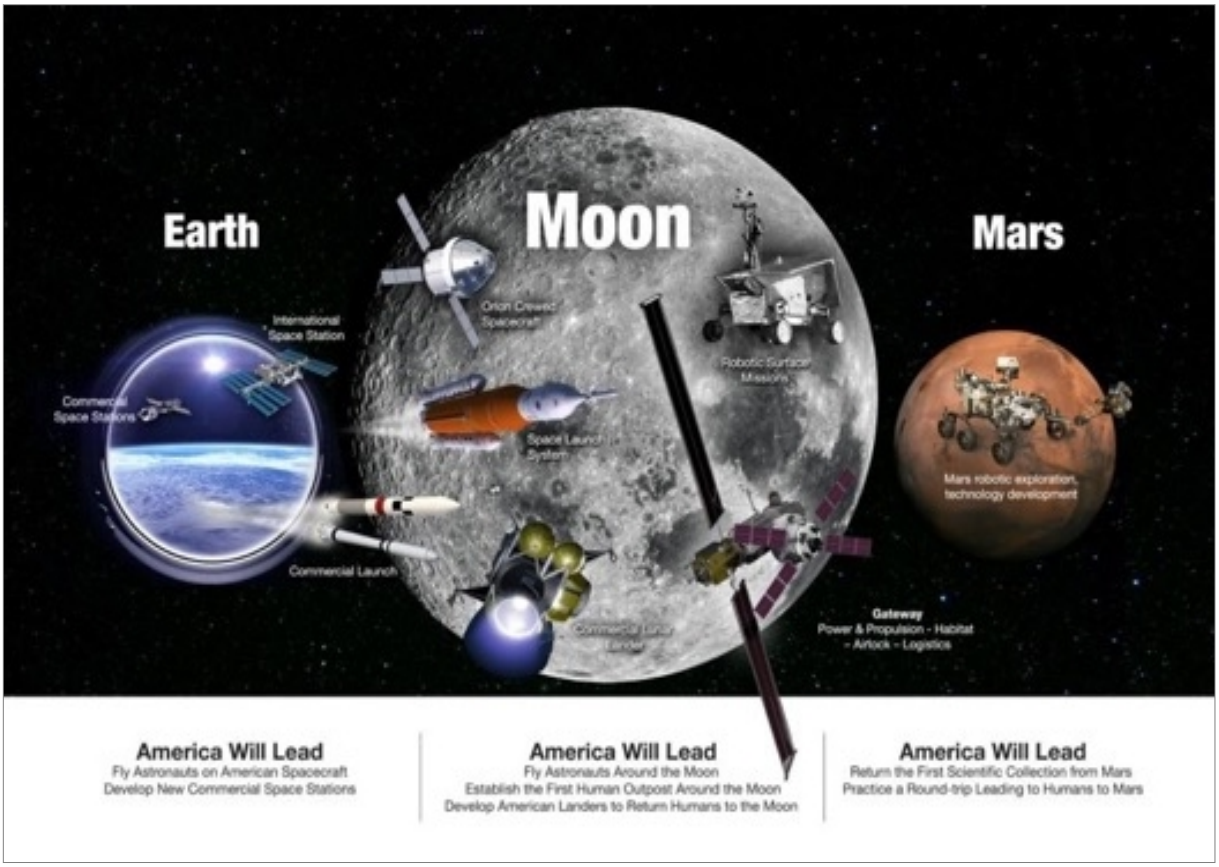


Figure 1: Platforms - From Earth, to the Moon, to Mars

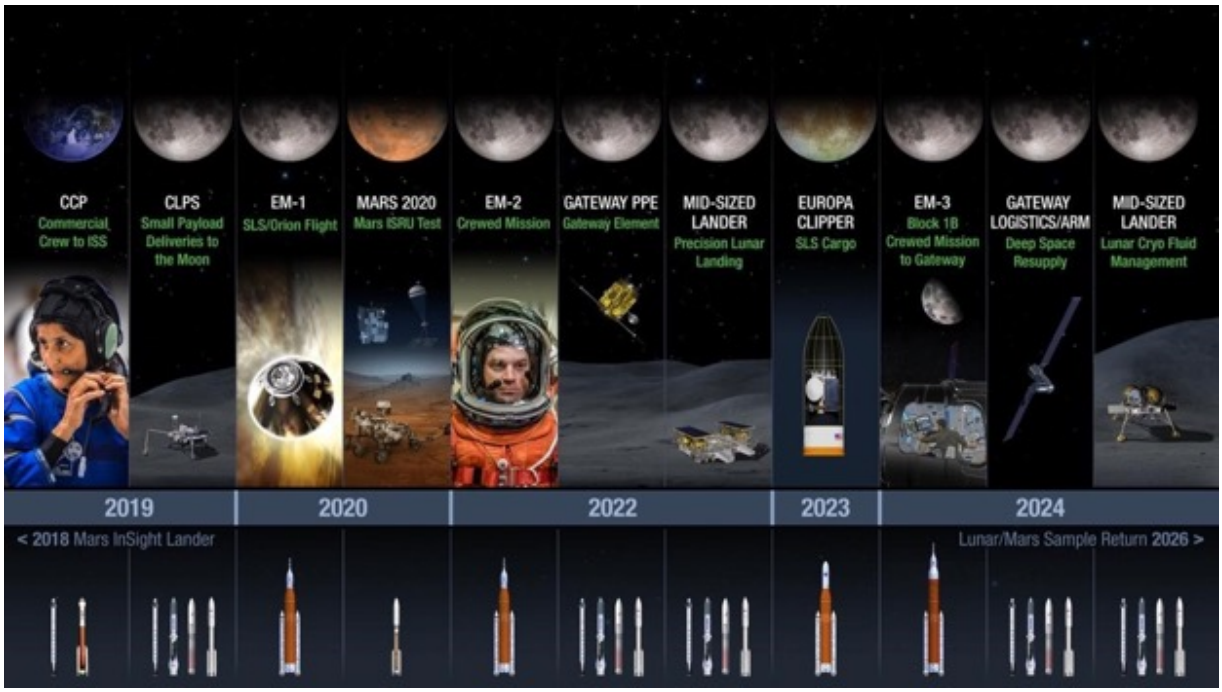


Figure 2: Moon to Mars Timeline

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's offshore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first walked on its surface roughly 50 years ago, our explorers left only fleeting footprints at a few sites, over a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different. NASA is building a plan for Americans to orbit the Moon, starting in 2023, and land astronauts on the surface by no later than the late 2020s. This will be the first chance for the majority of people alive today to witness a U.S. lunar encounter and landing – a moment when, in awe and wonder, the world holds its breath. But, America will not stop there. A core focus of this Campaign is to extend the nation's geo-strategic and economic sphere to encompass the Moon.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar and cosmic radiation for billions of years and left largely undisturbed, the Moon is a historic archive of our Sun and solar system. Scientific mysteries are locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Like the harnessing of fire, making the first solar cells or fuel from lunar regolith will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out) – Living and Working Around the Moon

The American Gateway under development will forge U.S. leadership and presence over the region between the Moon and Earth. It will serve as both a ship and a port. This platform will host astronauts farther from Earth than ever before. A radical advancement in space technology and human life support systems, the platform will offer astronauts longer stays on the lunar surface, easier crew returns, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, validating technologies and systems as we prepare for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the radiation and microgravity environment beyond LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by hosting biological and biomedical studies over longer periods than previously possible. It also will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub, evolving to serve as a way station for the development of refueling depots, servicing platforms, and a sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low-Earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship presently is under construction at NASA centers across the United States, including facilities in Ohio, Texas and Alabama. The first element will launch from Florida in 2022, and crews will be able to inhabit starting in 2023. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar electric propulsion technology, and provide critical functionality for the rest of the space vehicle. NASA will call upon its own workforce to build additional crucial pieces of hardware such as the power and propulsion element and habitation module; push industry to advance the state-of-the-art to deliver logistics modules; and utilize key contributions from international partners, including additional habitat modules and a robotic arm.

We also will study the effects of the deep space environment on the Moon Ship, and its ability to serve as a platform to assemble payloads and systems – robotically or with humans – that could be used for human and scientific exploration. The Ship will be constructed in place, incrementally, using the American-built Space Launch System (SLS), Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

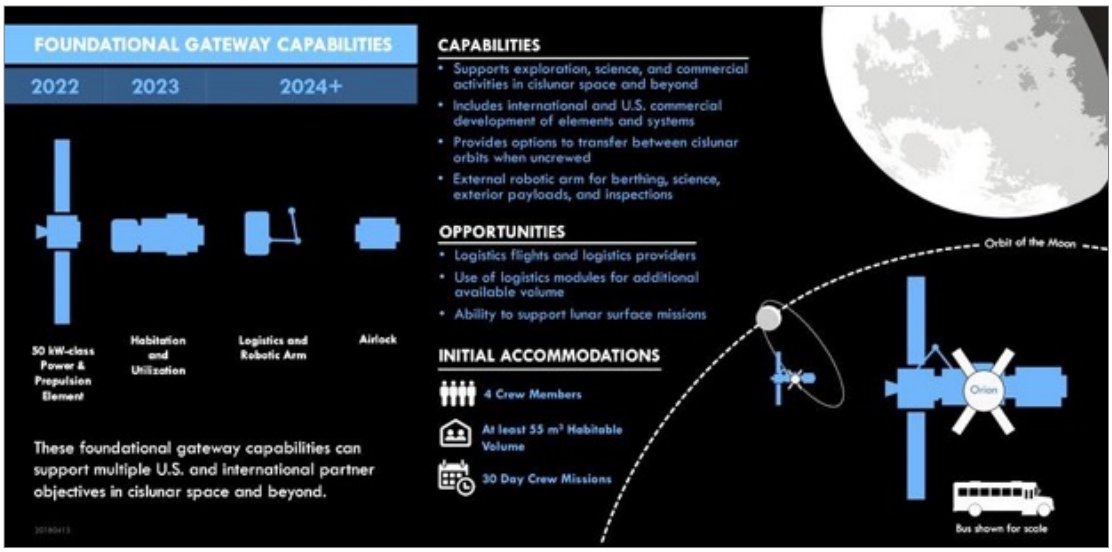


Figure 3: Foundational Gateway Capabilities

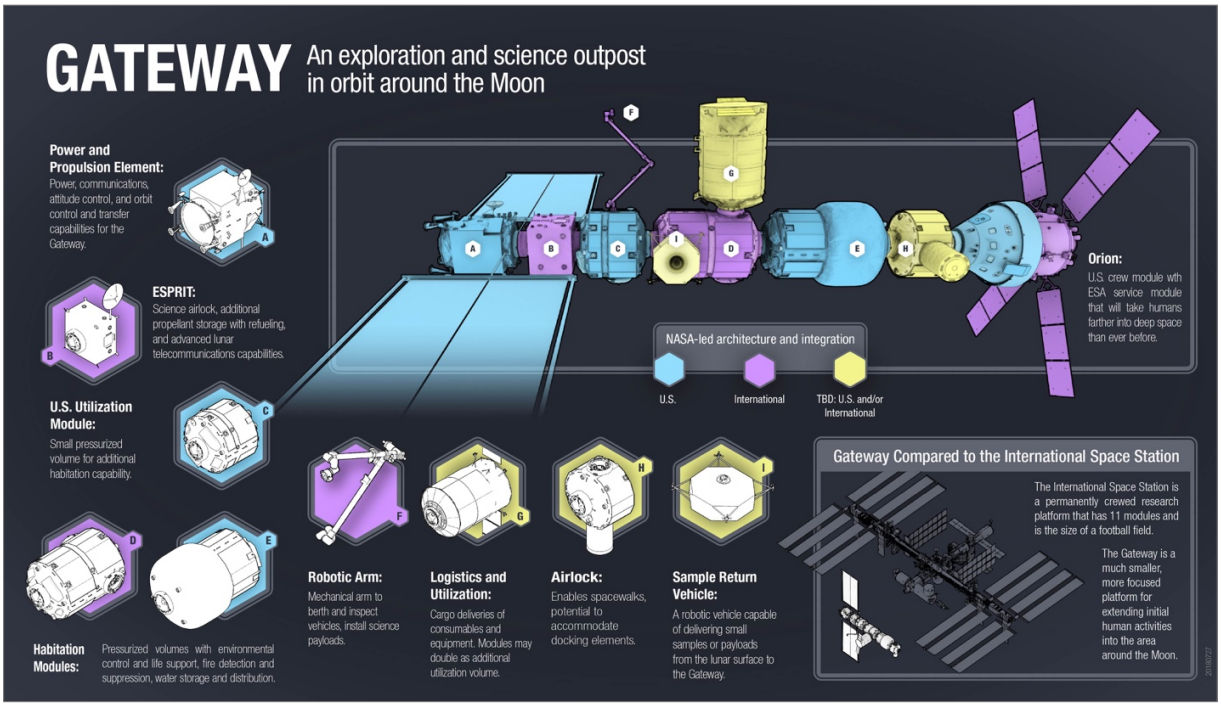


Figure 4: The Gateway

Humans and Robots: Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, training ground, and offshore continent where we will prepare for future human missions to Mars and other destinations. Through an innovative combination of missions involving commercial and international partners, robotic lunar surface missions will begin as early as 2019/20 and will focus on scientific exploration of lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in parallel with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts, in tandem with the Moon Ship, will expand and diversify over time, taking advantage of the Moon and cislunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far side of the Moon for astrophysics, focusing on space weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship combination offers unprecedented research infrastructure. Our current exploration missions, the Lunar Reconnaissance Orbiter and Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS), will be used immediately to support this increase in scientific discovery objectives.

Through the soon-to-be-released Commercial Lunar Payload Services (CLPS) procurement, NASA has started a program of robotic lunar missions overseen by its Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP) that will provide delivery of early, small payloads using emerging commercial landers – the defining values being speed and commercial partnership. In addition, NASA will focus on continued growth of emerging commercial capabilities to enhance further our human lunar lander capabilities and utilization of the Moon (including potential lunar communications networks). An assessment is underway to identify the best development path for an SMD-led rover capability and midsized lander. In every aspect, technology and commercial sector capabilities will feed forward and integrate with human exploration approaches.

While we have extensive orbital information about the lunar surface and potential resources, robotic lunar scouts are essential to validate past observations and prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data; multiple landers will provide a global-scale view of the Moon and its resources. Landers will be outfitted with sensor packages and provide critical risk-reduction activities for the human-scale lander descent stage and utilization capabilities, including development of critical technologies that will enable precise and soft landings on the lunar surface. Rovers will be used to explore the surface more extensively, carrying instruments such as ISRU experiments that will provide detailed information on the availability and extraction of usable resources, including oxygen and water.

An American human lander effort has been initiated within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T) to advance lower readiness-level technologies so they can be implemented in future lunar missions. Critical technology development underway infuses autonomous sensing, processing, guidance and navigation capabilities to enable safe, precise and controlled landings with real-time hazard detection and avoidance algorithms. In addition, long-term storage of cryogenic fluids is being developed to enable significantly greater performance capability of midsized and human-class landers at a substantially reduced mass. Also under development is a deep-space lander engine that uses a unique fuel mixture with a lower freezing point that will reduce the power required and lowers the system mass. NASA is reviewing longer-term, higher-power capabilities needed to survive lunar nights and operations in shaded portions of the lunar surface by considering surface fission power that will fuel ISRU demonstrations and other needs. NASA also is studying requirements for the next-generation spacesuits needed for lunar exploration. Planned landers

and rovers provide excellent platforms to demonstrate technologies that will enable greater lunar surface mission capabilities and have applications that extend beyond the Moon to Mars.

NASA is conducting a study to identify, and present for decision, the different trades from a midsized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is developing options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of ongoing national need, or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated and range from capability stimulation through funded Space Act Agreements to a single partner or contract approach, to an international partnership model or NASA-led, multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace; it takes about 10 years to develop a crewed system. The Apollo Lunar Module has been the only outlier. Produced in six years – but at a cost of $14.7 billion, in current dollars – the LM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

Human exploration of both the Moon's surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is building an exploration launch and crew system – the Orion spacecraft, heavy-lift SLS launch vehicle, and supporting ground systems – and will rely on commercial launch providers to support robotic lunar surface and orbit operations. The Orion spacecraft will carry up to four humans into deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days, with additional habitation volume and systems. New engines for Orion's Orbital Maneuvering System-E engine will need to be developed, with designs shaped by future service module development approaches and other possible applications and upgrades currently under assessment. The SLS Block 1 cargo variant will be capable of delivering 70 metric tons to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 metric tons to LEO, co-manifested with Orion, in the mid- to late-2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), currently scheduled to launch to lunar orbit in FY2020, followed by the first crewed SLS/Orion mission, EM-2, no later than 2023. These SLS/Orion missions will demonstrate the capability to reach, and operate safely and productively around, the Moon.

Decisions related to performance, fairing volume, payload delivery mass, and fairing capability evolution on SLS Block 1, 1B, and 2 also will need to be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing also will significantly shape the rest of the architecture. In addition, decisions to augment the SLS flight rate need to be laid out five years in advance of the added flights. Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability and cost of commercial launch options.

NASA's leadership with its current international partners involved with the ISS is shifting towards the Moon. We also are moving on new opportunities to create partnerships that add to the overall lunar orbit and surface parts of the Campaign. We intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation. In addition, China has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to a taikonaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans.

Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing, and ceding global leadership in cislunar space overall.

NASA currently is prohibited, by law, from establishing a bilateral partnership with China.

Overall, this Exploration Campaign is different from past attempts that were unsustainable or never matured. With an open architecture approach, the Campaign's lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of newly acquired knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early- to mid-2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that, as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)

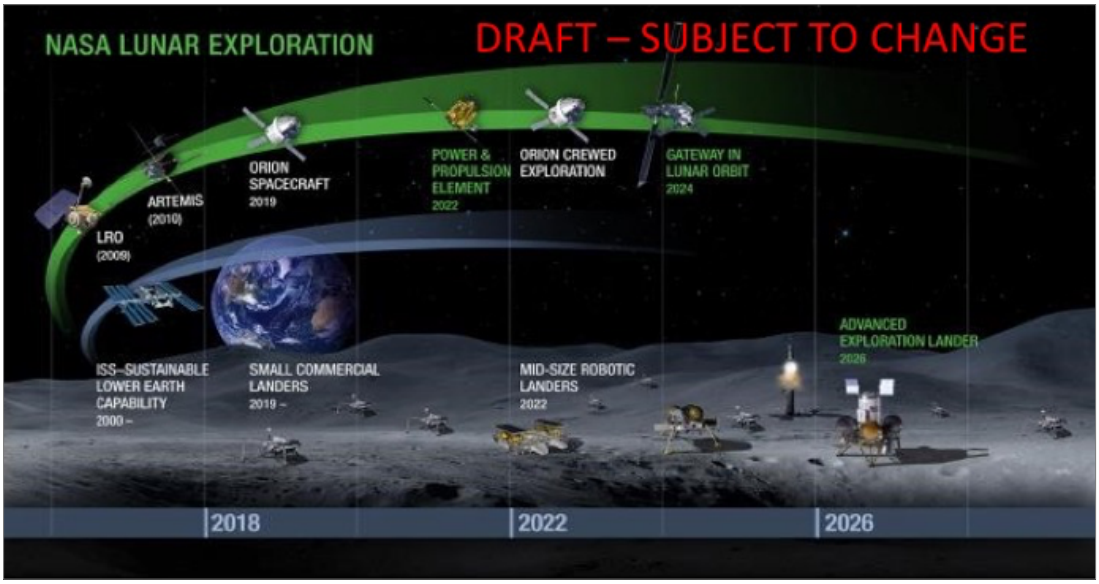


Figure 5: NASA Lunar Exploration to 2026

Initial Conops for discussion as part of overall lander assessment

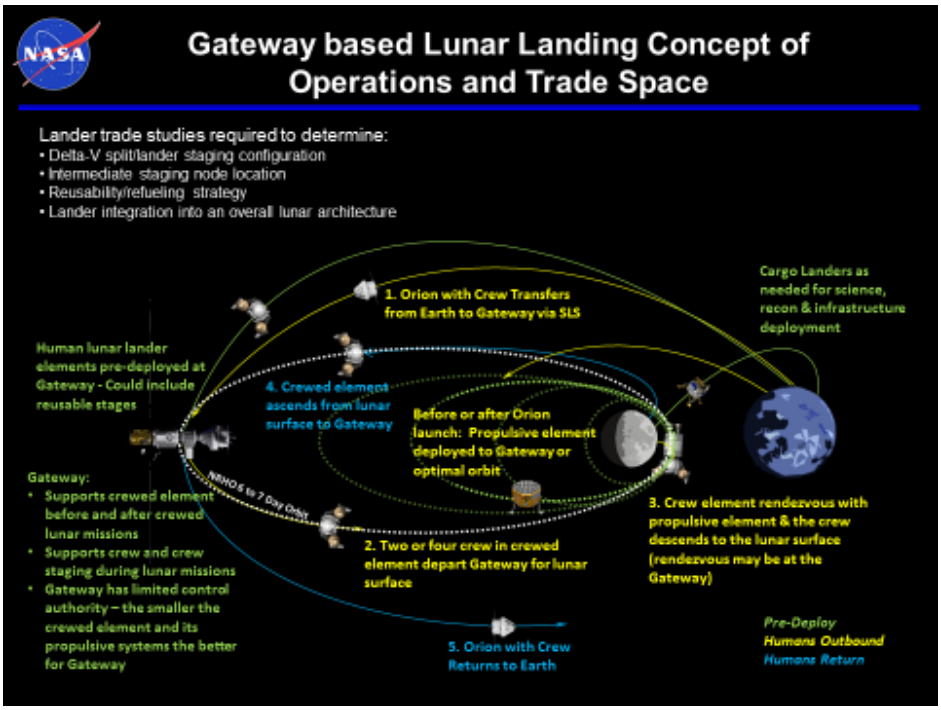


Figure 6: Lunar Landing Concept of Operations

With our resilient Campaign approach, NASA will allow, as warranted, its concept of operations for human lunar surface and orbit activities to mature. Specifically, reusability and the evolution of other architectures will remain in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander also is envisioned, as is the reuse of Orion systems. SLS currently is being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) With an open architecture, on-ramps for new and broadened commercial and international engagement, there will be other growth as the Campaign continues to innovate and adapt.

As we move beyond Earth's shores, America will be answering critical strategic questions, such as:

Can the Moon become a center for commercial enterprise? Are there significant deposits of water that can be used to support human settlement, or extracted for fuel on a human journey to deep space? In the long-term scale of human endeavors, understanding what is possible on the Moon and being the first to realize its potential could be transformational. When the explorers Meriwether Lewis and William Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities, and they did not know what they might find. Today, the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the Campaign engage broader industrial sectors in our nation? American companies will help lead this effort. Not only will they build the small landers, the U.S. government will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a company has experience drilling into the Earth's crust, several miles under the ocean, such research and development (R&D) created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign into American and global society as a whole? Just as the ISS spurred broader applications and innovations on Earth, America goes to the Moon to extend humanity's presence in the solar system and to improve the lives of people on Earth. The ultra-efficient use of scarce resources in orbit, the production of tools and systems from extant resources off the Earth, or the extraction of water from frozen lunar regolith are challenges that, once mastered, will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces, and in orbit, will push the technological frontier and support current trends in autopiloted vehicles – with exceptional quality control and robust engineering needed to design vehicles to operate in the most difficult environment known to humanity.

How will advanced propulsion play a role in opening the ocean of space for American voyagers well beyond today's limitations? For example, what role will nuclear propulsion for space transportation play? Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future systems.

Critical Decisions and Milestones:

Lunar Surface

2018

- Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019
- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020).
- Decision to develop human-class lunar lander capability for demonstration mission in 2024.
- Decision to develop and launch Discovery-class NASA lunar rover mission in 2022 – a 500 kilogram-class rover mission focused on resources and other scientific discoveries, including mobility and sample return capabilities.
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Based on early results of human-class lunar lander development and human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems and partnerships, or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on the cost of lunar surface access, viability of higher-power systems and ISRU, as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship, international partnerships, and Moon Port configuration. The Moon Ship also will provide broad science research and technology demonstration opportunities from cislunar space, in areas including lunar surface (e.g., lunar sample return, telerobotics, etc.), astrophysics, heliophysics and Earth science.

2020

- SLS/Orion first flight (EM-1), uncrewed, to the lunar vicinity.
- Initiate scientific payload development for Moon Ship by competitively assessing the most suitable and impactful scientific analysis.
- Science and industry missions flown on EM-1 using 13 co-manifested cube sats launched as secondary payloads.
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Based on status of launch vehicle development, decide on future Moon Port/Ship logistic resupply missions.

2022

- By June, conduct crewed flight, EM-2, sending Americans around the Moon.
- First element of Moon Port/Moon Ship – the power-propulsion (including communications) element (PPE) – placed in lunar orbit.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need for, and viability of, developing and placing propellant depots in lunar orbit. Assess and make appropriate decisions on Moon Ship/Port evolution requirements.

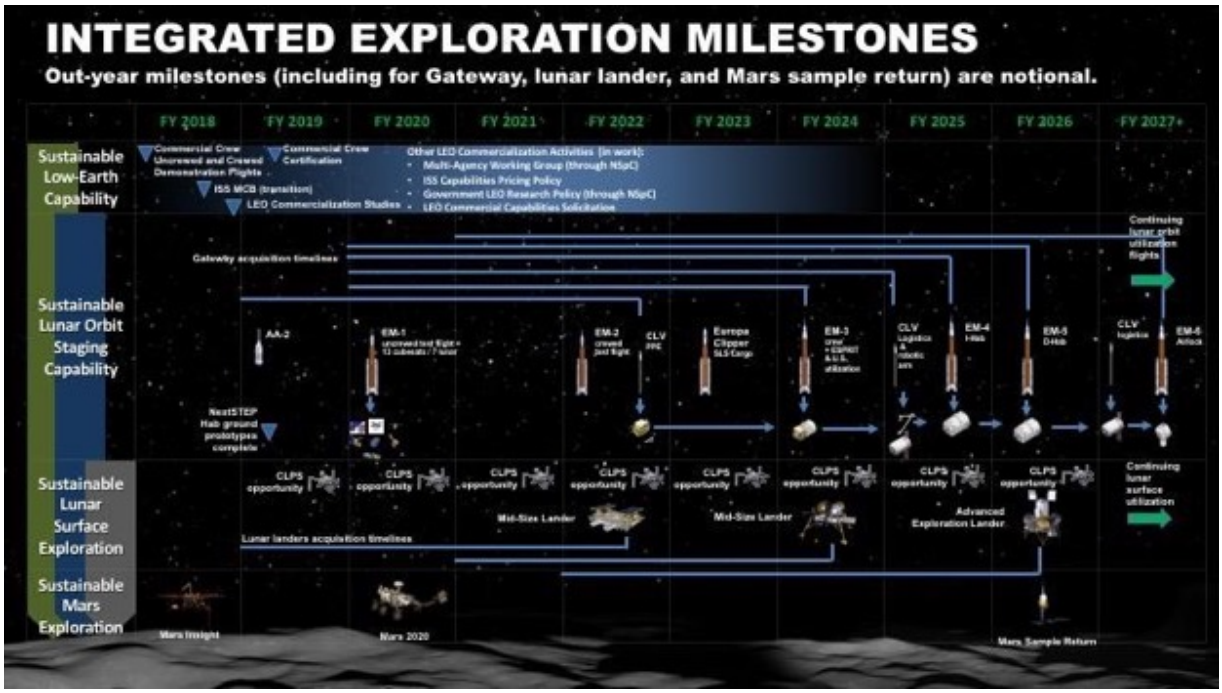


Figure 7: Integrated Exploration Milestones

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for humanity. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon, combined with continued U.S. access to commercial platform(s) in low-Earth orbit, will ensure we advance American leadership in opening up the heavens to further human and scientific development well into the future.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests on the advanced technologies necessary for long voyages and stays away from Earth. Long-duration, exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA also is using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration missions. For example, elements of ISS life support and other habitation systems will be evolved into the systems for deep space missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently-crewed testbed prior to deploying these capabilities beyond LEO.

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling the research and development of advanced robotics, communications, medicine, agriculture, and environmental science. The station's unique infrastructure has provided and unequalled platform for several Earth and space science instruments that conduct high-priority investigations with strong appeal throughout the global science community

Ongoing operations and research on the ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities to answer many forward-looking questions. How can we to allow a movie director one day to produce entertainment on the space station, or enable a tourist astronaut to dock to the facility and stay the night? Can biotechnology, materials or manufacturing

companies install equipment to produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In pursuit of a timely development and transition of commercial capabilities in LEO, where NASA envisions being one of many customers in the mid-2020s, the Administration is requesting $150 million in FY2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities that will ensure commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services and, more importantly, strengthen overall demand and interest in utilizing a commercial platform(s) in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low-Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it will open significant new opportunities for commercial space flight. U.S. companies will begin to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless – from tourism to training for deep space missions. It could also enable highly trained, discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers, specifically, nations with human spaceflight capability. Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station as soon as 2019. Upon completion, it will represent the extension of China's military operations to a human habitation platform in low-Earth orbit. For purposes of diplomacy and commerce, it also may offer a strategic alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of companies such as SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include*:*

- Expand partnerships in LEO to include new companies and nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including those that continue scientific exploration in low-Earth orbit.
- Pursue other efforts to enable the shift away from direct government-funded support of the ISS. For a full assessment on the transition of LEO, please refer to the recently published NASA ISS Transition Report at https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13 selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY2019 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development.
- Work with the U.S. Departments of Commerce and State to spur greater use of ISS and overall interest in LEO development. Identify and eliminate regulatory barriers to enable increased commercial activity. Identify and implement incentives for LEO efforts. Examine funding models, such as the Aviation Trust Fund, that may aid the development of ongoing non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether to extend ISS operations to 2026.

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate NASA and overall governmental support to ensure ongoing NASA requirements and permanent U.S. presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe far into humanity's future. As part of the Exploration Campaign, in response to SPD-1, this voyage will be able to take place in the 2030s. Key components of this part of the Campaign already are underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit, and continuing to lead and advance the world in science missions beyond LEO – including a civilization first roundtrip voyage to Mars. The U.S. will embark on this first roundtrip to another planet, Mars, in 2026. This mission will bring back samples that focus on answering the ageless question of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes the development of technologies and systems that enable a series of human and robotic lunar missions and are extensible to destinations beyond the Moon, including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. NASA's InSight mission is on its way to Mars now and will land in November to study the interior of Mars. The Mars 2020 rover is continuing to make excellent progress and is scheduled to launch in July 2020. Planning to return samples from the Martian surface is well underway. Research on Mars is paving the way for human exploration and utilization of the Red Planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

For example, Mars robotic missions have: enabled the United States to master the incredibly complex task of entry, descent and landing of one-metric-ton payloads (similar to the size of a compact car); gathered data about radiation in transit and on the surface of Mars; investigated the Martian atmosphere and weather; and shown the existence of significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric carbon dioxide while selecting and encapsulating samples for potential return to Earth. Future robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built on the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other and, collectively, build the world's knowledge base for Mars exploration. These missions have revealed that Mars has a diverse mineralogy indicative of a water-related environment; could have supported life in its past; experienced a massive loss of its atmosphere over time; has thick deposits of ice beneath its surface; holds methane and other organics; and is a dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include: Maintain and grow U.S. leadership at Mars with a rover in 2020 – as the first step of a sample-return strategy – to search for past life and demonstrate the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent roundtrip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship, and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crewed Mars missions starting in the 2030s and culminating in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the universe, and this may bode well for a future discovery of life on the planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest-priority flagship missions and is relevant to the human exploration initiative, as well. Such a mission would be the first interplanetary roundtrip mission, demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture;
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning; and
- Two high-visibility technology demonstrations, as part of Mars 2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable oxygen from Mars' thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships and assert continuing U.S. leadership by filling a void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the ESA (European Space Agency), among others. NASA and ESA recently signed a letter of intent to develop a joint MSR plan and complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked private industry for input, with regard to commercial solutions, and this dialogue is ongoing. Given the expected increase in data rates (for downlink) required by science and, in the future, human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Critical Decisions and Milestones

<u>2019</u>

- Decision on Mars robotic roundtrip mission (Mars Sample Return) implementation and architecture and target launch date (2026 or 2029).
- Decision on Mars-forward technology investment R&D portfolio in ER&T.

- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (ongoing).
- Develop standards for human long-duration deep space transportation vehicles (ongoing).

2021

- Based on results of Mars 2020, the Mars Oxygen ISRU Experiment (MOXIE) payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T.

2024

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic roundtrip mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms and Organizing to Win
OR
How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

To achieve extraordinary success, NASA must consider extraordinary changes, from streamlining our organization and management to becoming even more efficient and effective. The Exploration Campaign does not assume or require Apollo levels of funding but, instead, seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage partnerships for up to 30 percent in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission, and we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

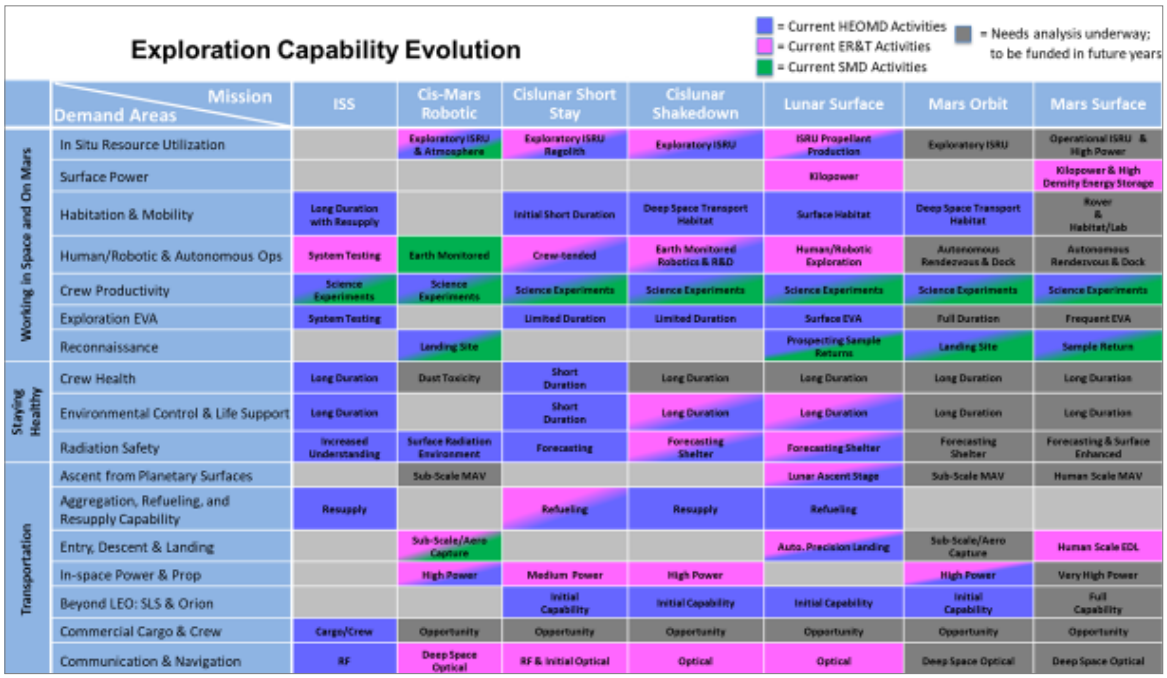
Lastly, NASA recognizes the need for lunar exploration integration between its Science, Human Exploration and Operations, and Space Technology Mission Directorates, and is looking at different ways to align and focus the Campaign elements. The Agency already has initiated a federated core team for the lunar portion of the Exploration Campaign that is orchestrated by the Agency Administrator with day to day support by his direct, front-office staff. r. NASA is looking at formalizing this approach through the establishment of a senior leadership coordination group reporting to the Administrator, and Associate Administrator. In support of this effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA also is examining how to most effectively organize to lead in this key Exploration Campaign initiative.

–Cross-Cutting Technologies: Focused On and in Support of the Campaign

Exploration Research & Technology (ER&T) is undergoing significant organizational change to support the Exploration Campaign. The Agency is working to mature exploration technologies and systems in preparation for cislunar Moon Ship and deep space missions. ER&T is developing advanced power and propulsion technology – including 13-kilowatt solar electric propulsion Hall thrusters, power processing units, and associated hardware – to support Moon Ship power and propulsion needs and, potentially, extend to meet the needs of deep space architectures. ER&T also is advancing promising transformative technologies across other technology focus areas, including: next-generation environmental control and life support systems; ISRU; cryogenic fluid management and long-term storage; fission power systems (perhaps leading to nuclear propulsion systems for Mars); advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; entry, descent and landing; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High readiness-level technologies will be applied to near-term missions, while the Agency invests in low readiness-level technologies to address challenges of future exploration missions. Wherever possible, these technologies also are being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities, as well as Agency architecture strategies.



Exploration Capability Evolution

= Current HEOMD Activities
= Current ER&T Activities
= Current SMD Activities
= Needs analysis underway; to be funded in future years

	Mission / Demand Areas	ISS	Cis-Mars Robotic	Cislunar Short Stay	Cislunar Shakedown	Lunar Surface	Mars Orbit	Mars Surface
Working in Space and On Mars	In Situ Resource Utilization		Exploratory ISRU & Atmosphere	Exploratory ISRU Regolith	Exploratory ISRU	ISRU Propellant Production	Exploratory ISRU	Operational ISRU & High Power
	Surface Power					Kilopower		Kilopower & High Density Energy Storage
	Habitation & Mobility	Long Duration with Resupply		Initial Short Duration	Deep Space Transport Habitat	Surface Habitat	Deep Space Transport Habitat	Rover & Habitat/Lab
	Human/Robotic & Autonomous Ops	System Testing	Earth Monitored	Crew-tended	Earth Monitored Robotics & R&D	Human/Robotic Exploration	Autonomous Rendezvous & Dock	Autonomous Rendezvous & Dock
	Crew Productivity	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments
	Exploration EVA	System Testing		Limited Duration	Limited Duration	Surface EVA	Full Duration	Frequent EVA
	Reconnaissance		Landing Site			Prospecting Sample Returns	Landing Site	Sample Return
Staying Healthy	Crew Health	Long Duration	Dust Toxicity	Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Environmental Control & Life Support	Long Duration		Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Radiation Safety	Increased Understanding	Surface Radiation Environment	Forecasting	Forecasting Shelter	Forecasting Shelter	Forecasting Shelter	Forecasting & Surface Enhanced
Transportation	Ascent from Planetary Surfaces		Sub-Scale MAV			Lunar Ascent Stage	Sub-Scale MAV	Human Scale MAV
	Aggregation, Refueling, and Resupply Capability	Resupply		Refueling	Resupply	Refueling		
	Entry, Descent & Landing		Sub-Scale/Aero Capture			Auto. Precision Landing	Sub-Scale/Aero Capture	Human Scale EDL
	In-space Power & Prop		High Power	Medium Power	High Power		High Power	Very High Power
	Beyond LEO: SLS & Orion			Initial Capability	Initial Capability	Initial Capability	Initial Capability	Full Capability
	Commercial Cargo & Crew	Cargo/Crew	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity
	Communication & Navigation	RF	Deep Space Optical	RF & Initial Optical	Optical	Optical	Deep Space Optical	Deep Space Optical

Figure 8: Exploration Capability Evolution

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Framing the Week Ahead - Office of Communications - June 22

From: Jacobs, Bob (HQ-NA000) <bob.jacobs@nasa.gov>, Jacobs, Bob (HQ-NA000) </O=NASA/OU=JSC/CN=RECIPIENTS/CN=747738362>
Sent: June 22, 2018 5:39:06 PM EDT
Received: June 22, 2018 5:39:06 PM EDT

Framing the Week Ahead

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This week we look forward to the next commercial resupply mission to the International Space Station with the launch of SpaceX Dragon CRS-15 on Friday. We're also planning to host an update on the James Webb Space Telescope. Throughout the week, students from across the U.S. will participate in three live events with astronauts aboard the International Space Station. The events serve as question-and-answer sessions and are hosted as part of NASA's Year of Education on Station.

Administrator's Activities

On June 25, Jim speaks on a panel at the White House State-Federal STEM Summit about the Importance of STEM and the role of our agency in promoting it. He also speaks at the HQ Fitness Center Awards that day. On June 27, he talks about the Future of Exploration at the White House Youth Summit. He'll also be interviewed by Politico during the public event: "The New Space Age: A Conversation with NASA Administrator Jim Bridenstine" from 7-8 p.m. EDT.

Media Teleconference on James Webb Space Telescope

On June 27, NASA is planning to host a media teleconference at 1 p.m. EDT, to provide an update on the agency's James Webb Space Telescope – what will be the world's premier space observatory and the biggest astronomical space science telescope ever built. The most technically demanding and powerful space observatory ever developed, Webb will solve mysteries of our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Audio of the call will stream live on NASA's website along with associated report and other materials.

Launch of SpaceX Dragon CRS-15 Mission to ISS

On June 29, NASA commercial cargo provider SpaceX is targeting launch of its 15th resupply mission to the space station for no earlier than 5:42 a.m. EDT. Packed with more than 5,900 pounds of research, crew supplies and hardware, the SpaceX Dragon spacecraft will launch on a Falcon 9 rocket from the Cape Canaveral Air Force Station in Florida for a 3-day trip to the station. Live coverage begins on NASA Television and the agency's website <https://www.nasa.gov/nasalive> Thursday, June 28, with prelaunch events, including a What's On Board Science Briefing at 11 a.m. EDT followed by a Prelaunch News Conference at 12:45 p.m. EDT. Launch day coverage begins at 5:15 a.m. A Postlaunch news conference is scheduled for8 a.m.

International Space Station Activities

Students in New York, Washington, DC, and California talk to astronauts on orbit during three downlink events. Coverage airs live on NASA Television and the agency's website.

On June 25, at 11:15 a.m. EDT, students at the Spruce Street School in New York will speak with NASA's Ricky Arnold who is onboard the space station.

On June 27 at 11:05 a.m. EDT, NASA’s Serena M. Auñón-Chancellor talks with students at the Smithsonian’s National Air and Space Museum in Washington. Attendees will include 300-400 middle school students from the greater D.C. metro area. Future Engineers, an online K-12 educational platform, is partnering with the Smithsonian and including its national design challenge winners.

On June 28 at 1:40 p.m. EDT, NASA’s Auñón-Chancellor speaks with students at Armstrong Flight Research Center in California during the center’s first-ever ISS downlink event. The event is part of Armstrong’s Bring Your Child to Work Day. Several local scout groups and summer camps will make up an audience of about 200 students.

METRICS

• The June 18 Space Council meeting and signing of Space Policy Directive-3 was the busiest day in the news this week. There were about 300 media hits (in Agility) mentioning Space Council+NASA, with stories noting comments by former astronauts serving on the council, pickups of the NASA press release with the Administrator's statement and preview content carried by newswires and NPR affiliates mentioning plans to tackle issues of orbital debris. Our best-performing Tweet for this event featured a video clip of Administrator Bridenstine talking about returning to the Moon, while our best-performing Facebook post <https://www.facebook.com/NASA/photos/a.67899501771.69169.54971236771/10156344498856772/?type=3> reached 457K people and asked them to tune in to watch the event.

• There were over 1,300 media hits from June 18-19 for the "space force" proposal, including coverage in major outlets: Washington Post, Yahoo news, NPR, Fox News, CNET, Forbes, the New York Times, Axios, Bloomberg, The Week, Atlanta Journal-Constitution, Philadelphia Inquirer, Popular Science, CNBC, the Verge, VOX. The majority of these stories (about 1,100) did not mention NASA. Google Trends found over 500K Google searches for June 18 for "space force,” making it #4 on the list of breakout top search topics for the entire day of June 18 in the United States. Search queries most used by the public for this topic associate it with branches of the military and terms like "enlistment" or "recruitment," or with pop culture references.

• The NASA and FEMA teleconference focusing on the near-Earth object preparedness plan release drew around 150 media hits this week, the majority of which (65%) were radio news bulletins from stations around the country. There was a steady audience though not a large one for the teleconference itself, peaking at 257 simultaneous listeners and a total of 882 unique listeners tuning in. The web feature had about 9.5K pageviews.

• An unexpected traffic spike on NASA.gov came at the end of the week, thanks to a question from the public (on Reddit) - a Space Station Research web page outlining the Aquatic Habitat experiment on the station received over 65K pageviews in a day, when a user on the /askScience message board posted the question, "How would having a fish in the ISS work? <https://www.reddit.com/r/askscience/comments/8syf6g/how_would_having_a_fish_in_the_iss_work/>" and others responded with a link to the NASA.gov page <https://www.nasa.gov/mission_pages/station/research/experiments/221.html>.

• For the past week, Mars was once again the most popular content on NASA.gov as well as in social media conversations related to NASA, with the "perfect storm" web feature <https://www.nasa.gov/feature/jpl/nasa-encounters-the-perfect-storm-for-science> on Opportunity ranking as the most-viewed, followed by an image from the Mars Reconnaissance Orbiter <https://www.nasa.gov/image-feature/jpl/bang-and-whoosh/>, and the organic materials news release from Curiosity, which continues to draw traffic and now has over 520K pageviews total for the year. @NASA’s most popular tweet <https://twitter.com/NASA/status/1009590475840466944> was a different Mars Reconnaissance Orbiter image of a “blue dune” on Mars, which was posted as NASA's Image of the Day on June 20 and shared to our flagship social media accounts. It was retweeted 3,691 times and achieved a reach of 61.8 million. Elon Musk retweeted <https://twitter.com/elonmusk/status/1009605123117670400> this post, and this retweet became the second most retweeted NASA-related tweet this week.

• NASA was one of the first brands to roll out vertical video on Instagram - IGTV - when the company announced the product update earlier this week. We have two longer form videos on our channel: one showing Earth views from the Space Station and the "What's Up for June" video. In less than 24 hours, the What's Up video has garnered 680k views and the Earth views video has 218k views. We were as high as the #17 most popular video on launch day, and eventually moved up to #10.

• On Facebook, the top post this week <https://www.facebook.com/NASA/posts/10156345125156772> highlighted the anniversary of Sally Ride's historic flight on STS-7, using the text and images from a web feature posted by Johnson Space Center. This post reached nearly 1.1 million people and drew over 14.5K engagements (shares, comments, and reactions). An aurora image from the SOFIA mission was our top NASA Instagram post <https://www.instagram.com/p/BkLl_PCA4nP/> of the week.

• NASA's popular Spot the Station <https://spotthestation.nasa.gov/> website continues to grow in traffic. The site’s unique visitor count increased 40% from last month and 33% from last year. The United States still leads in the number of visits to the site (800,046), followed by the United Kingdom (103,315) and Brazil (72,160). The top 3 domestic sighting opportunity pages are Seattle, WA, Indianapolis, Ind. and Phoenix, Ariz. Spot The Station ranks the 3rd most popular website in the NASA.gov domain for the month of May; the same place as the last two months.

FULL SCHEDULE OF ACTIVITIES AND PRODUCTS

Saturday, June 23

Activities

• Arroyo Seco Weekend festival, Pasadena, California

• Trenton Summer Festival, Trenton, Michigan

Products

• JPL Exhibit, Social Media Activity: Arroyo Seco Weekend festival

Sunday, June 24

Activities

• NASA Innovative Advanced Concepts at the Philadelphia Maker Faire

• Arroyo Seco Weekend festival, Pasadena, California

• Trenton Summer Festival, Trenton, Michigan

Products

• JPL Exhibit, Social Media Activity: Arroyo Seco Weekend festival

Annual Events

• Birthday: Late Astronaut Ellison Onizuka (STS-51C, 51L) birthday

Monday, June 25

Activities

• Bridenstine speaks at the White House State-Federal STEM Summit

• Bridenstine speaks at the HQ Fitness Center Awards

• ISS: Year of Education on Station (YES) Downlink with Spruce Street School in New York City

• ISS: Downlink Message for Orlando STEM Conference

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

• JSC: Suni Williams and Bob Behnken with Space City Films

Products

• Aero: AFRC Media Release, NASA HQ Social Media Activity: Landing Gear Noise Research Reduction

• Earth: LARC Web Article: Long Island Sound Ozone Study

• Earth, ISS: JPL Web Article, NASA HQ Social Media Activity: ECOSTRESS Observes Plants' Day-Night Cycle

• ISS: JSC Blog Post, Image/Video, Social Media Activity: YES Downlink with Spruce Street School in New York City

• ISS: NASA HQ Web Article: NASA Selects 15 Research Opportunities in Space Biology

• Mars: KSC Image/Video: Aeroshell arrival for Orion Ascent Abort-2 pathfinding operation

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: JPL Web Article, NASA HQ Social Media Activity: Exoplanet atmospheres web feature

• Solar System and Beyond: JPL Web Article: New summer dates for Mars Insight Roadshow

• Solar System and Beyond: NASA HQ Media Release, Web Article: Scientists Developing Strategies to Search for Life on Exoplanets

• Solar System and Beyond: GSFC Image/Video, Web Article: NASA's James Webb Space Telescope Targets Jupiter's Great Red Spot

• Space Tech: LARC Media Advisory: Testing of Commercial Infrastructure for Robotic Assembly and Services

Annual Events

• Anniversary: Progress-Mir Collision (1997)

Tuesday, June 26

Activities

• The White House State-Federal STEM Summit

• National Park Service Online Media Briefing for Space Pup, 11 a.m. – noon EDT

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: ARC Web Article: SpaceX CRS-15 Science: Electric Possibilities for Bacteria in Space

• LARC Blog Post: LGBT Pride Month: "Sex, Gender and Reaching New Heights with the Science of Nonconformance"

• Mars: KSC Other, NASA HQ Social Media Activity: Rocket Ranch Podcast Episode 1

• Mars, Space Tech: JSC Image/Video, Web Article, Social Media Activity: Next Step Habitat Media Op

• Solar System and Beyond: NASA HQ Media Advisory: Media advisory for Webb media teleconference

• Solar System and Beyond: GSFC Web Article: Hubble Messier Catalog Update (3 new images)

• Solar System and Beyond: NET JPL Web Article: What Else Looks Like Ceres?

Annual Events

• Anniversary: 40th Anniversary: SeaSat A launch (1978)

Wednesday, June 27

Activities

• Bridenstine speaks at the White House Youth Summit

• Event with Jim Bridenstine: A Conversation with Politico at The Willard Hotel, 7 – 8 p.m. EDT

• Webb media teleconference

• ISS: NASA Future Engineers In-Space Manufacturing Event/Downlink at NASM

• Next Step Habitat Media Op

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

• Interview: Dr. Grace Douglas, JSC Food Lab, with New York Academy of Sciences Magazine

• Interview: Tracy Caldwell Dyson with Psychology Today (JSC)

Products

• Aero: NASA HQ Web Article: Sonic Booms and How They're Created

• Earth: LARC Image/Video: TEMPO Thermal Vacuum Testing

• Earth, ISS: JPL Web Article: Four Things ECOSTRESS Can See from Space

• GRC (Local) Media Release: NASA, astronaut to appear at Medina Bicentennial Celebration

• ISS: KSC Web Article: Students Select Crops for ISS

• ISS, Mars: NASA HQ Blog Post, Image/Video, Social Media Activity: NASA Future Engineers In-Space Manufacturing Event/Downlink at National Air and Space Museum

• Mars: NASA HQ Image/Video, Web Article: NET: NASA Provides Update on Gateway Configuration, Partnerships

• Mars: JSC Image/Video, Social Media Activity, Web Article: Next Step Hab Gateway-oriented imagery

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: NASA HQ Image/Video; Media Release; Social Media Activity: Webb media teleconference

• Solar System and Beyond: NASA HQ Image/Video, Media Release: NASA Report to Congress: Webb LRD / IRB Assessment

• Solar System and Beyond: NASA HQ Image/Video, Media Release, Social Media Activity: Interstellar Visitor Gets An Unexpected Boost In Speed -Oumuamua

Annual Events

• 5th Anniversary: IRIS Solar Observatory Launch (2013)

Thursday, June 28

Activities

• SpaceX CRS-15 Prelaunch News Conference, 12:45 a.m. EDT

• SpaceX CRS-15 What's On Board Briefing, 11 a.m. EDT

• ISS Downlink: Serena Auñón-Chancellor with AFRC

• Media Event: Commercial Infrastructure for Robotic Assembly and Services Testing, LARC

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: AFRC Blog Post, Image/Video, Media Release: NASA Armstrong ISS Downlink

• ISS: JSC Blog Post, Image/Video, Social Media Activity: Serena Auñón-Chancellor with AFRC

• LARC Social Media Activity, Web Article: NASA Langley Teams with Local Small Businesses to Advance Technology

• Solar System and Beyond: JPL Image/Video: JunoCam image of the week

• Solar System and Beyond: JPL Web Article: (NET) "We Fly Kepler" timeline & profiles

• Solar System and Beyond: GSFC Image/Video, Web Article: Parker Solar Probe Gets Its HeatShield

• Space Tech: GSFC Web Article: Interns Create Viz of Space Comm Resources

Annual Events

• Hubble discovers 4th moon of Pluto (2011)

Friday, June 29

Activities

• ISS: SpaceX Dragon CRS-15 Launch from Cape Canaveral, Fla., 5:42 a.m. EDT

• SpaceX CRS-15 Post Launch News Conference, 8 a.m. EDT

• AIAA Aviation Conference, Atlanta, Georgia (June 25-29)

• BBC Arabic crew interviewing re: GSFC Earth science

Products

• ISS: KSC Blog Post, Image/Video, Media Release, Social Media Activity: SpaceX/Dragon CRS-15 Launch from Cape Canaveral, Fla.

• ISS: JSC Image/Video, Media Release: Astronaut Dan Burbank retirement release

ISS: JSC Blog Post, Image/Video, Social Media Activity, Media advisory on YES event w/Eisenhower Museum

• ISS, Aeronautics: Image/Video, Podcast: Houston We Have a Podcast “Airspace”

• Mars: MSFC Web Article: Web Feature: Space Launch System Forward Skirt Complete

• Mars, Space Tech: JSC Image/Video, Social Media Activity, Web Article: Next Step Habitat Media Op

• Solar System and Beyond: GSFC Image/Video: Hubble Friday image and caption

• Solar System and Beyond: JPL Web Article: (NET) Exoplanet atmospheres feature

• Solar System and Beyond: JPL Web Article: (NET) Stellar Quakes feature

Annual Events

• Launch of 1st nuclear powered satellite (Transit 4A) (1961)

Saturday, June 30

Activities

• 2018 Hampton Roads Pride Fest

Products

• LARC Exhibit, Image/Video, Social Media Activity: 2018 Hampton Roads Pride Fest

• Solar System and Beyond: NASA HQ Image/Video: World Asteroid Day

FYI: Space Force OpEd WaPo

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I was an astronaut. We need a Space Force.

Terry Virts, a retired U.S. Air Force colonel, is a former astronaut who served as commander of the International Space Station. He is a special adviser to Govini, a data and analytics firm based in Arlington.

Space has been a hotly contested domain for decades. I can personally attest to this: While I wascommander of the International Space Station in 2015, we had to maneuver our spaceship to avoid debris left over from a 2007 Chinese anti-satellite missile demonstration.

The threat, however, is only going to get worse. The United States must proactively ensure its ability to operate and defend itself in space — which is why Congress needs to act to finalize the U.S. Space Force as a sixth independent branch of our armed forces.

It’s hard to overstate the importance of space in our military operations and civilian life. Though the United States is the world’s leader in space, China and Russia have made it clear they are not willing to accept the status quo. They already have access to weapons that threaten our assets in space, either by destroying them in orbit or by crippling ground control through cyberattacks or radio jamming.

Since the Trump administration’s recent announcement of plans to create a Space Force, there has been a fair amount of criticism stemming from a lack of understanding about what such a force would be. It wouldn’t, of course, be a collection of “Star Wars” troops fighting battles in outer space. We cannot even call it a militarization of space — which already occurred in the 1950s when the Soviet army launched Sputnik and the U.S. Navy launched Vanguard.

But the Space Force could address serious shortcomings in how effectively our military is organized. As the administration laid out this month <https://www.washingtonpost.com/business/economy/pence-details-plan-for-creation-of-space-force-in-what-would-be-the-sixth-branch-of-the-military/2018/08/09/0b40b8d0-9bdc-11e8-8d5e-c6c594024954_story.html?utm_term=.d2d31bb704db>, the first steps toward creating a Space Force would include creating a subunified Space Command, a Space Operations Force that would initially recruit from the ranks of current military members and a Space Development Agency tasked with procuring space hardware.

Though these steps can be taken without major congressional legislation, the final and most important step in creating the Space Force would require legislators to rewrite Title 10 <https://www.defensenews.com/space/2018/06/20/space-force-will-require-legislation-and-a-lot-of-detail-planning-says-mattis/> of the U.S. Code, which outlines the role of armed forces. The last major rewrite was undertaken when the Air Force was created after World War II.

Why should Congress make the Space Force a reality? Because space is important and unique enough to deserve its own place at the Defense Department table to ensure rightful allocation of budget resources and power.

Our military uses a principle known as “multidomain warfare,” meaning that when tasked with combat, different services all work jointly across the five domains — air, sea, land, space and cyber. However, in peacetime, the Army, Navy, Air Force, Marine Corps and Coast Guard only “organize, train and equip” by their specific domain.

Space as a domain is now mature enough to stand alone. Today, there are officers who “grew up” in Air Force Space Command, beginning as second lieutenants and making their way through the ranks to four-star general. It simply defies logic to keep that domain in the Air Force — akin to having the infantry in the Navy. Air and space are completely unrelated domains, and the equipment, techniques and culture required to operate airplanes are entirely different from those required to launch and operate in space.

Though creating a Space Force makes sense from a theoretical point of view, there are legitimate practical concerns. The president wants a Space Force by 2020, a very ambitious timeline. However, the tight deadline serves to light a fire under the sprawling Pentagon bureaucracy, helping to prevent this initiative from floundering over a longer period. There would also be significant initial costs to standing up a new Space Force. In the long run, however, it would become more efficient as duplication across services was reduced.

The devil is in the details. What exactly would the Space Force entail? I recommend that such a branch consolidate missions that launch and control satellites in orbit; that develop and procure space-related equipment; and that maintain our land-based nuclear missiles as well as our land-based missile-defense system (for example, to protect us from North Korean missiles). I would also consolidate cyberforces into the Space Force. Though cyber is also its own domain, it is not yet mature enough to warrant a separate Cyber Force. This would also be a sound decision from both an organizational efficiency and a cultural point of view.

The 21st century will present continuous challenges to the United States, and we must realize that there is no “manifest destiny” that guarantees our status as world leader. Now is the time to show leadership and vision by properly realigning our military with the reality that space is an essential and unique domain of modern warfare.

https://www.washingtonpost.com/opinions/i-was-an-astronaut-we-need-a-space-force/2018/08/23/637667e6-a6fb-11e8-b76b-d513a40042f6_story.html?utm_term=.8df7bc9d5e4c

Best,
Megan

Megan Powers
Press Secretary
NASA

Gateway rebrand

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Did you see the full page on B2 in the Post today? It starts to merge Space Force and a Space Ship. While I have concerns(deeply) of too overtly overlapping them, there is a real opportunity to rebrand Gateway in September- in a powerful, meaningful way. Look forward to continuing to work it.

Tom

National Space Council
User's Advisory Group

June 19, 2018
NASA Headquarters
Washington, DC

MEETING MINUTES

_____

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

_____

Mr. Brandon Eden, Executive Secretary

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Appendix A Meeting Attendees
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Appendix C Agenda

Meeting Report prepared by
Elizabeth Sheley
Zantech

Tuesday, June 19, 2018

Call to Order, Announcements

Mr. Brandon Eden, Executive Secretary of the National Space Council (NSpC) Users' Advisory Group (UAG), introduced himself and welcomed the meeting participants. NASA sponsors UAG, which exists to ensure that industry and other stakeholders are adequately represented in the Space Council. This was an open Federal Advisory Committee Act (FACA) meeting, formal minutes were being taken for the public record, and all discussions were on the record. Each UAG member had been appointed by the NASA Administrator, Mr. James Bridenstine, as either representatives of specific entities, or as Special Government Employees (SGEs). All SGEs were required to recuse themselves whenever they might have a conflict of interest.

Opening Remarks by Chair, UAG

Admiral James Ellis welcomed the UAG members, other participants, and listeners. This was the inaugural session of UAG, and the purpose of the day's meeting was to address organization and structure. The UAG was enabled by legislation enacted decades ago, but it had only now been formed after 25 years of dormancy. UAG is to function as a think tank for the NSpC, in addition to advising the Council. UAG has many opportunities and few constraints. It will be a conduit for new ideas and will work to identify obstacles that can be quickly removed. This is both a challenge and an opportunity.

The organization is for all users of space, and so there will be continued outreach to those who were not present. UAG members are free to shape the Group as they deem appropriate. They can innovate to facilitate the goals of the NSpC, and they can expect NSpC tasking. In turn, NSpC expects UAG to take the initiative. Therefore, it is important to understand the NSpC priorities. While NASA is overseeing implementation, facilitation, and other aspects of the NSpC mission, additional organizations are involved. UAG should collect inputs from all space stakeholders. The Department of Defense (DOD), industry, and the science community are also users to which UAG must reach out. Through individual members and/or subcommittees, UAG will co-locate with existing venues, like the National Space Symposium, the Universities Space Research Association (USRA), and others. UAG will meet with NSpC annually, but otherwise will be able to hold its meetings independently.

Adm. Ellis invited the UAG members to review the charter, objectives, and scope, which are broad. UAG duties include: ensuring the interests of industry and other non-federal entities involved in aeronautical and space activities are represented on NSpC; providing subject matter expertise to the Council; submitting reports; conducting studies, reviews, etc., requested by NSpC; and reporting to the Council.

Adm. Ellis then presented a proposal for UAG subcommittees, with distinguished advisors as chairs:

- Exploration and Discovery – Gen. Lester Lyles, Chair
- National Security Space – Adm. Ellis
- Economic Development and Industrial Base – Dr. Mary Lynne Dittmar and Mr. Eric Stallmer
- Technology and Innovation – Ms. Pamela Melroy
- Outreach and Education – Ms. Eileen Collins
- Space Policy and International Engagement – Dr. David Wolf

The Executive Committee will comprise the subcommittee chairs.

Opening Remarks by NSpC Executive Secretary

Dr. Scott Pace, Executive Secretary of NSpC, began by noting that this is the third incarnation of the Space Council. The first was during the space race of the 1960s, and the second was during the

administration of President George H. W. Bush. The latter dealt with the aftermath of the Cold War and addressed cross-cutting issues like international partnerships and other areas beyond the scope of an individual agency. The current space environment includes many public and private sector actors, along with intense globalization. Not all of the international entities are fully engaged in all activities, but are all interested in what space activities can do for their people. The new private sector involvement has raised questions about how to innovate at less cost. The second NSpC reached out to the national labs for innovation, but now that role is now filled by industry and others outside the Federal government. The NSpC priority is a unity of effort, so that stakeholders can proceed in roughly the same direction. There are already directions provided from the Decadal Surveys (DSes), the NASA Advisory Council (NAC), and others, but the NSpC is the only place where it all comes together. It provides the larger perspective that is needed at this time.

Dr. Pace said that the NSpC is mindful of UAG member time, and therefore wants members to leverage their existing schedules to use their networks and other resources. However, they should also take a step further to connect with larger communities. None of this happens without public support, and the public trust must be earned. NSpC has embraced exploration because it is highly visible. While the White House and Congress are very supportive of ambitious directions, public support is crucial. There needs to be growth in international investments in order to expand the sector, and that requires being indispensable from the commercial standpoint.

There is a process here. In terms of reinvigorating the NSpC, it is to work through the differences among the various players. It is not to take over the Federal agencies. When problems occur in programs that have national impact, NSpC will be involved. The process is a cycle, which Dr. Pace described. The President directs the top level tone and direction, to grow the economy and sector. He also wants faster growth, not just for the sake of speed, but for rapid feedback as well. He wants to have smart people in the right places. NSpC tries to set up framework agreements and set up boundaries with agencies. The Interagency Working Group addresses what it can, but these are not easy issues. A lot of staff work is involved in shaping this effort in terms of principles.

Dr. Pace next turned to space exploration priorities. While other countries rejected the previous administration's plan for human exploration of Mars, they can envision going to the moon. Similarly, commercial companies saw no benefit from human exploration of Mars but did see a case for a return to the moon. The focus on Mars drove international partners away instead of aligning them with the United States. Space Policy Directive 1 corrects this and redirects NASA to the moon, with commercial and international partners. The United States is doing this because it is in our best interests and that of our allies. This is bigger than projects and hardware and astronauts.

In order to address commercial space priorities, the United States must retain its lead, and that means streamlining the regulatory system. National security space priorities are rooted in the fact that space is now recognized as a war-fighting domain. The United States' adversaries have weapons that threaten our space assets, which are considerable. The United States needs to dominate in space, as the nation is extremely reliant on it. Therefore, we need to make our space systems more resilient and less vulnerable to attack. The White House seeks to ensure that this happens. Space Policy Directive 2 provides more details in this area.

Transportation is a Federal Aviation Administration (FAA) responsibility, under Title 49. Other activities are under the Commerce Department. There is also a need to have a specific voice for commercial spectrum issues within the Federal Communications Commission, and this must be addressed from a space perspective. Space Policy Directive 3, signed just the day before, addresses space traffic management and will provide a broader civil interface through the Commerce Department.

Adm. Ellis asked about priorities that UAG might address. Dr. Pace replied that there is a need to strengthen public engagement with space, first. Next, the United States must increase commercial activities in low-Earth orbit (LEO), and shift from owning the International Space Station (ISS) to leasing portions of it. This will not be easy, as the nation does not want to lose the gains from LEO, nor the international partnerships involved. It is important to preserve the capabilities, if not the facilities. He is interested in determining where people can make money in space. The third priority is accelerating the return to the moon. Program management is a consideration – where are the necessary people who have a sense of urgency? Fourth is where the country competes and where it cooperates internationally, including the countries with which there is some friction. The success in keeping ISS out of geopolitics has taken a huge effort, which requires examination. Finally, there is a need for exploration-enabled science and science-enabled exploration. There is a relationship between the two, as they create opportunities for each other. There should be more geologists on the moon, for example. Science, technology development, and the science community are crucial.

Mr. Salvatore Bruno noted that commercial entities have had opportunities in LEO. He wondered if UAG might also consider cis-lunar space opportunities. Dr. Pace said that that was absolutely the case. Not only are there research needs, there is also a national security aspect – it is an integrated whole. Mr. Wes Bush observed that UAG meetings are public, but that is not always possible in the national security space. Dr. Pace replied that the National Space Strategy lays out priorities, and NSpC works closely with the National Security Council. In areas of overlap, NSpC will probably take the lead. Acquisition reform is a big concern. There are various organizational approaches that were considered, but this is being resolved. Adm. Ellis added that technology can drive things as well, and much of that will be in the classified area.

Ms. Marillyn Hewson asked how UAG might contribute to the space force. Dr. Pace answered that there is a need to speed up acquisition, identify capabilities where the effort can succeed, get right the people with hands-on experience, and obtain sufficient resources. It is also necessary to see the context regarding the major threats that exist. This should all take place as soon as practical, ideally starting with the Fiscal Year 2020 (FY20) budget. The Honorable Harrison Schmitt pointed out that the nuclear Navy has managed to stay young, which could be a model. NASA is not that young. Dr. Pace thought it was a matter of how to attract young people, by giving them something interesting to do. They want tacit, hands-on experience. The military gives responsibility to young people. Hon. Schmitt noted that that will require Congressional action and a restructuring of the civil service system.

Mr. Fatih Ozmen expressed concern about stove-piping and asked if it would make sense to have a group examine the committees and subcommittees that might contribute to that. Adm. Ellis said that he was open to that in the discussion of the groups. The elements will get worked out in the subcommittees, and the plenary group will make the recommendations. The process is designed to pull it together at this level. Dr. Pace added that sometimes issues have to go to the principals. This is why all final recommendations must go through the plenary group in a FACA environment. Where consensus does not exist, the discussion will be public. It is not required to have consensus.

Mr. Dennis Muilenburg pointed out that there will be a need to think differently about sectors and government agencies. For example, frequency management is beyond the purview of a U.S. agency, as it is international. Similarly, space use at the edge of the atmosphere will no longer make sense. Trends for the future are becoming apparent. There will be commercialization of space and there are other international agencies with requirements. The nature of commercializing space calls for stakeholders to think differently. Dr. Pace said that he was hopeful that the space and frequency issues would work in favor of the United States, noting that U.S. space interests often did well at the International Telecommunication Union (ITU) because our needs and interests in space aligned well with those of the developing countries. The biggest areas of problems he had internationally were countries that had narrow interests. Regarding the seamlessness of hypersonic vehicles and air traffic management, there are

fundamental legal and practical considerations about flying over sovereign air space, as well as overflight in space. However, there is also a need for international traffic management and interfaces.

Deregulation and Space Traffic Management Initiatives

Mr. James Uthmeier of the Department of Commerce (DOC), explained that the Trump Administration has established requirements to reduce rules, especially when implementing new ones. Mr. Uthmeier is focused on the deregulation of space. DOC hopes to enable more commercial success in space, and to that end is also addressing the entire supply chain. The Department also wants to determine how to continue government research and growth while better developing a market. DOC is creating a single interface for companies, a "one-stop shop." The right organization must be in place to ensure that everyone is working on the same page. When a company meets with DOC about space, the Department will have the right people at the table. As part of this effort, DOC has submitted a reprogramming plan to Congress, to establish a space office at Commerce and to take on mission support services.

To be clear, DOD will continue collecting data, and DOC will be the interface supporting companies to launch successfully and obtain their own data. Right now, for example, the Federal government provides raw weather data, which should go over to the commercial side. The appropriators in the House of Representatives approved the re-organization and discussions are ongoing with the Senate. DOC hopes to establish the right infrastructure and streamlining process to move into the future. At present, companies go overseas when they do not receive Federal support, so industry has been invited to discuss definitions in order to enable flexibility, and to explain what they need from DOC. A new rule will be issued later this year. In addition, DOC will convene discussions among the big lending institutions and NASA. Finally, in the area of Space Situational Awareness and Space Traffic Management (SSASTM), the current requirement is to work through the Department of State. However, there will be more initiatives to protect U.S. businesses and assets.

Adm. Ellis asked for a list of DOC priorities. Mr. Uthmeier replied that getting the new office stood up to have a true advocate for industry is first. The second priority is cutting red tape. Third is establishing creative ways to help businesses, enable space-oriented infrastructure, and address the frequency of launches. Fourth is to expose our ideas for investment overseas. Finally, the Federal government must work together in a cross-agency approach that can move quickly, keeping in mind the needs and constraints of national security.

Ms. Collins urged including the minimization of orbital debris as a priority, as it is an international issue that constitutes a major threat. This is also a technology problem. Mr. Uthmeier agreed, noting that this is above and beyond what he does, but Commerce is working hard to look at this. Ms. Collins explained that she had wanted to get it on the record because it is an important issue that calls for an international effort. Dr. Pace added that there is a strategy on debris in the works. Guidelines are going through the United Nations (UN) into nations' laws and regulations. However, it is important to avoid a top-down, centralized approach. Regarding export control, NSpC has been hearing from companies about the problems of dealing with antiquated, non-user-friendly IT systems. There may also be friction in terms of what happens commercially on ISS. As the nation transitions to a different use model of ISS, there will need to be more government-to-government dialogues about trade and impact, and DOC can help with that.

Mr. Stuart Witt asked what DOC might do about past contracting practices. This is not a one-size-fits-all issue, but he would like to see a review of what does and does not work, and what might work in the future. Hon. Schmitt noted that international forums work out some of the issues mentioned, and they operate on consensus. He wondered if those would be reviewed as well. Mr. Uthmeier said that the reviews are under consideration. Dr. Pace urged caution in creating new international organizations, though he was initially a skeptic of the consensus required in ITU and is now a fan. That organization has

turned out to protect U.S. interests and is helpful overall. It is easy for leading countries to find themselves isolated or outnumbered, but finding our way forward with like-minded countries is probably the best hope for the United States. Hon. Schmitt said that his experience was that it was important to have the U.S. commercial sector deeply involved. It helped illustrate to other countries the value of our technologies. Dr. Pace added that one of the most impressive things was the breadth and diversity of the U.S. delegation. Other countries did not always have that, and it is something to build on.

Mr. Uthmeier closed by stating that the DOC Secretary, Mr. Wilbur Ross, will come to the next UAG meeting.

Space Exploration Priorities; ISS Transition and Lunar Exploration Roadmap

Mr. Bridenstine thanked the meeting participants, stating that UAG can be effective in moving the country forward. He sees NSpC and UAG as key in the interagency space area. When he served on the House Armed Services Committee, he identified communications architectures that need to be brought together. It is notable that commercial interests jump in to act while DOD takes 2 years to do an analysis that is already obsolete upon publication. The issues then become how to develop a low-latency capability for bandwidth, how might the United States best take advantage of it, how do Federal agencies work together to maximize that capability, what does DOD need and how does it get out in front on that, and are we communicating it early enough to have the capabilities?

NASA plays a role in the robotic servicing piece, because the Agency has thousands of satellites in LEO. The congestion is a massive challenge that is only growing with greater launch cadences. The prediction is that collisions will occur at a rate of one every 4 to 9 years. That raises the issue of how to prevent this congested, contested environment in LEO. NASA's role could be the robotic element. In addition, the Restore-L mission addresses the issue, though it does not go far enough. NASA can make the investments that industry does not where there is no commercial payoff. However, NASA can also license those activities to companies.

Mr. Bridenstine explained that when he was in Congress, tornadoes occasionally killed some of his constituents. At the same time, there were delays in the weather models and missions that ought to protect his constituents. He therefore worked on developing commercial activities to mitigate the gaps in data delivery. The companies had problems due to the fact that the data had to be given away free internationally, however. The United States needs to think about its capabilities. While we receive a lot of our data from the international community, we might try to find a way to license companies so that the data do not have to be given away. The global public good is not a global public good if the framework prevents it from being created to begin with. Our international obligations constrain us and prevent the government from keeping up. Mr. Bridenstine hopes UAG can help in this area. The transformational things happening in space are critical, and the government must be responsive to that.

Mr. Stallmer asked if Mr. Bridenstine had any insight or thoughts about the space force that had been announced the day before. Mr. Bridenstine replied that as a member of the House Armed Services Committee, he voted to support the space corps the three times it came up. This is not an easy thing, but it is an idea whose time has come. The United States faces unprecedented challenges in space and has been contested in space. It is become a very dangerous environment. His Navy experience showed that two things matter: how good your commerce is, and how good your defense of that commerce is. The same is true in space. Commerce is critical for space, which is a major industry and an element of our international export strategy. The commerce is there right now, but the defense of that commerce is not. Therefore, the White House is moving forward on that. Mr. Bridenstine gave the example of General Billy Mitchel, who after WWI was vocal about the need for an air force with a bombing ability. While his advice was ignored for many years, WWII proved him to be right, and the U.S. Air Force (USAF) was created as a result. The space force is an idea whose time has come, though it is not yet clear what it will

look like. Military services organize, train, and equip. A space force within the military would come out of USAF, and it could take many different forms. There is a lot of work to be done.

Mr. Bruno asked about whether the government might be a customer in LEO and cis-lunar space. Mr. Bridenstine said that it will be, and there are international consortia interested in taking ISS over commercially. These are serious conversations currently underway. It is important to not have a gap in LEO; rather, there should be a permanent human presence there. ISS is a government function that could transition to where the government is a tenant alongside private industry tenants. Following that, the government could be the anchor customer for lunar capabilities with payloads from various sources. There is a lot that can be done, but he supports being a customer. The Federal government should lead where the commercial side is not yet ready, or take over where industry cannot operate.

Mr. Muilenburg observed that UAG is eager to help strengthen public advocacy for space exploration and asked how that might best occur. Mr. Bridenstine replied that a recent Pew Research Center poll found that 72 percent of Americans think the United States should be a leader in space. That is an enormous level of agreement. In addition, 80 percent of Americans believe ISS has been a good investment for the U.S. taxpayer. This says that NASA has communicated well how ISS establishes U.S. leadership. The poll shows that 65 percent of Americans believe the United States should lead in the use of space to understand Earth, and to track objects that could be a threat to Earth. However, he was surprised to see that the exploration of the moon and Mars was at the 15-20 percent approval level. This means there is a need to change that narrative.

NASA excels at transdisciplinary thought. When the Agency does human exploration, it conducts science that helps our own planet. He gave the example of Mars losing its oceans and atmosphere, which scientists need to understand. The United States must be the first nation to discover life on another world, not the second. That is why exploration is important. However, astronauts returning to Earth face significant health problems and deficits. For example, it takes an astronaut up to 60 days just to be able to touch his or her nose with a finger. This illustrates why there are issues with sending them on a 6-month journey to Mars, where they will have to do the hardest work they have done in their lives. This is the kind of thing that must be tested and addressed.

NASA operates in a different environment from that of the Apollo era. The level of redundancy is an example. There must be a sustainable lunar architecture, and the sustainability element is key. This shows the need to communicate to the American people why it is important to go to the moon. It is good that Americans see the importance of studying Earth from space, but they also need to understand the importance of studying other planets and bodies.

Hon. Schmitt cited the geopolitical context in going back to the moon and on to Mars. Mr. Bridenstine said that the United States has the opportunity to open dialogues with Russia due to our ISS collaboration, as long as the United States leads. Hon. Schmitt pointed out that China wants to lead, too. Mr. Bridenstine said that he thinks the United States can do this. We are the only nation that has successfully landed on Mars, for example, having done it seven times and preparing for an eighth. He believes our leadership position is sustainable.

Ms. Hewson asked what the U.S. government should own to support U.S. businesses in space. Mr. Bridenstine replied that the Lunar Gateway provides an opportunity to take advantage of commercial partnerships in a new way. The United States is going to the moon, and the Gateway will provide even greater access to the moon rather than diminishing that access. With Apollo, NASA missed a lot of science – the ice being an example - by going to a single spot on the moon. The United States wants to do more science on the moon and will use the Gateway to do so. The country needs a station orbiting the

moon that enables other travel in the solar system as well. The Gateway will provide this kind of broad access. This is the United States' opportunity to prove those technologies and lead internationally.

Mr. Buzz Aldrin said that the Chinese will have a halo orbit around L2, with the capability of a landing on the dark side of the moon. The United States denied the Chinese the opportunity to go to the ISS. If the Chinese launch as planned, they can launch to larger inclinations than what is planned by the United States. We denied them something, and they can deny us something and encourage other international partners to join them. Therefore, we should attract other nations with compelling inclinations. The country needs an organization and a plan that international partners would like to have. Mr. Bridenstine offered to discuss this further.

Formation of Work Plan and UAG Subcommittees

Adm. Ellis explained that his list of proposed subcommittees was a draft, though each subcommittee was the result of a specific conversation with Vice President Pence on the topic of the NSpC charge. UAG was free to reorganize the subcommittees as long as the issues are covered. He asked each member to communicate to Mr. Eden about a couple of committees of interest to them. There may need to be some shuffling around in order to achieve balance. Adm. Ellis's initial choices for chairs might change as well.

He elaborated on what some of the subcommittees might cover. In Exploration and Discovery, the "discovery" element addresses science. The National Security Space subcommittee might be best for people with active security clearances. Economic Development and Industrial Base addresses a major NSpC focus. Outreach and Education is important and will address making the case for support of space exploration. Space Policy and International Engagement is an area in which technology has outpaced both policy and international agreements.

Gen. Lyles pointed out that the subcommittees are broad, and he wanted to know about the subsets and specificity under each. Adm. Ellis said that aside from Dr. Pace's top five priorities, this is an ongoing dialogue. The subcommittee chairs will help prioritize, which will involve tradeoffs. He wants to increase the pace and sustain the work going forward, and would prefer to decide on a few things for focus rather than be spread too thin. That was also advice from Vice President Pence. It is important to identify the issues to work on quickly rather than seek complete solutions. UAG will learn the NSpC priorities as they evolve.

Mr. Aldrin asked if UAG should look at the education pipeline. He also stated that there are disadvantages to international cooperation. Adm. Ellis thought that while the pipeline might be beyond UAG, they need to point it out and note the linkage to space. International bodies share interests, which can lead to some issues over who gets what. The commercialization of LEO falls under the Economic Development and Industrial Base Subcommittee. Ms. Collins asked why UAG did not include any members of the active duty military. Adm. Ellis said that there was some thought that the retired military members could serve that function. DOD is also a constituent of UAG, and there will be outreach to that department in order to facilitate addressing their needs.

Dr. Wolf asked what license UAG has to investigate some of these issues. Adm. Ellis replied that in regard to "third rails," sensitive areas, etc., there are none. UAG needs to emphasize what is important within its charge, and there is nothing to stop them from following up on their priorities. Dr. Wolf observed that those they talk to might not agree. Adm. Ellis said that while that is true, they work for the Vice President and are almost obligated to think broadly about where the important issues lie. Most of what the subcommittees focus on should be welcome.

He turned to the schedule. The UAG charter says they should meet three times per year, and at least once with NSpC. Other than the joint meeting, the UAG sessions will be decoupled from NSpC. Members will

have other obligations resulting in conflicting schedules, so he wanted to get a sense of the number of meetings they wanted to hold. Gen. Lyles pointed out that the NAC subcommittees meet right before the NAC meetings, which is one way to structure it. Hon. Schmitt advised quarterly meetings. Mr. Fred Klipsch said that the subcommittees will need to meet in order to organize. Adm. Ellis said that he envisioned an organizational teleconference for the subcommittees, with their meetings before the UAG meeting. Ms. Mandy Vaughn said that much of what they will want to do will be cross-cutting more than strictly in the purview of any one subcommittee.

Dr. Dittmar asked if the subcommittees will need to take findings and recommendations to the Executive Committee and then to the UAG. Adm. Ellis thought that was the way they would do it, though there might be quorum concerns. At the same time, they will need to work through concepts before they go public. He could see UAG holding meetings at NASA facilities outside of Washington. They have already been invited to both Huntsville, Alabama, and the Johnson Space Center (JSC), for example. As for field hearings, they might be able to put panels together at other events so that they are listening as well as speaking. This will likely be in the form of small groups. People are curious about this effort and UAG wants their input. The subcommittees and UAG as a whole can also request briefings. There is a lot of interest in addressing this group. If members need something broader and more in-depth, they should tell him and Mr. Eden. He has had international partners express interest. There are many opportunities, but they need to make sure they advance the issues.

Adm. Ellis asked the industry representatives which meetings they considered to have the most impact, both national and worldwide. Mr. Ozmen said that they might consider whether to have a website and social media presence. This can be hard to manage and would require a budget, but it could broaden the base. Adm. Ellis said that he would like to float a NASA-designed website up to NSpC, but he advised caution with social media. He would investigate further. Hon. Schmitt said that on the science side, there are annual meetings of groups with which NASA is loosely affiliated. The Lunar Exploration Analysis Group (LEAG) is one. USRA also hosts a group. The Solar System Exploration Research Virtual Institute (SSERVI) meets at the NASA Ames Research Center (ARC) each year. In addition, there are conferences for the broader community, such as the American Geophysical Union (AGU); every discipline has its annual meetings. UAG cannot appear at all of them, but there are many from which to choose. Adm. Ellis said that he would like Hon. Schmitt's help in capturing those communities without becoming too specialized. UAG does not have unlimited time or funds, so would he would rather find opportunities where some of the members are already involved, then pull in one or two more members. He added that the legal pieces of some of the security policies are huge, with a great deal of uncertainty. There needs to be that understanding. Hon. Schmitt noted that a lot of non-space-faring nations would like to see the policies change, which he considered inadvisable. Adm. Ellis said he would like to talk with these groups, agreeing that they should not dictate policy.

He would like the subcommittees to be aligned by July 1. He asked that as UAG members volunteered for subcommittees, they also submit their priorities and questions. He would then have a teleconference of the Executive Committee to address this, the schedule, and the priorities. He would like to have a couple of issues to take forward to the next NSpC meeting, which would mean having another UAG meeting before then. It is important to emphasize UAG's expertise and collective insights. He would like to have the subcommittees to bring forward six or seven important recommendations that the Executive Committee could take to UAG and then to NSpC. Within the FACA guidelines, UAG can do pretty much whatever the members want, so they need to determine how to add value and make progress.

Adm. Ellis asked that each UAG member volunteer to be on at least two subcommittees, ideally as many as they feel they could be part of and have time for. Dr. Robert Smith said that it would be helpful to have criteria for the recommendations, for example placing an emphasis on something that could be implemented and is economically feasible. The direction would be helpful so they do not spend too much

time arguing about outcomes. Adm. Ellis agreed and asked for UAG member thoughts on this. He promised to put together some guidelines on the qualities a recommendation should have. He added that there are things that do not make economic sense and have no business case but still need to be done.

Public Input
Adm. Ellis opened the microphones for public comment.

Mr. Joseph Gillen, affiliated with a small consulting group, said that he believed he was speaking for a larger community of the many individuals who are retired or left the industry and who are chomping at the bit to use their talents and passions to become involved in this effort. This included public outreach and specialty areas. He asked if there might be any way that UAG could use their help. Adm. Ellis thanked Mr. Gillen and said that UAG will find ways to fully engage and communicate.

Ms. Stephanie Wan introduced herself as the former chair of the Space Generation Advisory Council, which is affiliated with the UN and provides a youth perspective on space policy. The Council has an observer with the UN Committee on the Peaceful Uses of Outer Space. She said that the workforce, the younger generation, is a great community for UAG to work with. Adm. Ellis praised Ms. Wan's initiative, thanked her, and said that he is familiar with her organization. It will be important in outreach.

Mr. Keith Cowing of Nasawatch.com stated that UAG appeared to have only one person under the age of 50. He also stated that the panel seemed to be largely made up of big aerospace representatives. He asked if the lack of younger people was deliberate. Mr. Stallmer said that there were some younger people in the room, Ms. Vaughn stated that she was younger, and Ms. Gwynne Shotwell said she represented many younger individuals. Dr. Wolf said that he has mentored younger astronauts and was still in frequent contact with many of them, but he welcomed anything Mr. Cowing could do to help with connections.

Mr. Asian Zuckery thanked the UAG members for their service and said he would be happy to help.

Mr. Gary Barnhart of Extraordinary Innovative Space Partnerships said that it is important that UAG be involved in LEO commercialization, as the attention paid now will make a tremendous difference. There is interest from a number of groups, such as the Planetary Society, as well as the broader entrepreneurial community. An example of the latter is a ULA initiative that now has over 160 participants. He suggested that UAG seek out such groups.

Mr. Keith Catterfelt asked about the best way for younger people to get involved in the effort. Adm. Ellis said that he appreciates this kind of support. Committee membership is limited to UAG participants, but there are generational or space organizations with which young people can associate. The interest in space is a passion we all share, and he advised interested individuals to make their presence and views known with the other organizations.

Roundtable Discussion and Final Wrap-Up
Adm. Ellis asked the UAG members for their thoughts at the end of the meeting. Mr. David Thompson thanked Adm. Ellis and the other UAG members. Mr. Witt thought that they have a short-term opportunity in which to be bold. Mr. Aldrin explained that he is establishing a human spaceflight institute for academic judgment of innovative, game-changing ideas, located in Houston. Ms. Collins said that it is an honor to chair the outreach subcommittee and members had sent ideas to her already. She is a member of many of the organizations mentioned and wants to hear from the public. Speaking for Mr. Muilenburg, who had had to leave, Mr. James Hughes said that Mr. Muilenburg was grateful for the privilege of serving. Mr. Klipsch appreciated the opportunity. He suggested that the process for output and what it might look like be a future topic. Ms. Vaughn said that this was a good opportunity to make a real impact.

Gen. Lyles also appreciated the opportunity. He pointed out that the UAG charter refers to both aeronautics and space, and yet there was nothing in UAG related to aeronautics. He asked how it might be addressed. Adm. Ellis replied that there will be no spin-off group, but there was a lots of aeronautics representation on UAG. There are both legal boundaries and other boundaries that are blurring. If they need specificity, that will be addressed. Mr. Stallmer and Dr. Dittmar both said that it was an honor to be present. The Honorable Kay Ivey said she was thrilled to have a vision of the United States as a leader in space again and looked forward to working with this group.

Mr. Bruno said that they will be bold. Dr. Pamela Vaughan said she was proud and honored to be there. Dr. Smith thanked Adm. Ellis, and Ms. Shotwell urged UAG to get the work done. Dr. Wolf compared this to his first astronaut class, and said he was feeling again that this is a great opportunity. A spokeswoman for Ms. Hewson thanked the group and took note of the diversity of the people in the room. Mr. Ozmen was grateful for the leadership and said that this is a time to take advantage of the opportunities. Mr. Bush called it a unique moment. Mr. Tim Ellis said that in regard to public outreach, they share the dream of going to the moon and Mars, which calls for bold, inspirational ideas.

Adm. Ellis thanked everyone for being part of this. Space is daunting in many ways. There is now an opportunity to do things differently. How we differentiate ourselves will be hugely important. They will find the things to which they can uniquely add value.

Adjournment
The meeting was adjourned at 1:53 p.m.

Appendix A
Attendees

UAG Membership
James Ellis, *UAG Chair*
Brandon T. Eden, *UAG Executive Secretary*
Buzz Aldrin
Salvatore Bruno
Wes Bush
Eileen Collins
Mary Lynne Dittmar
Tim Ellis
Marillyn Hewson
Kay Ivey
Fred Klipsch
Lesley Lyles
Dennis Muilenburg
Fatih Ozmen
Harrison Schmitt
Gwynne Shotwell
Robert Smith
Eric Stallmer
David Thompson
Pamela Vaughan
Mandy Vaughn
Stuart Witt
David Wolf

Other attendees
Barbara Adde
William Beckman
Cindy Brennan
Sandy Coleman
Mat Dun
Martin Frederick
Rebecca Gilchrist
Newt Gingrich
Marchel Holk
Tim Hughes
Teddy Jonston
Cody Knipfe
Doug Lauren
Alex MacDonald
Mark Mozem
Scott Pace
Ben Preugh

Alex Rodriguez
Robbie Sabathier
Tommy Sanford
Elizabeth Sheley
Jared Staut
James Uthmeier
Stephanie Wan

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

Wes Bush
CEO of Northrop Grumman

Dean Cheng
Scholar at the Heritage Foundation

Eileen Collins
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

Kay Ivey
Governor of Alabama

Fred Klipsch
Founder and Chairman of Hoosiers for Quality Education

Les Lyles
Retired 4-star Air Force General and member of the NASA Advisory Council

Pamela Melroy
Three-time Shuttle astronaut and former Deputy Director of the Tactical Technology Office at the Defense Advanced Research Projects Agency

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

Jack Schmitt
Apollo 17 Astronaut and former Senator

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
Agenda

National Space Council Users' Advisory Group
First meeting

Tuesday, June 19, 2018
9:00 a.m. to 2:00 p.m.

NASA Headquarters
Executive Conference Center, Room 8Q40B
300 E Street, SW
Washington, DC 20546

Public Agenda

9:00 a.m.	Call to Order, Announcements	Mr. Brandon Eden Executive Secretary Users' Advisory Group
9:03 a.m.	Opening Remarks by Chair Users' Advisory Group (UAG)	Admiral James Ellis *(USN Ret.)* Chair Users' Advisory Group
9:10 a.m.	Opening Remarks by Executive Secretary National Space Council	Dr. Scott Pace Executive Secretary National Space Council
9:20 a.m.	Candidate Topics for UAG Review	Dr. Pace
10:00 a.m.	Deregulation and Space Traffic Management Initiatives	Mr. James Uthmeier Department of Commerce
10:45 a.m.	Space Exploration Priorities; ISS Transition and Lunar Exploration Roadmap	Mr. James Bridenstine NASA Administrator
11:30 a.m.	Lunch	
12:30 p.m.	Formation of Work Plan and UAG Subcommittees	All
1:30 p.m.	Public Input	
1:40 p.m.	Roundtable Discussion and Final Wrap-Up	All
2:00 p.m.	Adjournment	

Axios interview prep doc

From:	Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>, Powers, Megan K. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=POWERS, MEGAN K 670907028CD2>
To:	Bridenstine, James F. (HQ-AA000) <james.f.bridenstine@nasa.gov>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>
Sent:	June 25, 2018 9:20:29 AM EDT
Received:	June 25, 2018 9:20:31 AM EDT

1:00 PM - 1:30 PM: Axios Interview in JBO with Alison Snyder (Editor with focus on Technology) and Andrew Freedman (Editor with focus on Science)

Proposed topics:

• Commercialization of space

- Axios corporate sponsors include Boeing.

• Future of NASA / path to the moon and Mars.

- Recommend (b) (5) [redacted]

Probable additional topics:

• Climate change and NASA's commitment to science

- Recommend (b) (5) [redacted]

• Space Force

- Recommend (b) (5) [redacted]

About Axios:

Axios is a new but widely read short form news organization. Their audience is not scientific and we should steer away from getting too down in the details. Analogies and widely understood examples ("space traffic management will protect our satellites and without our satellites there would be no milk in the grocery store") would be best.

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A National Exploration Campaign –

"Eagle Rising"

pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1: *Forward to the Moon, Mars and Beyond – "Eagle Rising"*

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign, "Eagle Rising," laid out herein is NASA's answer to that bold call. The Campaign aims to revitalize and add direction within NASA's enduring charter to build missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to increase market share and create new market. It responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the country in space. Challenges and opportunities exist in now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation, centered in part on the U.S.-led International Space Station, is today starting to unleash a new economic realm. Action, though, is needed to unleash this new commercial engine and to provide the regulatory and security environment to enable and protect this new economic zone. Further out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond comes as more countries robotically begin establish a presence in this region.

When Americans reach the Moon starting early in the next decade, we will not be alone. Foreign nations are planning their own missions to send spacecraft into orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations have all stated plans or already initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013. It has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to an astronaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans. *Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing and ceding global leadership in cislunar space overall.* Even out to Mars, opportunities and challenges exist. American has been the unsurpassed leader in this domain. American robotic craft have been the only ones in history to have successfully landed on Mars. Now, many Nations are planning their own missions to Mars's surface in the coming years. China in the next decade also plans to be the first nation to bring back samples- that may show the first signs of life beyond our planet.

While NASA is currently prohibited by law from establishing a bilateral partnership with China, we intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation.

"Eagle Rising" – Time to Move Out

The overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and most importantly, the American public. It is not a return to the past or a repeat of previous efforts of the past 25 years that have sought to move beyond the near-Earth regions of space. It is not about a geo-political competition to re-do Apollo. A lot has changed – and is changing.

"Eagle Rising" builds upon the past 17 years of Americans and their partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies; and begins operations in the next few years of the first American capsule and rocket system capable of establishing the first American permanent presence and infrastructure on and around the Moon. At same time, with rapid advances in American private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and even commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and space traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA' relationship and collaboration with other U.S. Government agencies will be expanded to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the Nation's space goals. To supplement our own well of creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call (see list of upcoming requests for information in the Appendix). We seek to engage and inspire the next generation, in particular the large number of science, technology, engineering and mathematics (STEM) professionals that support major challenges needing these skills.

"Eagle Rising" therefore complements and directly responds to the policy objectives found in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which called upon the Agency to develop a Human Exploration Roadmap, including a critical decision plan, to expand human presence beyond low Earth orbit (LEO) to the surface of Mars and beyond, considering interim destinations such as cislunar space and the moons of Mars.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create dominance beyond the littoral shores of space – out to, around and on the Moon. NASA's civil pursuit and international leadership of scientific advancement, the frontiers of human exploration, technological primacy and civilizational achievement fill in the American strategic approach to the space domain.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations, which support NASA and the needs of an emerging private sector market.

2. Lead the emplacement of capabilities in lunar orbit that support surface operations and feed forward to missions beyond cis-lunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, "Eagle Rising" will be led by NASA as architect, mission leader, and in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. The following Report provides NASA's strategic implementation approach for "Eagle Rising."

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's off-shore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first placed footprints on its surface roughly 50 years ago, our explorers left only fleeting footsteps at a few sites for a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different than the past. NASA is building a plan for Americans to orbit the moon starting in 2023 and land astronauts on the surface by the late 2020s. For the majority of people alive today, this will be their first chance to witness a lunar encounter with Americans and a lunar landing – collective moments when the world holds it breath in awe and wonder. America will not stop there. A core focus of this Campaign is to bring the Moon into the nation's geo-strategic and economic sphere.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar rays and cosmic detritus for billions of years – left largely undisturbed, the Moon is an archive of the history of our solar system and our Sun. There are scientific mysteries locked in its regolith that could lead to improved understanding of our own planet. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Making the first solar chips or gallons of fuel from the regolith of the Moon, like the harnessing of fire, will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out)– Living and Working Around the Moon

The American Moon Port/Ship under development will forge U.S. leadership and presence over the region from the Moon to the Earth. This platform will host astronauts further from Earth than ever before. A radical advancement in space technology and human life support systems, the platform will serve as a Moon Ship that will offer astronauts longer stays on the surface, easier crew return, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, we will check technologies and systems as we get ready for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the unique radiation and microgravity environment beyond-LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by conducting biological and biomedical studies over longer periods than ever previously possible. At the same time, the platform will serve as a port and transit hub, it will evolve to serve as a way station for the development of refueling depots, servicing platforms, and sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship/Port is presently under construction at NASA centers across the U.S. including in Ohio, Texas and Alabama. The first element will be launched from Florida in 2022 and crews will be able to stay aboard starting in 2023. NASA will call upon its own workforce to build critical pieces of hardware such as the power and propulsion element and habitation module, push industry to advance the state-of-the-art to deliver logistics modules, and utilize key contributions from international partners including additional habitat modules and a robotic arm. The Ship will be incrementally built in place using the American-built Space Launch System, Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

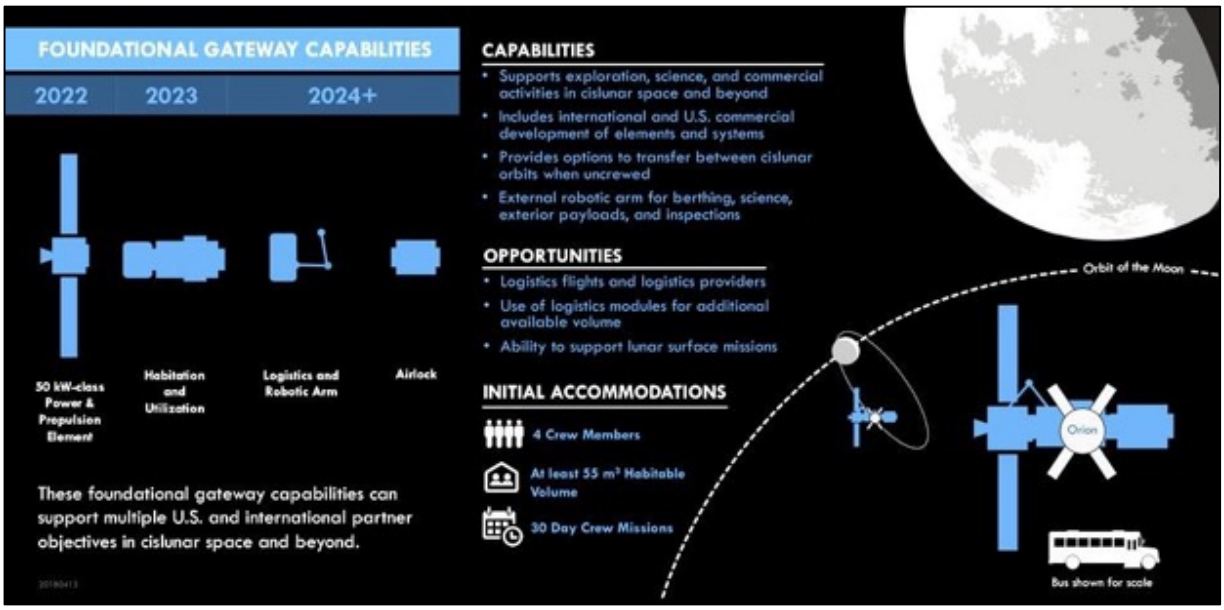


Figure 5: Gateway Development

Humans and Robots - Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, a training ground, and an off-shore continent to prepare for future human missions to Mars and other destinations. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in concert with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts and working in tandem with the Moon Ship/Port will expand and diversify over time.

NASA has started a program of robotic lunar missions through the Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP), including delivery of early, small payloads using emerging commercial landers through the soon-to-be-released Commercial Lunar Payload Services (CLPS) procurement. In addition, NASA will focus on continued growth of emerging commercial capabilities to further enhance human lunar lander capabilities and utilization of the Moon. An assessment is underway on the best development path for an SMD-led rover capability and mid-size lander. Options are being examined that range from NASA in-house development to procurement, and/or service and data purchase-based models.(update after decision)

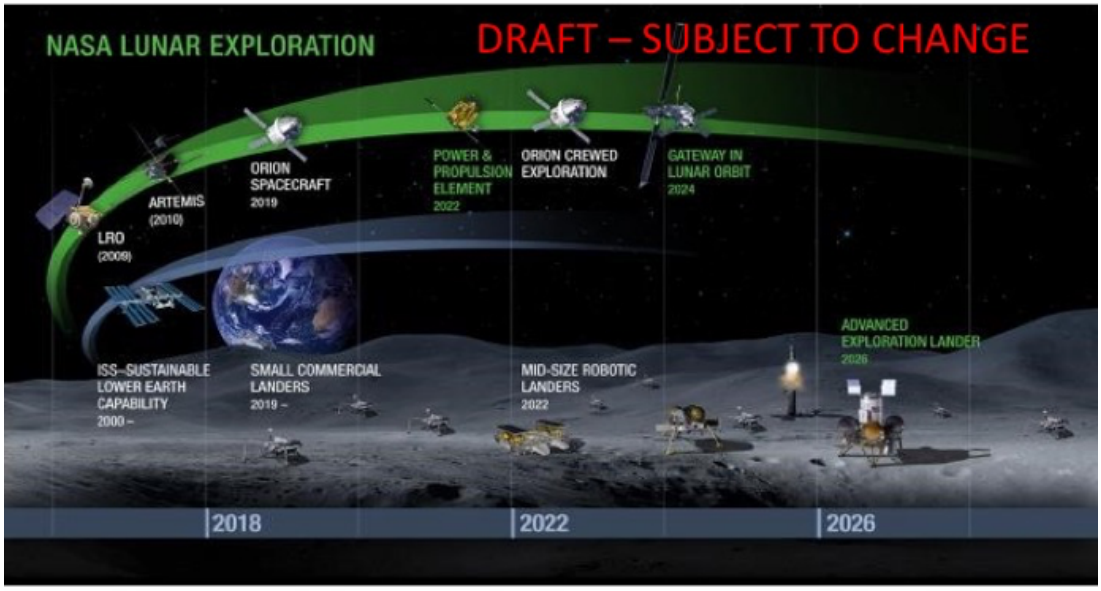
While we have extensive orbital information about the lunar surface and potential resources, robotic scouts are needed on the Moon to validate prior observations and are essential to prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data. Landers will specifically be outfitted with sensor packages, while also providing lunar surface access for rovers that can explore the surface more extensively, as well as carry instruments such as *in situ resource utilization* (ISRU) experiments that will provide detailed information on extraction of usable resources such as oxygen. In addition to obtaining this information, robotic landers will provide critical risk reduction activities for the human-scale lander descent stage and utilization capabilities.

An American human lander effort is underway within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T) (NEED more on ERT in this overall) to advance lower-readiness-level technologies so they can be implemented in future lunar missions. NASA is currently assessing different trades from a mid-sized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is examining options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of on-going National need or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated that range from capability stimulation through funded Space Act Agreements to a single partner or contract approach to an international partnership model, or a NASA-led multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace – it takes about 10 years to develop a crewed system. The Apollo LEM has been the only outlier. Produced in 6 years– but at a cost of 24B at current dollars – the LEM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

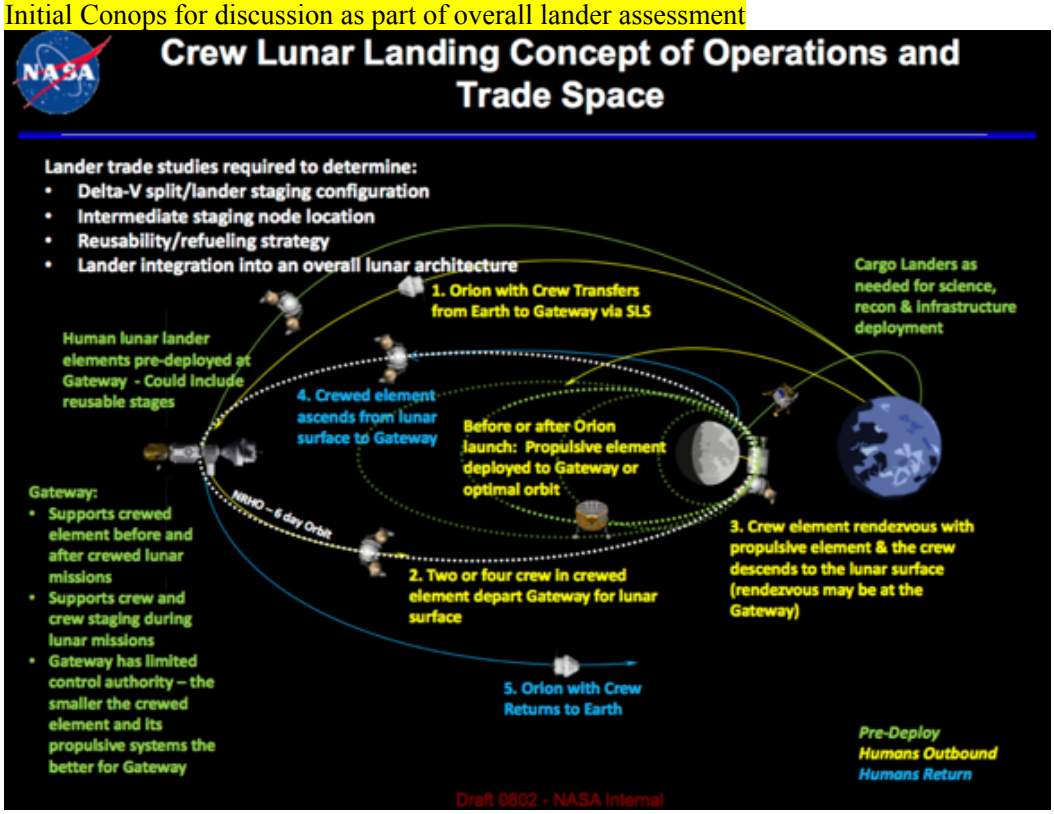
Human exploration of both the lunar surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is both building an exploration launch and crew system (the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting ground systems), and will rely on commercial launch providers to support both robotic surface and lunar orbit operations. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days with additional habitation volume and systems. The SLS Block 1 cargo variant will be capable of delivering 70 mT to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 mT to LEO co-manifested with Orion in the mid-to-late 2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), to be launched to lunar orbit in FY 2020 followed by the first crewed SLS/Orion mission, EM-2 no later than 2023. These SLS/Orion missions will demonstrate the capability to reach and operate safely and productively around the Moon.

With an overall open architecture approach, the “Eagle Rising” Campaign and lunar concept of operations allows for systems and capabilities to be inserted as they develop. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early-to-mid 2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)



Initial Conops for discussion as part of overall lander assessment



With our open architecture and resilient Campaign approach, NASA will allow for the evolution of its current concept of operations for human lunar surface and orbit activities. Specifically, reusability and the evolution of other architectures are being kept in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander is envisioned, as are the use of Orion systems. SLS is currently being designed to be

disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) Additionally, NASA is looking at other options like a stretched Orion service module and/or a co-manifested retro stage. With open architecture, on-ramps for new and broadened commercial and international engagement, there will be other trades as the "Eagle Rising" campaign continues to innovate, adapt and grow.

As we move out with Eagle Rising, America will be answering critical strategic questions, such as:

Can the moon become a center for commercial enterprise? Are there significant deposits of water that could be utilized to support human settlement, or extracted for fuel on a human journey to deep space? In the long term scale of human endeavors, understanding what is possible on the moon and being the first to realize its potential could be transformational. Historically, when the explorers Lewis and Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities and they did not know what they might find. Today the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the campaign engage broader sectors of the nation? American companies will help lead this effort. Not only will they build the small landers, NASA will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a major company has experience drilling into the Earth's crust several miles under the ocean, such R&D created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign towards American and global society as a whole? Just as the ISS has spurred broader applications on Earth, America goes to the moon to extend humanity's presence in the solar system and also to improve the lives of people on Earth. The ultra-efficient use of scarce resources by humans in orbit, the production of tools and systems from extant resource off the Earth, or the extraction of water from the frozen lunar regolith are challenges that once mastered will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces and in orbit will push the technological frontier, supporting current trends in autopilot cars, trucks and trains - but with exceptional quality control and robust engineering - designed to operate in the most difficult environment known to human kind.

Critical Decisions and Milestones:

Lunar Surface

2018

- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020) and potentially a new Discovery-class 500 kg lunar lander(s?).
- Decision to develop human-class lunar lander capability for demonstration mission in 2024.
- Decision to develop and launch *Discovery*-class NASA lunar resource and science rover mission in 2022.
- Decision to procure commercial lunar payload services for NASA payloads starting in 2019.

- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Based on early results of human-class lunar lander development and on the results of the human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial lunar payload services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on results of the cost of lunar surface access, viability of ISRU as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship and decision on international partnerships and Moon Port configuration. The Moon Ship will also provide broad science research opportunities from cis-lunar space, including lunar surface (e.g., lunar sample return, telerobotics, etc), astrophysics, heliophysics, and Earth science. (Add/Highlight in earlier text).

2020

- Based on status of launch vehicle development, decide on Moon Port/Ship logistic resupply missions, conduct the uncrewed SLS/Orion first flight (Exploration Mission 1, or EM-1) in 2020 to the lunar vicinity.
- Conduct science and commercial activity using 13 co-manifested cube sats launched as secondary payloads on this mission. (Add/Highlight in earlier text).
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Establish a lunar communications network to better enable robotic and human exploration activities on the lunar surface.

2022

- Emplace power-propulsion (including communications) element (PPE) around the Moon. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar-electric propulsion technology, and provide the critical functionality for the rest of the Moon Ship.
- Perform science and technology activities, for example, lunar sample return and the operation of lunar robotic and in-space systems.
- Conduct a crewed flight – EM-2 – sending Americans around the Moon by June of 2022.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need and viability of developing and emplacing propellant depots in lunar orbit.
- Payload Delivery Mass and Fairing Capability Evolution on SLS Block 1, 1B, and Block 2 Building on the initial Block 1 and 1B designs for SLS, the performance and fairing volume for future SLS crew and cargo missions will be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing will also significantly shape the rest of the architecture.
- Study the Effects of the Deep Space Environment on Moon Ship.
- Orion Capability Upgrades - New engines for Orion's Orbital Maneuvering System-E engine need to be developed. Designs will be shaped by future service module development approaches. Other possible applications and upgrades under assessment.
- Flight Rate Support for Europa and Other Payloads. Decisions to augment the SLS flight rate need to be laid out five years in advance of the added flight. Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability, and cost of commercial launch options.

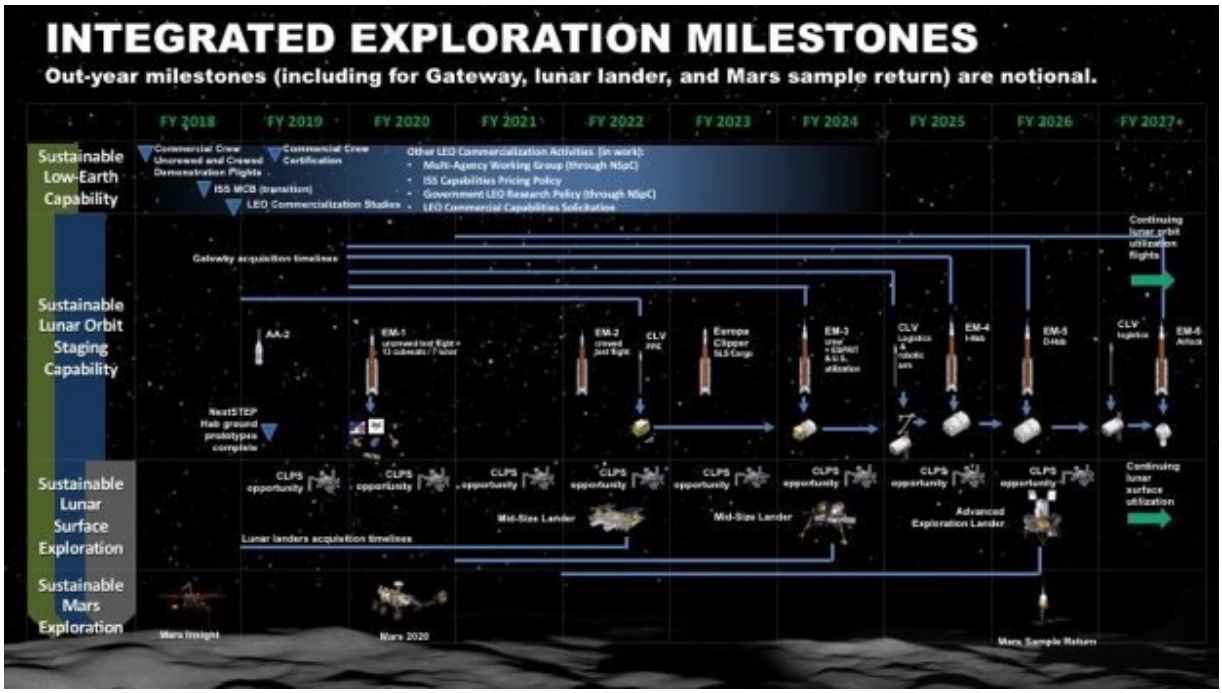


Figure 3: NASA's Exploration Campaign

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for human civilization. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon combined with continued U.S. access to commercial platform(s) in low-Earth orbit will ensure we will continue to advance American leadership in opening up the heavens to further human and scientific development.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests the advanced technologies necessary for long voyages and stays away from Earth. Long-duration exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health, and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to best address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently- crewed testbed prior to deploying these capabilities beyond low-Earth orbit (LEO).

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling discovery and development of advanced robotics, communications, medicine, agriculture, and environmental science. The Station has been an excellent platform for several Earth and space science instruments.

Ongoing operations and research on ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other Government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities. What is needed to allow a movie director to one day produce entertainment on the Station? What is needed to enable a astronaut tourist dock to the facility and stay the night? Can biotech, materials or manufacturing companies install equipment to produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services, but more importantly, strengthen overall demand and interest in utilizing a commercial platform in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it opens up significant new opportunities for commercial space flight. U.S. companies could become the first to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless, from tourism to training for deep space missions, it could also enable highly-trained and discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers. Specifically, nations with human spaceflight capability including Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station beginning as early as 2019. Upon completion, it will represent the extension of China's military operations onto a human habitation platform in low Earth orbit. For purposes of diplomacy and commerce, it may also offer an alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include:

- Expand the partnerships in LEO to include new companies and new nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services.
- Pursue other efforts to enable this shift away from direct government funded support of the ISS. For a fuller assessment of the transition of LEO, please refer to the recently published *NASA ISS Transition Report*: https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY19 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development

- Work with Commerce and State, in particular, to spur greater use of ISS and interest in LEO development overall. Identify and eliminate regulatory barrier to enable more commercial activity. Identify and implement incentives for LEO efforts. Examine funding models like the Aviation Trust Fund that may aid the development of on-going non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2026 (Gerst-when is the latest date or necessary date to decide this?)

2024

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2028

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate the appropriate NASA and overall governmental support to ensure on-going NASA requirements in LEO, as well as, ensuring permanent U.S. citizen presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe for thousands of years. As part of the "Eagle Rising" Campaign in response to SPD-1, this voyage will be able to occur in 2030s. Key components of this part of the Campaign are already underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit and, continuing to lead and advance the world in science missions beyond LEO, including a civilization first round-trip voyage to Mars. The U.S. will embark on the first round-trip return from another planet, Mars, launched by 2026. This mission will bring back samples with a focus on proving the existence of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes development of technologies and systems capabilities that enable a series of human and robotic lunar missions that are extensible to destinations beyond the Moon including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. The InSight mission is on its way to Mars now and will land in November to conduct research into the interior of Mars. The Mars2020 rover is continuing to make excellent progress and will be launching in July 2020. The planning for the return of samples from the Martian surface in the next decade are well under way. Research on Mars continues to pave the way for eventual human exploration of the red planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

For example, Mars robotic missions have enabled the U.S. to master the incredibly complex task of entry, descent, and landing (EDL) for one-metric-ton payloads (similar to the size of a compact car), gathered data about radiation in transit and on the surface of Mars, investigated the Martian atmosphere and weather, and shown there exist significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric CO_2 while selecting and encapsulating samples for potential return to Earth. Future lunar robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built upon the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other, and collectively build the world's knowledge base for Mars exploration. These missions have revealed a planet of diverse mineralogy indicating a water-related environment, that Mars could have supported life in its past, the massive loss of the Martian atmosphere through time, thick deposits of ice beneath Mars' surface, the presence of methane and other organics, and a still dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include:
Maintain and grow U.S. leadership at Mars with a rover in 2020, as a first step of a sample-return strategy, searching for past life and demonstrating oxygen production. Use this mission as a building block for a subsequent round-trip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crew Mars missions starting in the 2030s that will culminate in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the Universe and this may bode well for one day finding life on the planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest flagship priorities for future missions and is relevant to the human exploration initiative as well. Such a mission would be the first interplanetary roundtrip mission demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture; and
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships. It will also fill a leadership void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the European Space Agency (ESA), among others. NASA and ESA recently signed a letter of intent to mutually develop a joint MSR plan and to complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

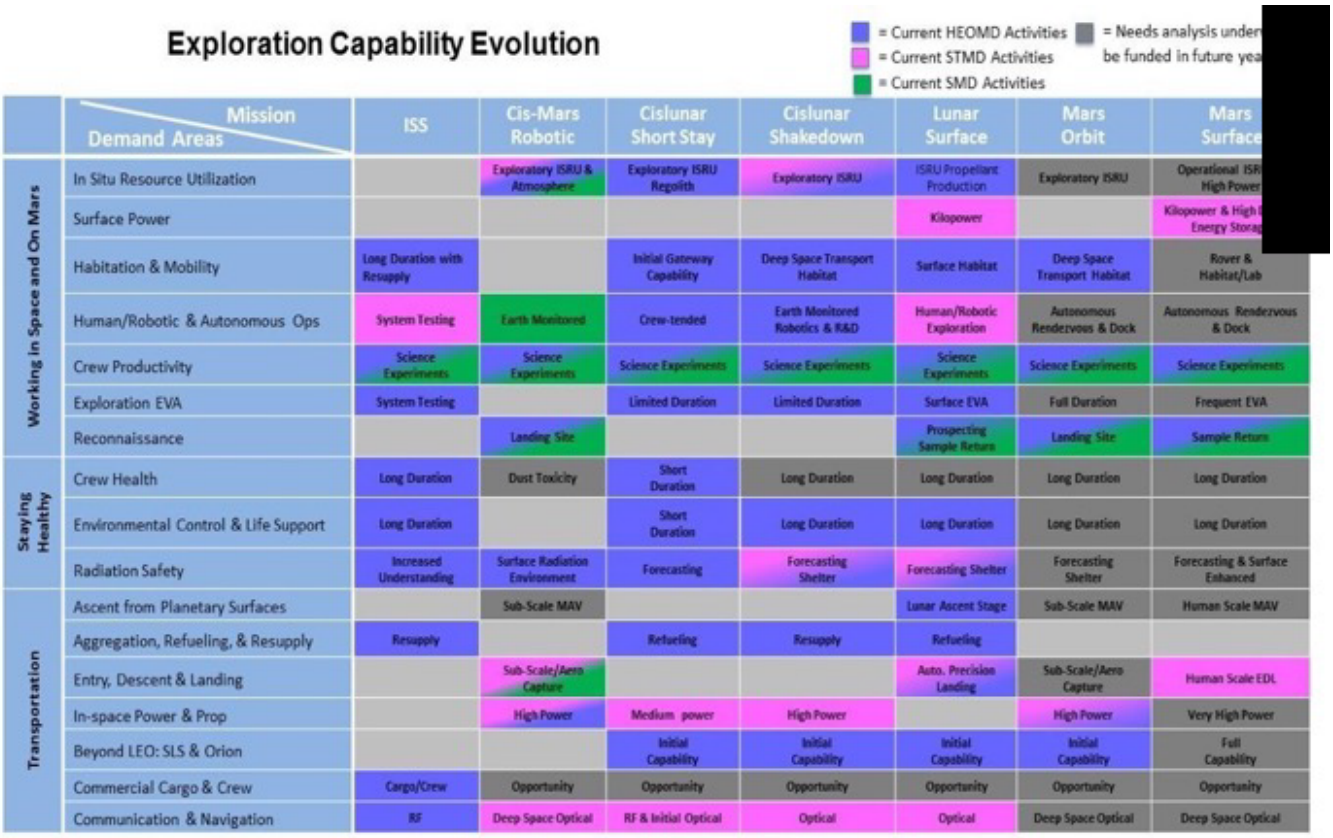
NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked industry for inputs with regard to commercial solutions and this dialogue is ongoing. Given the expected increased data rates (for downlink) required by the science and eventual human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Move up/Weave In or Appendix -
Exploration Research & Technology - Focused and in Support of the Campaign

The Agency is working to mature exploration technologies and systems in preparation for these cislunar Moon Ship and deep space missions. Exploration Research & Technology (ER&T) is developing advanced power and propulsion technology, including 13 kW SEP Hall thrusters, power processing units, and associated hardware supporting Moon Ship power and propulsion needs and potentially extensible to the needs of deep space architectures. ER&T is also advancing promising transformative technologies across other technology focus areas, including next-generation environmental control and life support

systems; ISRU; advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; EDL; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High-TRL technologies will be applied to near-term missions, while the Agency invests in low-TRL technologies to address challenges of future exploration missions. Wherever possible, these technologies are also being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities as well as Agency architecture strategies.



Long-term Strategies

There are a number of long-pole technology challenges related to lunar and Mars space exploration that we recognize will need concerted and sustained efforts to surmount. As an initial step to guide on-going development efforts, we formulated the following strategies:

- Spacesuit Evolution Strategy - Existing spacesuit designs on the ISS will need to be evolved and replaced for lunar surface and deep space missions, requiring significant development and testing.

- Nuclear Propulsion for in-Space Transportation - Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future engineering systems.

- Communications and Data Relay Strategy - Securing and building upon data relay and communications infrastructure will be needed prior to some missions. NASA will consider commercial providers for this service.

- Role of ISRU to Sustain Operations - Beyond testing ISRU technologies, planning for how ISRU will support human exploration activities through consumables and propellants will affect the rest of the architecture.

- Logistics Strategy - The choice of how to pre-position payloads on the lunar and Mars surface prior to human landing will strongly drive future flight rate and other system development needs.

- Maximizing Science Return with Humans on the Surface - Humans will provide the ability to perform science quickly and flexibly. A strategy for research approaches and instruments needed to support science activities will be a core part of achieving maximum science returns from human exploration.

- In-Space Propulsion Strategy - The choice of in-space propulsion has significant systems impact on the overall human Mars architecture, including ISRU, and commonality with lander propulsion.

- Reconnaissance/Technology Development Strategy - Such a strategy will consider the need for pre-emplacement of equipment and materials, as well as the need for reconnaissance and technology development/verification to inform construction of ISRU and lander systems.

- ISRU Strategy - To validate the performance of ISRU systems in the operational environments of the Moon or Mars, testing of these technologies on the actual lunar or Martian environment may be necessary. (Repetitive)

Critical Decisions and Milestones

2019

- Decision on Mars robotic round trip mission (Sample Return) implementation and architecture and target launch date (2026, 2029, 2031)
- Decision on Mars-forward technology investment R&D portfolio in ER&T
- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (on-going).
- Develop standards for human long-duration deep space transportation vehicles (on-going).

2021

- Based on results of Mars 2020, MOXIE payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T

2024

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic round trip Mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms, and Organizing to Win
OR
How NASA Will Change to Achieve Mission Success

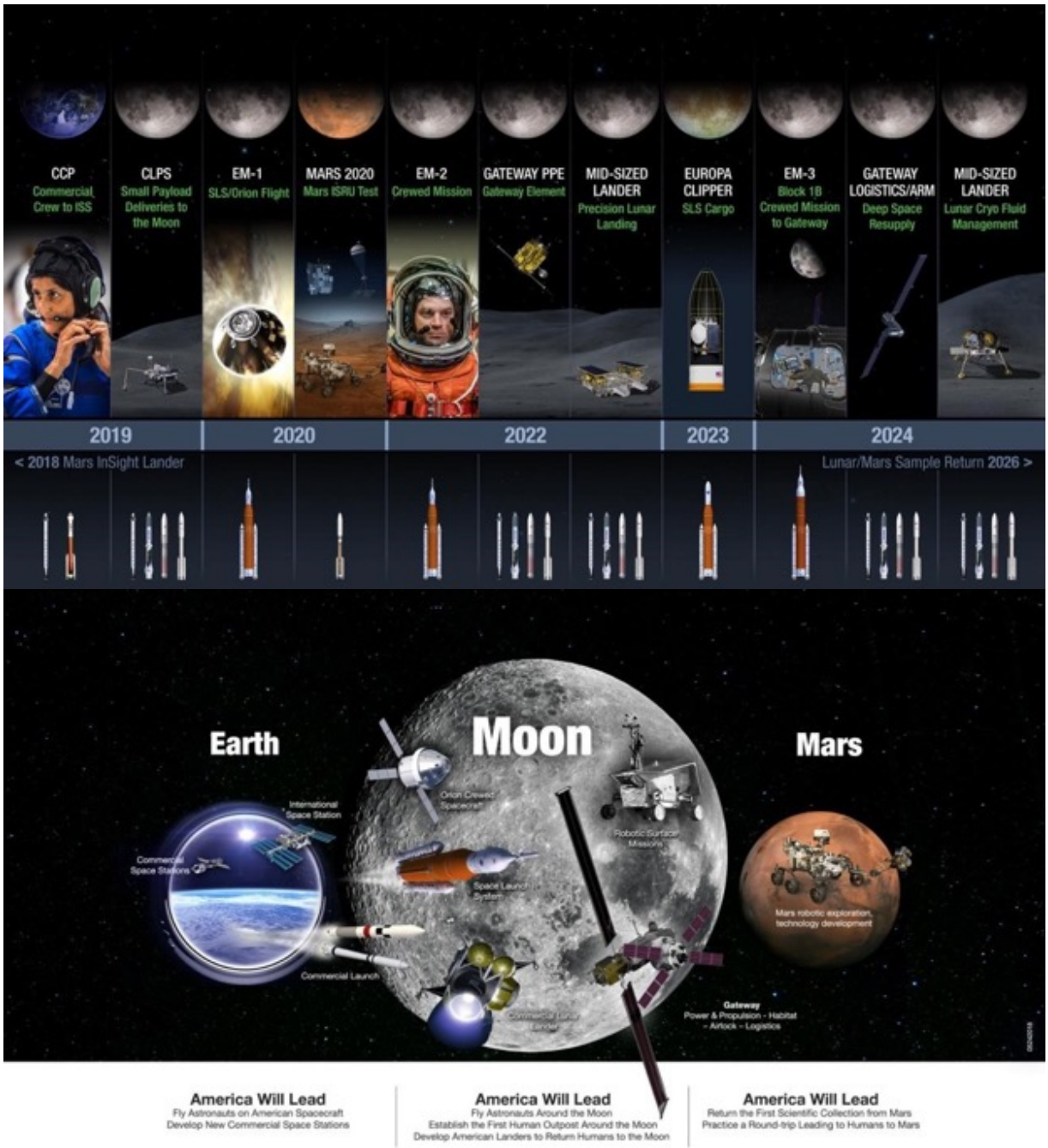
(placeholder for discussion only at this point or update based on decisions?)

To achieve extraordinary success, NASA must consider extraordinary changes from streamlining our organization and management to becoming even more efficient and effective. The "Eagle Rising" Campaign does not assume or require Apollo levels of funding, but instead seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage and partner for up to 30% in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission – we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

Lastly, NASA recognizes the need SMD/HEOMD/STMD lunar exploration integration and is looking at different ways to align and focus the Campaign elements. The Agency has already initiated a federated, core Team for the lunar portion of the Exploration Campaign that consists of AA and DAA level participation working with A-suite orchestration. NASA is looking at formalizing this approach thru the establishment of a senior leadership coordination group reporting to the Administrator, Deputy Administrator, or Associate Administrator. In support of this overall Agency effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to the Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA is also examining how to most effectively organize to lead in this key Exploration Campaign initiative.


CCP
Commercial Crew to ISS
CLPS
Small Payload Deliveries to the Moon
EM-1
SLS/Orion Flight
MARS 2020
Mars ISRU Test
EM-2
Crewed Mission
GATEWAY PPE
Gateway Element
MID-SIZED LANDER
Precision Lunar Landing
EUROPA CLIPPER
SLS Cargo
EM-3
Block 1B Crewed Mission to Gateway
GATEWAY LOGISTICS/ARM
Deep Space Resupply
MID-SIZED LANDER
Lunar Cryo Fluid Management
2019
2020
2022
2023
2024
< 2018 Mars InSight Lander
Lunar/Mars Sample Return 2026 >
Earth
Moon
Mars
International Space Station
Commercial Space Stations
Commercial Launch
Orion Crewed Spacecraft
Space Launch System
Robotic Surface Missions
Commercial Lunar Landers
Gateway
Power & Propulsion - Habitat - Airlock - Logistics
Mars robotic exploration, technology development
America Will Lead
Fly Astronauts on American Spacecraft
Develop New Commercial Space Stations
America Will Lead
Fly Astronauts Around the Moon
Establish the First Human Outpost Around the Moon
Develop American Landers to Return Humans to the Moon
America Will Lead
Return the First Scientific Collection from Mars
Practice a Round-trip Leading to Humans to Mars

SECTION 6 - CONCLUSION

The challenge of creating a human exploration program that will be sustainable across multiple decades is widely recognized. The complexity of developing and flying safe and productive human missions into space requires significant investments of national resources, including workforce, funding, and time. It is important that decision makers understand how these investments can enable further expansion of national capabilities and options for the future. It is NASA's hope that this report, directed by the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), Section 432(b), as well as its biennial updates, will inform decision makers now and in the years to come by outlining both the current progress of the Agency's human exploration efforts, as well as the next steps.

NASA appreciates Congress' continuing support of America's human space exploration efforts. The Agency looks forward to working with Congress in the years ahead as it gains experience from its research, development activities, and missions, and uses that experience to evolve the Exploration Campaign and critical decision plan. Through the Campaign outlined here, NASA will advance core U.S. interests in scientific knowledge, global engagement, national security, economic development, societal improvement, and continue to lead and inspire the world.

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A National Exploration Campaign –

"Eagle Rising"

pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 6
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Appendix A
Recent Achievements and Planned Activities

Section 1: *Forward to the Moon, Mars and Beyond – "Eagle Rising"*

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign, "Eagle Rising," laid out herein is NASA's answer to that bold call. The Campaign aims to revitalize and add direction within NASA's enduring charter to build missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to increase market share and create new market. It responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the country in space. Challenges and opportunities exist in now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation, centered in part on the U.S.-led International Space Station, is today starting to unleash a new economic realm. Action, though, is needed to unleash this new commercial engine and to provide the regulatory and security environment to enable and protect this new economic zone. Further out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond comes as more countries robotically begin establish a presence in this region.

When Americans reach the Moon starting early in the next decade, we will not be alone. Foreign nations are planning their own missions to send spacecraft into orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations have all stated plans or already initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013. It has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to an astronaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans. *Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing and ceding global leadership in cislunar space overall.* Even out to Mars, opportunities and challenges exist. American has been the unsurpassed leader in this domain. American robotic craft have been the only ones in history to have successfully landed on Mars. Now, many Nations are planning their own missions to Mars's surface in the coming years. China in the next decade also plans to be the first nation to bring back samples- that may show the first signs of life beyond our planet.

While NASA is currently prohibited by law from establishing a bilateral partnership with China, we intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation.

"Eagle Rising" – Time to Move Out

The overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and most importantly, the American public. It is not a return to the past or a repeat of previous efforts of the past 25 years that have sought to move beyond the near-Earth regions of space. It is not about a geo-political competition to re-do Apollo. A lot has changed – and is changing.

"Eagle Rising" builds upon the past 17 years of Americans and their partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies; and begins operations in the next few years of the first American capsule and rocket system capable of establishing the first American permanent presence and infrastructure on and around the Moon. At same time, with rapid advances in American private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and even commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and space traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA' relationship and collaboration with other U.S. Government agencies will be expanded to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the Nation's space goals. To supplement our own well of creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call (see list of upcoming requests for information in the Appendix). We seek to engage and inspire the next generation, in particular the large number of science, technology, engineering and mathematics (STEM) professionals that support major challenges needing these skills.

"Eagle Rising" therefore complements and directly responds to the policy objectives found in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which called upon the Agency to develop a Human Exploration Roadmap, including a critical decision plan, to expand human presence beyond low Earth orbit (LEO) to the surface of Mars and beyond, considering interim destinations such as cislunar space and the moons of Mars.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create dominance beyond the littoral shores of space – out to, around and on the Moon. NASA's civil pursuit and international leadership of scientific advancement, the frontiers of human exploration, technological primacy and civilizational achievement fill in the American strategic approach to the space domain.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations, which support NASA and the needs of an emerging private sector market.

2. Lead the emplacement of capabilities in lunar orbit that support surface operations and feed forward to missions beyond cis-lunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, "Eagle Rising" will be led by NASA as architect, mission leader, and in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. The following Report provides NASA's strategic implementation approach for "Eagle Rising."

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's off-shore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first placed footprints on its surface roughly 50 years ago, our explorers left only fleeting footsteps at a few sites for a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different than the past. NASA is building a plan for Americans to orbit the moon starting in 2023 and land astronauts on the surface by the late 2020s. For the majority of people alive today, this will be their first chance to witness a lunar encounter with Americans and a lunar landing – collective moments when the world holds it breath in awe and wonder. America will not stop there. A core focus of this Campaign is to bring the Moon into the nation's geo-strategic and economic sphere.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar ~~rays and cosmic detritus~~and cosmic radiation for billions of years – left largely undisturbed, the Moon is an archive of the history of our solar system and our Sun. There are scientific mysteries locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Making the first solar chips or gallons of fuel from the regolith of the Moon, like the harnessing of fire, will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out)– Living and Working Around the Moon

The American Moon Port/Ship under development will forge U.S. leadership and presence over the region from the Moon to the Earth. This platform will host astronauts further from Earth than ever before.

A radical advancement in space technology and human life support systems, the platform will serve as a Moon Ship that will offer astronauts longer stays on the surface, easier crew return, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, we will check technologies and systems as we get ready for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the ~~unique~~ radiation and microgravity environment beyond-LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by conducting biological and biomedical studies over longer periods than ever previously possible. The Moon Ship will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub, it will evolve to serve as a way station for the development of refueling depots, servicing platforms, and sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship/Port is presently under construction at NASA centers across the U.S. including in Ohio, Texas and Alabama. The first element will be launched from Florida in 2022 and crews will be able to stay aboard starting in 2023. NASA will call upon its own workforce to build critical pieces of hardware such as the power and propulsion element and habitation module, push industry to advance the state-of-the-art to deliver logistics modules, and utilize key contributions from international partners including additional habitat modules and a robotic arm. The Ship will be

incrementally built in place using the American-built Space Launch System, Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

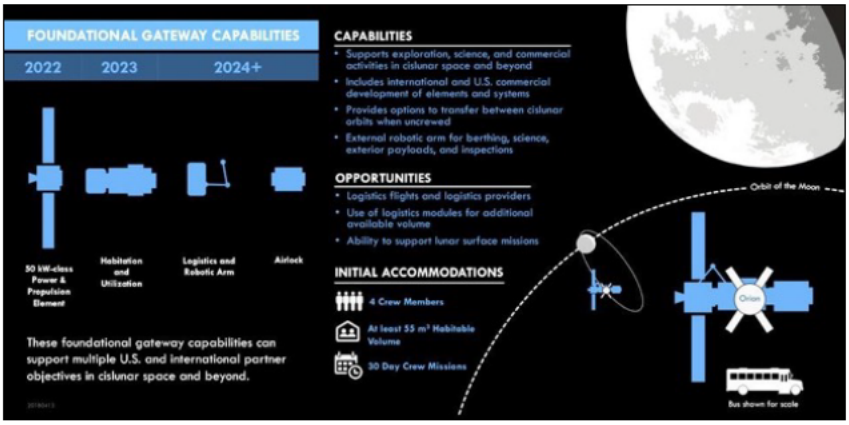

Figure 5: Gateway Development

Humans and Robots - Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, a training ground, and an off-shore continent to prepare for future human missions to Mars and other destinations. Through an innovative combination of robotic and human missions involving commercial and international partners, robotic lunar surface missions will start as early as 2019/20 focused on scientific explorations with a focus on lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in concert with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts and working in tandem with the Moon Ship/Port will expand and diversify over time, taking advantage of the Moon and cis-lunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far-side of the Moon for Astrophysics, focusing on Space Weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship/Port combination offers an unprecedented research platform and infrastructure. Our currently active scientific exploration missions, Lunar Reconnaissance Orbiter and ARTEMIS will be used immediately to support this rationale.

NASA has started a program of robotic lunar missions through the Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP), including delivery of early, small payloads using emerging commercial landers through the soon-to-be-released Commercial Lunar Payload Services (CLPS) procurement with speed and commercial partnerships as defining values. In addition, NASA will focus on continued growth of emerging commercial capabilities to further enhance human lunar lander capabilities and utilization of the Moon. An assessment is underway on the best development path for an SMD-led rover capability and mid-size lander. In every case, technology and commercial sector capabilities will feed forward toward and integrated into the human exploration approaches. Options are

being examined that range from NASA in-house development to procurement, and/or service and data purchase-based models.(update after decision)

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While we have extensive orbital information about the lunar surface and potential resources, robotic scouts are needed on the Moon to validate prior observations and are essential to prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data – multiple landers will provide a global-scale view of the Moon and its resources. Landers will specifically be outfitted with sensor packages, while also providing lunar surface access for rovers that can explore the surface more extensively, as well as carry instruments such as *in situ resource utilization* (ISRU) experiments that will provide detailed information on extraction of usable resources such as oxygen. In addition to obtaining this information, robotic landers will provide critical risk reduction activities for the human-scale lander descent stage and utilization capabilities. Still trying to better shop how these activities feed forward..

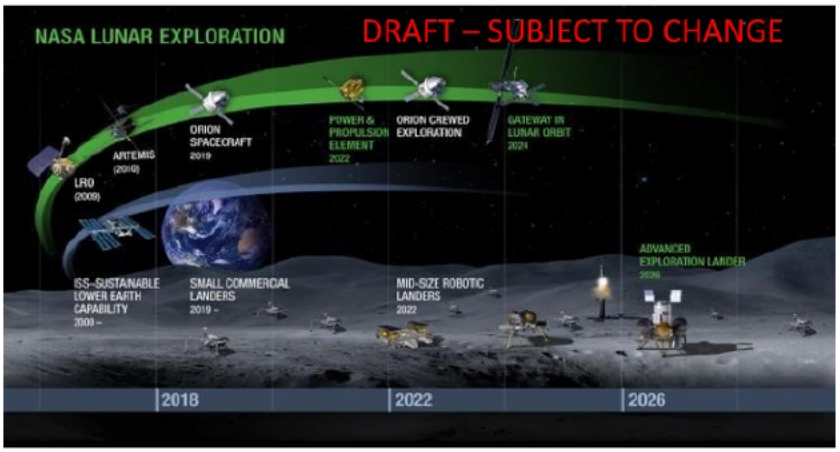
An American human lander effort is underway within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC -is partnering with the new Exploration Research & Technology organization (ER&T) (NEED more on ERT in this overall) to advance lower-readiness-level technologies so they can be implemented in future lunar missions. NASA is currently assessing different trades from a mid-sized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is examining options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of on-going National need or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated that range from capability stimulation through funded Space Act Agreements to a single partner or contract approach to an international partnership model, or a NASA-led multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace – it takes about 10 years to develop a crewed system. The Apollo LEM has been the only outlier. Produced in 6 years– but at a cost of 24B at current dollars – the LEM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

Human exploration of both the lunar surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is both building an exploration launch and crew system (the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting ground systems), and will rely on commercial launch providers to support both robotic surface and lunar orbit operations. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days. It is the only vehicle, at this point in the development of the Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days with additional habitation volume and systems. The SLS Block 1 cargo variant will be capable of delivering 70 mT to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 mT to LEO co-manifested with Orion in the mid-to-late 2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), to be launched to lunar orbit in FY 2020 followed by the first crewed SLS/Orion mission, EM-2 no later than 2023. These SLS/Orion missions will demonstrate the capability to reach and operate safely and productively around the Moon.

With an overall open architecture approach, the "Eagle Rising" Campaign and lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of new gained knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple

new heavy-lift systems expected to be operational between today and the early-to-mid 2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)



Initial Conops for discussion as part of overall lander assessment

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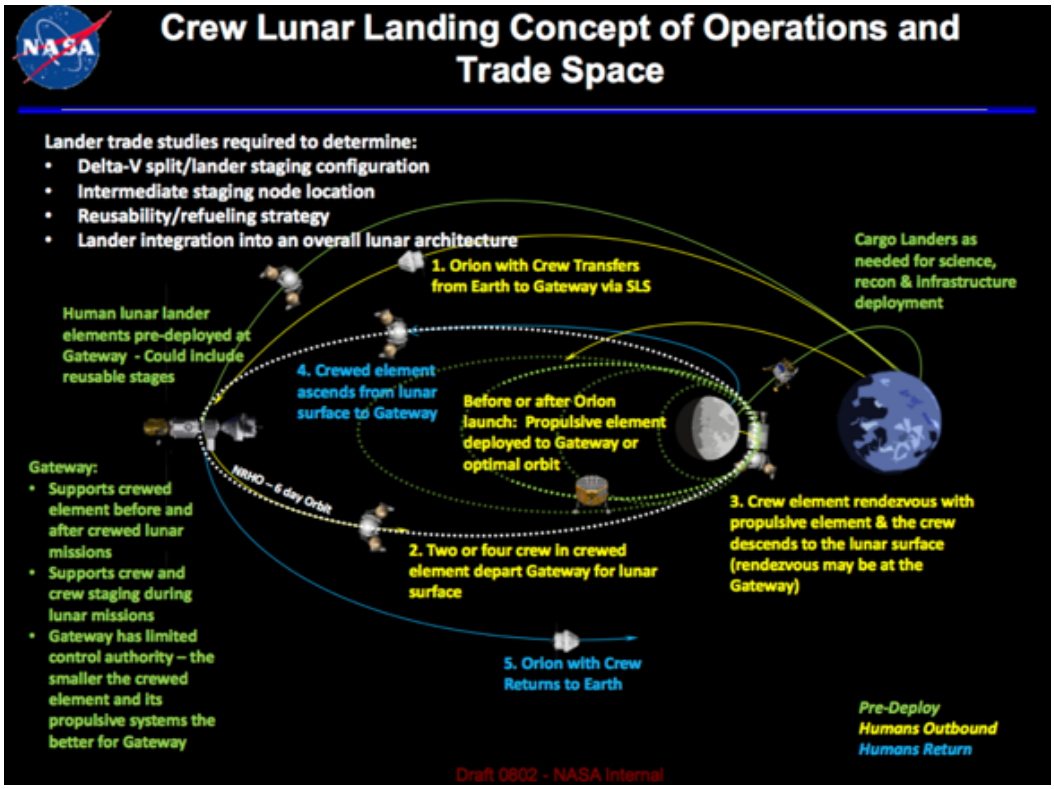

With our open architecture and resilient Campaign approach, NASA will allow for the evolution of its current concept of operations for human lunar surface and orbit activities. Specifically, reusability and the evolution of other architectures are being kept in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander is envisioned, as are the use of Orion systems. SLS is currently being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) Additionally, NASA is looking at other options like a stretched Orion service module and/or a co-manifested retro stage. With open architecture, on-ramps for new and broadened commercial and international engagement, there will be other trades as the "Eagle Rising" campaign continues to innovate, adapt and grow.

As we move out with Eagle Rising, America will be answering critical strategic questions, such as:

Can the moon become a center for commercial enterprise? Are there significant deposits of water that could be utilized to support human settlement, or extracted for fuel on a human journey to deep space? In the long term scale of human endeavors, understanding what is possible on the moon and being the first to realize its potential could be transformational. Historically, when the explorers Lewis and Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities and they did not know what they might find. Today the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the campaign engage broader sectors of the nation? American companies will help lead this effort. Not only will they build the small landers, NASA will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a major company has experience drilling into the Earth's crust several miles under the ocean, such R&D created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the

knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign towards American and global society as a whole? Just as the ISS has spurred broader applications on Earth, America goes to the moon to extend humanity's presence in the solar system and also to improve the lives of people on Earth. The ultra-efficient use of scarce resources by humans in orbit, the production of tools and systems from extant resource off the Earth, or the extraction of water from the frozen lunar regolith are challenges that once mastered will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar and Martian surfaces and in orbit will push the technological frontier, supporting current trends in autopilot cars, trucks and trains - but with exceptional quality control and robust engineering - designed to operate in the most difficult environment known to human kind.

Critical Decisions and Milestones:

Lunar Surface

2018

- Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019~~in 2019~~
- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020) ~~and potentially a new Discovery-class 500-kg lunar lander(s?).~~
- Decision to develop human-class lunar lander capability for demonstration mission in 2024.
- Decision to develop and launch *Discovery*-class NASA lunar resource and science rover mission in 2022
- ~~Decision to procure commercial lunar payload services for NASA payloads starting in 2019.~~
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Potential development of 500 kg-class lunar landers focused on resources and other scientific discovery, focused on mobility and sample return, as well as other scientific objectives
- Based on early results of human-class lunar lander development and on the results of the human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial lunar payload services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

Commented [ZTH(3]: Moved this one up front because of its enabling character for what follows. Did I mis-understand?

Commented [ZTH(4]: I assume that bullet is pending decisions wrt the two studies and the budget discussions

Commented [ZTH(5]: I think we need to discuss that as part of next year s discussion.

- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on results of the cost of lunar surface access, viability of ISRU as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship and decision on international partnerships and Moon Port configuration. The Moon Ship will also provide broad science research opportunities from cis-lunar space, including lunar surface (e.g., lunar sample return, telerobotics, etc), astrophysics, heliophysics, and Earth science. (Add/Highlight in earlier text)

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2020

- Based on status of launch vehicle development, decide on Moon Port/Ship logistic resupply missions, conduct the uncrewed SLS/Orion first flight (Exploration Mission 1, or EM-1) in 2020 to the lunar vicinity.
- Initiation of scientific payload development for Moon Ship, by competitivey assessing the most suitable and impactful scientific analysis.
- Conduct science and commercial activity using 13 co-manifested cube sats launched as secondary payloads on this mission. (Add/Highlight in earlier text).

Commented [CSW(7]: EM-1 I assume

- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Establish a lunar communications network to better enable robotic and human exploration activities on the lunar surface

Commented [CSW(8]: My input incorporated

2022

- Emplace power-propulsion (including communications) element (PPE) around the Moon. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar-electric propulsion technology, and provide the critical functionality for the rest of the Moon Ship.
- Perform science and technology activities, for example, lunar sample return and the operation of lunar robotic and in-space systems.
- Conduct a crewed flight – EM-2 – sending Americans around the Moon by June of 2022.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need and viability of developing and emplacing propellant depots in lunar orbit.
- Payload Delivery Mass and Fairing Capability Evolution on SLS Block 1, 1B, and Block 2 Building on the initial Block 1 and 1B designs for SLS, the performance and fairing volume for future SLS crew and cargo missions will be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing will also significantly shape the rest of the architecture.
- Study the Effects of the Deep Space Environment on Moon Ship and its ability to serve as a platform to assemble payloads and systems robotically or with humans, that could be used for human and scientific exploration.
- Orion Capability Upgrades - New engines for Orion's Orbital Maneuvering System-E engine need to be developed. Designs will be shaped by future service module development approaches. Other possible applications and upgrades under assessment.
- Flight Rate Support for Europa and Other Payloads. Decisions to augment the SLS flight rate need to be laid out five years in advance of the added flight. Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability, and cost of commercial launch options.

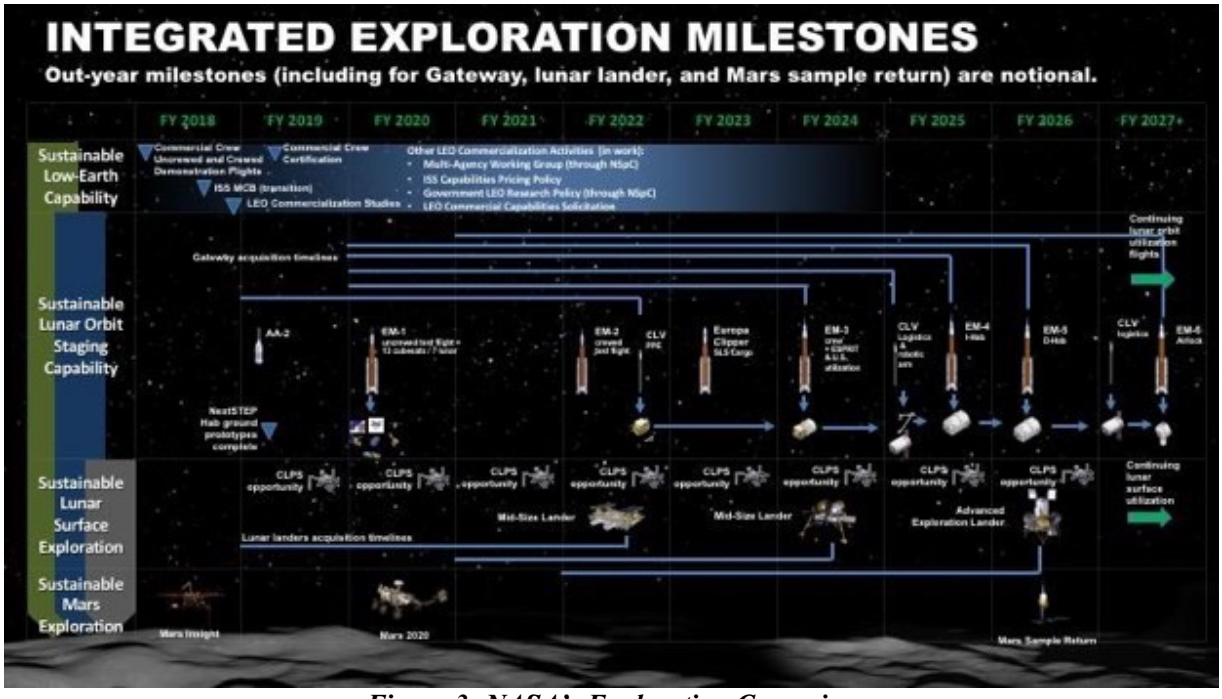


Figure 3: NASA's Exploration Campaign

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for human civilization. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon combined with continued U.S. access to commercial platform(s) in low-Earth orbit will ensure we will continue to advance American leadership in opening up the heavens to further human and scientific development.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests the advanced technologies necessary for long voyages and stays away from Earth. Long-duration exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health, and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to best address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently- crewed testbed prior to deploying these capabilities beyond low-Earth orbit (LEO).

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling discovery and development of advanced robotics, communications, medicine, agriculture, and environmental science. The Station has been an excellent platform for several Earth and space science instruments that leverage the unique infrastructure by mounting high-priority scientific investigations with strong appeal throughout the community.

Ongoing operations and research on ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other Government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities. What is needed to allow a movie director to one day produce entertainment on the Station? What is needed to enable a astronaut tourist dock to the facility and stay the night? Can biotech, materials or manufacturing companies install equipment to produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services, but more importantly, strengthen overall demand and interest in utilizing a commercial platform in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it opens up significant new opportunities for commercial space flight. U.S. companies could become the first to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless, from tourism to training for deep space missions, it could also enable highly-trained and discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers. Specifically, nations with human spaceflight capability including Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station beginning as early as 2019. Upon completion, it will represent the extension of China's military operations onto a human habitation platform in low Earth orbit. For purposes of diplomacy and commerce, it may also offer an alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include*:*

- Expand the partnerships in LEO to include new companies and new nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including for continuing scientific exploration in low-Earth orbit.~~.~~
- Pursue other efforts to enable this shift away from direct government funded support of the ISS. For a fuller assessment of the transition of LEO, please refer to the recently published *NASA ISS Transition Report*: https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY19 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development
- Work with Commerce and State, in particular, to spur greater use of ISS and interest in LEO development overall. Identify and eliminate regulatory barrier to enable more commercial activity. Identify and implement incentives for LEO efforts. Examine funding models like the Aviation Trust Fund that may aid the development of on-going non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2026 (Gerst-when is the latest date or necessary date to decide this?)

2024

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2028

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate the appropriate NASA and overall governmental support to ensure on-going NASA requirements in LEO, as well as, ensuring permanent U.S. citizen presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe for thousands of years. As part of the "Eagle Rising" Campaign in response to SPD-1, this voyage will be able to occur in 2030s. Key components of this part of the Campaign are already underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit and, continuing to lead and advance the world in science missions beyond LEO, including a civilization first round-trip voyage to Mars. The U.S. will embark on the first round-trip return from another planet, Mars, launched by 2026. This mission will bring back samples with a focus on proving the existence of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes development of technologies and systems capabilities that enable a series of human and robotic lunar missions that are extensible to destinations beyond the Moon including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. The InSight mission is on its way to Mars now and will land in November to conduct research into the interior of Mars. The Mars2020 rover is continuing to make excellent progress and will be launching in July 2020. The planning for the return of samples from the Martian surface in the next decade are well under way. Research on Mars ~~continues to~~is pavinge the way ~~for eventual human exploration of the red planet.~~for human exploration and utilization of the red planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

Commented [CSW(9]: My input incorporated

For example, Mars robotic missions have enabled the U.S. to master the incredibly complex task of entry, descent, and landing (EDL) for one-metric-ton payloads (similar to the size of a compact car), gathered data about radiation in transit and on the surface of Mars, investigated the Martian atmosphere and weather, and shown there exist significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric CO_2 while selecting and encapsulating samples for potential return to Earth. Future ~~lunar~~ robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

~~Expand American~~Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built upon the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other, and collectively build the world's knowledge base for Mars exploration. These missions have revealed a planet of diverse mineralogy indicating a water-related environment, that Mars could have supported life in its past, the massive loss of the Martian atmosphere through time, thick deposits of ice beneath Mars' surface, the presence of methane and other organics, and a still dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include:
Maintain and grow U.S. leadership at Mars with a rover in 2020, as a first step of a sample-return strategy, searching for past life and demonstrating ~~oxygen production~~the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent round-trip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crew Mars missions starting in the 2030s that will culminate in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the Universe and this may bode well for one day finding life on the planet. Later in 2018, NASA will land the InSight lander, a sophisticated analysis into the geology of the Red Planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest flagship priorities for future missions and is relevant to the human exploration initiative as well. Such a mission would be the first interplanetary roundtrip mission demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture; and
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning.
- Two high-visibility technology demonstrations as part of Mars2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable Oxygen from Martian's thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships, and through it assert continuing US leadership throughout, by. ~~It will also~~ filling a leadership void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the European Space Agency (ESA), among others. NASA and ESA recently signed a letter of intent to mutually develop a joint MSR plan and to complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked industry for inputs with regard to commercial solutions and this dialogue is ongoing. Given the expected increased data rates (for downlink) required by the science and eventual human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Move up/Weave In or Appendix -
Exploration Research & Technology - Focused and in Support of the Campaign

The Agency is working to mature exploration technologies and systems in preparation for these cislunar Moon Ship and deep space missions. Exploration Research & Technology (ER&T) is developing advanced power and propulsion technology, including 13 kW SEP Hall thrusters, power processing units, and associated hardware supporting Moon Ship power and propulsion needs and potentially extensible to the needs of deep space architectures. ER&T is also advancing promising transformative technologies across other technology focus areas, including next-generation environmental control and life support systems; ISRU; advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; EDL; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High-TRL technologies will be applied to near-term missions, while the Agency invests in low-TRL technologies to address challenges of future exploration missions. Wherever possible, these technologies are also being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities as well as Agency architecture strategies.

Exploration Capability Evolution

= Current HEOMD Activities
= Current STMD Activities
= Current SMD Activities
= Needs analysis under
be funded in future yea

	Mission / Demand Areas	ISS	Cis-Mars Robotic	Cislunar Short Stay	Cislunar Shakedown	Lunar Surface	Mars Orbit	Mars Surface
Working in Space and On Mars	In Situ Resource Utilization		Exploratory ISRU & Atmosphere	Exploratory ISRU Regolith	Exploratory ISRU	ISRU Propellant Production	Exploratory ISRU	Operational ISR High Power
	Surface Power					Kilopower		Kilopower & High E Energy Storag
	Habitation & Mobility	Long Duration with Resupply		Initial Gateway Capability	Deep Space Transport Habitat	Surface Habitat	Deep Space Transport Habitat	Rover & Habitat/Lab
	Human/Robotic & Autonomous Ops	System Testing	Earth Monitored	Crew-tended	Earth Monitored Robotics & R&D	Human/Robotic Exploration	Autonomous Rendezvous & Dock	Autonomous Rendezvous & Dock
	Crew Productivity	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments
	Exploration EVA	System Testing		Limited Duration	Limited Duration	Surface EVA	Full Duration	Frequent EVA
	Reconnaissance		Landing Site			Prospecting Sample Return	Landing Site	Sample Return
Staying Healthy	Crew Health	Long Duration	Dust Toxicity	Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Environmental Control & Life Support	Long Duration		Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Radiation Safety	Increased Understanding	Surface Radiation Environment	Forecasting	Forecasting Shelter	Forecasting Shelter	Forecasting Shelter	Forecasting & Surface Enhanced
Transportation	Ascent from Planetary Surfaces		Sub-Scale MAV			Lunar Ascent Stage	Sub-Scale MAV	Human Scale MAV
	Aggregation, Refueling, & Resupply	Resupply		Refueling	Resupply	Refueling		
	Entry, Descent & Landing		Sub-Scale/Aero Capture			Auto. Precision Landing	Sub-Scale/Aero Capture	Human Scale EDL
	In-space Power & Prop		High Power	Medium power	High Power		High Power	Very High Power
	Beyond LEO: SLS & Orion			Initial Capability	Initial Capability	Initial Capability	Initial Capability	Full Capability
	Commercial Cargo & Crew	Cargo/Crew	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity
	Communication & Navigation	RF	Deep Space Optical	RF & Initial Optical	Optical	Optical	Deep Space Optical	Deep Space Optical

Long-term Strategies

There are a number of long-pole technology challenges related to lunar and Mars space exploration that we recognize will need concerted and sustained efforts to surmount. As an initial step to guide on-going development efforts, we formulated the following strategies:

(b) (5)

- Spacesuit Evolution Strategy - Existing spacesuit designs on the ISS will need to be evolved and replaced for lunar surface and deep space missions, requiring significant development and testing.
- Nuclear Propulsion for in-Space Transportation - Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future engineering systems.
- Communications and Data Relay Strategy - Securing and building upon data relay and communications infrastructure will be needed prior to some missions. NASA will consider commercial providers for this service.
- Role of ISRU to Sustain Operations - Beyond testing ISRU technologies, planning for how ISRU will support human exploration activities through consumables and propellants will affect the rest of the architecture.
- Logistics Strategy - The choice of how to pre-position payloads on the lunar and Mars surface prior to human landing will strongly drive future flight rate and other system development needs.
- Maximizing Science Return with Humans on the Surface - Humans will provide the ability to perform science quickly and flexibly. A strategy for research approaches and instruments needed to support science activities will be a core part of achieving maximum science returns from human exploration.
- In-Space Propulsion Strategy - The choice of in-space propulsion has significant systems impact on the overall human Mars architecture, including ISRU, and commonality with lander propulsion.
- Reconnaissance/Technology Development Strategy - Such a strategy will consider the need for pre-emplacement of equipment and materials, as well as the need for reconnaissance and technology development/verification to inform construction of ISRU and lander systems.
- ISRU Strategy - To validate the performance of ISRU systems in the operational environments of the Moon or Mars, testing of these technologies on the actual lunar or Martian environment may be necessary. (Repetitive)

Critical Decisions and Milestones

2019

- Decision on Mars robotic round trip mission (Sample Return) implementation and architecture and target launch date (2026, or 2029, ~~2031~~)
- Decision on Mars-forward technology investment R&D portfolio in ER&T
- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (on-going).
- Develop standards for human long-duration deep space transportation vehicles (on-going).

2021

- Based on results of Mars 2020, MOXIE payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T

2024

Commented [ZTH(12]: To be consistent with 19 budget.

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic round trip Mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms, and Organizing to Win OR How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

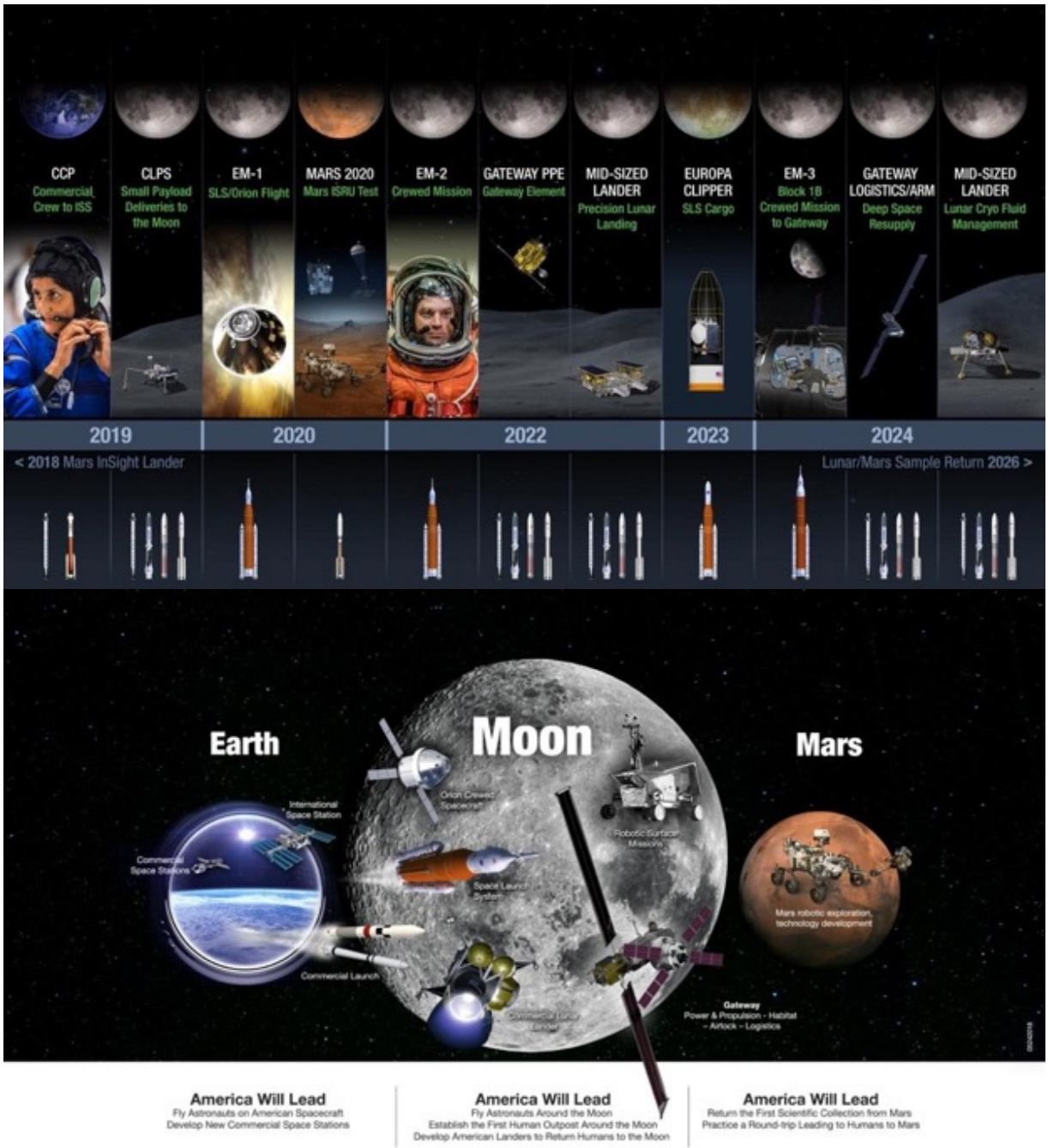
To achieve extraordinary success, NASA must consider extraordinary changes from streamlining our organization and management to becoming even more efficient and effective. The "Eagle Rising" Campaign does not assume or require Apollo levels of funding, but instead seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage and partner for up to 30% in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission – we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

Lastly, NASA recognizes the need for SMD/HEOMD/STMD lunar exploration integration and is looking at different ways to align and focus the Campaign elements. The Agency has already initiated a federated, core Team for the lunar portion of the Exploration Campaign that consists of AA and DAA level participation working with A-suite orchestration. NASA is looking at formalizing this approach thru the establishment of a senior leadership coordination group reporting to the Administrator, Deputy Administrator, or Associate Administrator. In support of this overall Agency effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Commented [CSW(13]: My input incorporated

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to the Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA is also examining how to most effectively organize to lead in this key Exploration Campaign initiative.


CCP
Commercial Crew to ISS
CLPS
Small Payload Deliveries to the Moon
EM-1
SLS/Orion Flight
MARS 2020
Mars ISRU Test
EM-2
Crewed Mission
GATEWAY PPE
Gateway Element
MID-SIZED LANDER
Precision Lunar Landing
EUROPA CLIPPER
SLS Cargo
EM-3
Block 1B Crewed Mission to Gateway
GATEWAY LOGISTICS/ARM
Deep Space Resupply
MID-SIZED LANDER
Lunar Cryo Fluid Management
2019
2020
2022
2023
2024
< 2018 Mars InSight Lander
Lunar/Mars Sample Return 2026 >
Earth
Moon
Mars
International Space Station
Commercial Space Stations
Commercial Launch
Orion Crewed Spacecraft
Space Launch System
Robotic Surface Missions
Commercial Lunar Landers
Gateway
Power & Propulsion - Habitat - Airlock - Logistics
Mars robotic exploration, technology development
America Will Lead
Fly Astronauts on American Spacecraft
Develop New Commercial Space Stations
America Will Lead
Fly Astronauts Around the Moon
Establish the First Human Outpost Around the Moon
Develop American Landers to Return Humans to the Moon
America Will Lead
Return the First Scientific Collection from Mars
Practice a Round-trip Leading to Humans to Mars

SECTION 6 - CONCLUSION

The challenge of creating a human exploration program that will be sustainable across multiple decades is widely recognized. The complexity of developing and flying safe and productive human missions into space requires significant investments of national resources, including workforce, funding, and time. It is important that decision makers understand how these investments can enable further expansion of national capabilities and options for the future. It is NASA's hope that this report, directed by the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), Section 432(b), as well as its biennial updates, will inform decision makers now and in the years to come by outlining both the current progress of the Agency's human exploration efforts, as well as the next steps.

NASA appreciates Congress' continuing support of America's human space exploration efforts. The Agency looks forward to working with Congress in the years ahead as it gains experience from its research, development activities, and missions, and uses that experience to evolve the Exploration Campaign and critical decision plan. Through the Campaign outlined here, NASA will advance core U.S. interests in scientific knowledge, global engagement, national security, economic development, societal improvement, and continue to lead and inspire the world.

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A National Exploration Campaign –

"Eagle Rising"

pursuant to Section 432(b) of the NASA Transition Authorization Act of 2017 (P.L. 115-10)

August 2018

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Section 1: *Forward to the Moon, Mars and Beyond – "Eagle Rising"*

In December of 2017, President Donald J. Trump signed National Space Policy Directive-1 (SPD-1). The President directed the NASA Administrator "to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The National Exploration Campaign, "Eagle Rising," laid out herein is NASA's answer to that bold call. The Campaign aims to revitalize and add direction within NASA's enduring charter to build missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to increase market share and create new market. It responds to core national drivers:

- Scientific Knowledge
- Global Engagement
- National Security
- Economic Development
- Societal Improvement
- Leadership and Inspiration

The call for a national Exploration Campaign from the President and Congress emerges at a critical point in America's space program and its relationship to strategic issues facing the country in space. Challenges and opportunities exist in now and need to be addressed over the next several years.

Close to Earth, American leadership and commercial innovation, centered in part on the U.S.-led International Space Station, is today starting to unleash a new economic realm. Action, though, is needed to unleash this new commercial engine and to provide the regulatory and security environment to enable and protect this new economic zone. Further out, NASA's shift to focus on the creation of a sustainable presence on and around the Moon, and beyond comes as more countries robotically begin establish a presence in this region.

When Americans reach the Moon starting early in the next decade, we will not be alone. Foreign nations are planning their own missions to send spacecraft into orbit and to the surface. China, India, Russia, Japan, South Korea, Israel and European nations have all stated plans or already initiated missions. In particular, China demonstrated a successful lunar landing and rover mission in 2013. It has ambitious plans to land more sophisticated rovers and conduct a sample return mission in the near future. These are part of an emerging strategy that may ultimately build up to an astronaut landing and herald the first steps to build an extensive infrastructure for lunar research and settlement by humans. *Without sustained political and budget support, the lunar program and Exploration Campaign may be significantly delayed, returning Americans to the Moon after China's first landing and ceding global leadership in cislunar space overall.* Even out to Mars, opportunities and challenges exist. American has been the unsurpassed leader in this domain. American robotic craft have been the only ones in history to have successfully landed on Mars. Now, many Nations are planning their own missions to Mars's surface in the coming years. China in the next decade also plans to be the first nation to bring back samples- that may show the first signs of life beyond our planet.

Commented [JLR1]: **Consider using the Chinese term for astronaut (taikonaut).** Currently it isn't completely clear to me that this sentence refers to China vs. U.S.

While NASA is currently prohibited by law from establishing a bilateral partnership with China, we intend to partner with foreign nations aligned to our interests, which are a reflection of our values as a nation.

"Eagle Rising" – Time to Move Out

The overall Campaign strategy is ready. It includes direction from the White House, Congress, industry, academia, international partners and most importantly, the American public. It is not a return to the past or a repeat of previous efforts of the past 25 years that have sought to move beyond the near-Earth regions of space. It is not about a geo-political competition to re-do Apollo. A lot has changed – and is changing.

"Eagle Rising" builds upon the past 17 years of Americans and their partners living and working continuously on the International Space Station. It leverages advances in robotics and other technologies; and begins operations in the next few years of the first American capsule and rocket system capable of establishing the first American permanent presence and infrastructure on and around the Moon. At the same time, with rapid advances in American private sector capabilities and interests, NASA has started to weave together its commercial and international partners to lay the foundation of an unending future of opportunity, discovery and growth.

The priorities set out align to the White House Office of Science and Technology Policy's *FY 2020 Administration Research and Development Budget Priorities*. NASA seeks to ensure American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Our priorities also include facilitating the economic development of new space sectors, including microgravity-related research, commercial cargo and crew, and even commercial enterprise on the lunar surface and in lunar orbit. National Space Council policy directives SPD-2 and SPD-3, related to space commerce regulation and space traffic management, will enhance and enable the primary goals of our missions.

As part of this national Campaign, NASA' relationship and collaboration with other U.S. Government agencies will be expanded to take advantage of their expertise, create mutually beneficial synergies, and ensure ongoing coordination in the pursuit and achievement of the Nation's space goals. To supplement our own well of creative power and technical expertise, NASA is looking for innovative ideas from any American citizen, student, company or institution ready to answer the call (see list of upcoming requests for information in the Appendix). We seek to engage and inspire the next generation, in particular the large number of science, technology, engineering and mathematics (STEM) professionals that support major challenges needing these skills.

"Eagle Rising" therefore complements and directly responds to the policy objectives found in the National Aeronautics and Space Administration Transition Authorization Act of 2017 (P.L. 115-10), which called upon the Agency to develop a Human Exploration Roadmap, including a critical decision plan, to expand human presence beyond low Earth orbit (LEO) to the surface of Mars and beyond, considering interim destinations such as cislunar space and the moons of Mars.

Lastly, the Campaign strategy complements the President's call for the creation of the United States Space Force. President Trump declared, "It is not enough to merely have an American presence in space; we must have American dominance in space." NASA's role in the overall national space architecture is to create dominance beyond the littoral shores of space – out to, around and on the Moon. NASA's civil pursuit and international leadership of scientific advancement, the frontiers of human exploration, technological primacy and civilizational achievement fill in the American strategic approach to the space domain.

The Campaign has five strategic goals:

1. Transition U.S. human spaceflight in LEO to commercial operations, which support NASA and the needs of an emerging private sector market.

2. Lead the emplacement of capabilities in lunar orbit that support surface operations and feed forward to missions beyond cis-lunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.

4. Enable a sustained human presence around and on the Moon for exploration and utilization.

5. Advance knowledge of the Mars environment and demonstrate capabilities required for human orbital and surface missions to Mars.

Overall, "Eagle Rising" will be led by NASA as architect, mission leader, and in several key areas, systems integrator. NASA has defined an open architecture that meets our core national and Agency objectives and enables partners, where appropriate, to contribute to key goals and objectives. The following Report provides NASA's strategic implementation approach for "Eagle Rising."

Section 2: Americans in Lunar Orbit and on the Lunar Surface

The Moon is Earth's off-shore continent. Its sentinel presence is a fundamental part of our planet's past and future. Although Americans first placed footprints on its surface roughly 50 years ago, our explorers left only fleeting footsteps at a few sites for a total of 16 days on the surface. The next wave of lunar exploration will be fundamentally different than the past. NASA is building a plan for Americans to orbit the moon starting in 2023 and land astronauts on the surface by the late 2020s. For the majority of people alive today, this will be their first chance to witness a lunar encounter with Americans and a lunar landing – collective moments when the world holds it breath in awe and wonder. America will not stop there. A core focus of this Campaign is to bring the Moon into the nation's geo-strategic and economic sphere.

In the intervening time since the Apollo missions, our knowledge of our closest neighbor has grown exponentially. Bombarded by solar ~~rays and cosmic detritus~~and cosmic radiation for billions of years – left largely undisturbed, the Moon is an archive of the history of our solar system and our Sun. There are scientific mysteries locked in its regolith that could lead to improved understanding of our own planet and its evolution. It also harbors resources such as water that are among the rarest and most precious commodities in space, offering potential sustenance and fuel for future explorers. Making the first solar chips or gallons of fuel from the regolith of the Moon, like the harnessing of fire, will signal a fundamental shift in humanity's development.

The Moon Port and/or Moon Ship (decide now or use when roll out)– Living and Working Around the Moon

The American Moon Port/Ship under development will forge U.S. leadership and presence over the region from the Moon to the Earth. This platform will host astronauts further from Earth than ever before.

A radical advancement in space technology and human life support systems, the platform will serve as a Moon Ship that will offer astronauts longer stays on the surface, easier crew return, safe haven in the event of an emergency, and the ability to navigate to different orbits around the Moon.

On the Moon Ship, America and her partners will prepare to transit deep space, we will check technologies and systems as we get ready for the epochal journey beyond the Moon to Mars. We will learn how living organisms react to the ~~unique~~ radiation and microgravity environment beyond-LEO. The Moon Ship will serve as a critical laboratory to expand our knowledge in this area by conducting biological and biomedical studies over longer periods than ever previously possible. The Moon Ship will be a platform for broad scientific exploration, taking advantage of its unique vantage point in deep space. At the same time, the platform will serve as a port and transit hub;~~, it will~~ evolvinge to serve as a way station for the development of refueling depots, servicing platforms, and sample return facility from the Moon and other bodies in support of science and commerce.

From a strategic perspective, the Moon Ship moves the ISS partnership out from low earth orbit to this increasingly vital domain. With presence comes awareness, access and the ability to shape the seas between the Moon and the Earth. The Moon Ship/Port is presently under construction at NASA centers across the U.S. including in Ohio, Texas and Alabama. The first element will be launched from Florida in 2022 and crews will be able to stay aboard starting in 2023. NASA will call upon its own workforce to build critical pieces of hardware such as the power and propulsion element and habitation module, push industry to advance the state-of-the-art to deliver logistics modules, and utilize key contributions from international partners including additional habitat modules and a robotic arm. The Ship will be

incrementally built in place using the American-built Space Launch System, Orion crew vehicle, and commercial launch vehicles (see Figure x: Moon Ship Development – INSERT latest).

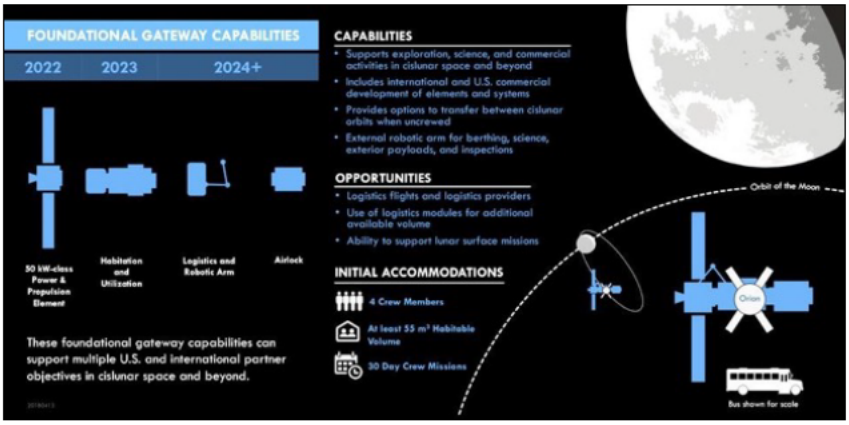

Figure 5: Gateway Development

Humans and Robots - Exploring and Developing the Moon

The surface of the Moon will serve as a stepping-stone, a training ground, and an off-shore continent to prepare for future human missions to Mars and other destinations. Through an innovative combination of robotic and human missions involving commercial and international partners, robotic lunar surface missions will start as early as 2019/20 focused on scientific explorations with a focus on lunar resources. By the late 2020s, an American human lander will begin sortie missions to the surface of the Moon. This lander will be developed in concert with precursor robotic missions to explore and prepare for a sustained human presence on the lunar surface. Lunar surface activities enabled by these efforts and working in tandem with the Moon Ship/Port will expand and diversify over time, taking advantage of the Moon and cis-lunar space for scientific exploration in the broadest sense. Whether it is using the radio-quiet far-side of the Moon for Astrophysics, focusing on Space Weathering of airless bodies, or understanding the processes that shape the solar system and the Earth, the Moon Ship/Port combination offers an unprecedented research platform and infrastructure. Our currently active scientific exploration missions, Lunar Reconnaissance Orbiter and ARTEMIS will be used immediately to support this rationale.

NASA has started a program of robotic lunar missions through the Science Mission Directorate (SMD) Lunar Discovery and Exploration Program (LDEP), including delivery of early, small payloads using emerging commercial landers through the soon-to-be-released Commercial Lunar Payload Services (CLPS) procurement with speed and commercial partnerships as defining values. In addition, NASA will focus on continued growth of emerging commercial capabilities to further enhance human lunar lander capabilities and utilization of the Moon. An assessment is underway on the best development path for an SMD-led rover capability and mid-size lander. In every case, technology and commercial sector capabilities will feed forward toward and integrated into the human exploration approaches. Options are

Commented [JLR2]: This sounds like it is a SMD led mid-sized lander. Should be HEO-led mid-sized lander? Also, "In every case…" seems too strong for stating the CLPS lander will feed forward to human exploration approaches. Valid for mid-sized lander.

being examined that range from NASA in-house development to procurement, and/or service and data purchase-based models.(update after decision)

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While we have extensive orbital information about the lunar surface and potential resources, robotic scouts are needed on the Moon to validate prior observations and are essential to prepare for humans and the utilization of the Moon's rich array of resources. Robotic landers are instrumental to obtain this "ground truth" data – multiple landers will provide a global-scale view of the Moon and its resources. Landers will specifically be outfitted with sensor packages, while also providing lunar surface access for rovers that can explore the surface more extensively, as well as carry instruments such as *in situ resource utilization* (ISRU) experiments that will provide detailed information on extraction of usable resources such as oxygen and water. In addition to obtaining this information, robotic landers will provide critical risk reduction activities for the human-scale lander descent stage and utilization capabilities, including development of critical technologies that will enable precise and soft landings on the lunar surface. Still trying to better shop how these activities feed forward.

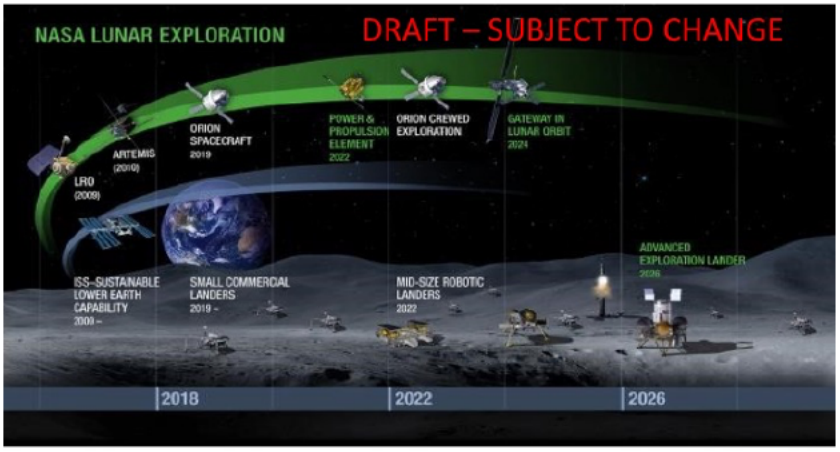
An American human lander effort is underway within the Human Exploration and Operations Mission Directorate (HEOMD)-led Advanced Cislunar and Surface Capabilities program (ACSC). ACSC is partnering with the new Exploration Research & Technology organization (ER&T) (NEED more on ERT in this overall) to advance lower-readiness-level technologies so they can be implemented in future lunar missions. A critical technology development underway involves infusing autonomous sensing, processing, guidance and navigation capabilities to enable soft, controlled landings within tens of meters of a selected target, utilizing real-time hazard detection and avoidance algorithms to ensure a safe and precise landing. In addition, long-term storage of cryogenic fluids is being developed that will enable significantly greater mid-sized and human class lander performance capability at a substantially reduced mass. A deep space engine for landers is being developed with an unique fuel mixture with a lower freezing point that will reduce the power required and lowers the system mass. NASA is also assessing the longer-term higher-power needs to surviving the lunar night and operations in shaded portions of the lunar surface by considering surface fission power that will power ISRU demonstrations and other needs. In addition, the available landers and rovers provide excellent platforms to demonstrate technologies that will not only enable greater lunar surface mission capabilities but also extend beyond the moon to Mars applications. NASA is currently assessing different trades from a mid-sized cargo, heavy cargo, and direct human lander evolution paths. As part of this assessment, the Agency is examining options that leverage its initial concept of operations (attachment below), along with trades on schedule, risk, cost, partnering/acquisition, NASA capabilities (including areas of on-going National need or where the state of the art resides within the government), and extensibility to future exploration missions to Mars and other destinations. Implementation variants for the human lander effort are being evaluated that range from capability stimulation through funded Space Act Agreements to a single partner or contract approach to an international partnership model, or a NASA-led multi-contractor approach. Historically, both government and industry develop human spaceflight hardware at roughly the same pace – it takes about 10 years to develop a crewed system. The Apollo LEM has been the only outlier. Produced in 6 years– but at a cost of 24B at current dollars – the LEM was built with a degree of unsustainable focus and risk not seen since. (Update after decision).

Human exploration of both the lunar surface and environment requires the capability to transport crew and large masses of cargo beyond LEO. To accomplish this, NASA is both building an exploration launch and crew system (the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting ground systems), and will rely on commercial launch providers to support both robotic surface and lunar orbit operations. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days. It is the only vehicle, at this point in the development of the

Campaign that is able to provide crew return and reentry from the vicinity of the Moon. Additionally, some of Orion's systems can operate in space for up to 1,000 days with additional habitation volume and systems. The SLS Block 1 cargo variant will be capable of delivering 70 mT to LEO in the early 2020s, and the Block 1B SLS will be capable of delivering 8-10 mT to LEO co-manifested with Orion in the mid-to-late 2020s. The first SLS/Orion mission will be the uncrewed Exploration Mission-1 (EM-1), to be launched to lunar orbit in FY 2020 followed by the first crewed SLS/Orion mission, EM-2 no later than 2023. These SLS/Orion missions will demonstrate the capability to reach and operate safely and productively around the Moon.

With an overall open architecture approach, the "Eagle Rising" Campaign and lunar concept of operations allows for systems and capabilities to be inserted as they develop, flexibly taking advantage of new gained knowledge and the technological and economic capabilities of all exploration partners. For example, commercial launch capabilities are increasing with multiple new heavy-lift systems expected to be operational between today and the early-to-mid 2020s. The Campaign will take advantage of those capabilities as they emerge. NASA has led the development of standards in key operations and interface areas that will ensure that as new capabilities are developed by industry and globally, the Campaign can incorporate them as appropriate.

The following two charts are DRAFT (changes will be made by Sept submit and our by Passback)



Initial Conops for discussion as part of overall lander assessment

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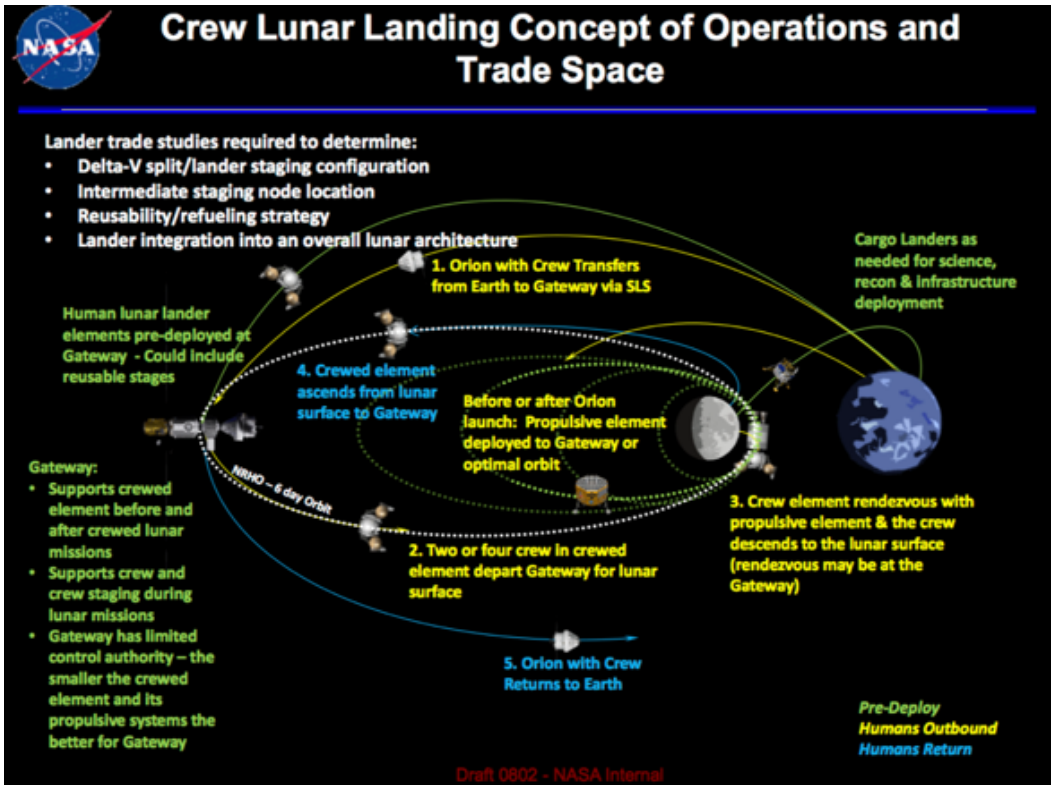

With our open architecture and resilient Campaign approach, NASA will allow for the evolution of its current concept of operations for human lunar surface and orbit activities. Specifically, reusability and the evolution of other architectures are being kept in the future trade space and growth path. For example, reusability in space is important. The Exploration Upper Stage (EUS) might play a role in reuse. Reuse of the human lander is envisioned, as are the use of Orion systems. SLS is currently being designed to be disposable due to initial performance needs. With time and capability evolution, NASA will be in a position to trade composite boosters and reuse. (Gerst?) Additionally, NASA is looking at other options like a stretched Orion service module and/or a co-manifested retro stage. With open architecture, on-ramps for new and broadened commercial and international engagement, there will be other trades as the "Eagle Rising" campaign continues to innovate, adapt and grow.

As we move out with Eagle Rising, America will be answering critical strategic questions, such as:

Can the moon become a center for commercial enterprise? Are there significant deposits of water that could be utilized to support human settlement, or extracted for fuel on a human journey to deep space? In the long term scale of human endeavors, understanding what is possible on the moon and being the first to realize its potential could be transformational. Historically, when the explorers Lewis and Clark first set out to traverse the western territories of the United States, they were tasked to survey scientific and commercial opportunities and they did not know what they might find. Today the people of the United States of America owe an impossible debt of gratitude to their exploration.

How can the campaign engage broader sectors of the nation? American companies will help lead this effort. Not only will they build the small landers, NASA will seek to encourage major mining and equipment companies to expand their expertise to the lunar surface. If a major company has experience drilling into the Earth's crust several miles under the ocean, such R&D created through trial and error in the harshest of environments may be useful to America's space program. Only by harnessing the

knowledge of U.S. corporate R&D and pairing it with NASA's vision and expertise can we truly achieve lasting success.

How can we translate the incredible developments from this Campaign towards American and global society as a whole? Just as the ISS has spurred broader applications on Earth, America goes to the moon to extend humanity's presence in the solar system and also to improve the lives of people on Earth. The ultra-efficient use of scarce resources by humans in orbit, the production of tools and systems from extant resource off the Earth, or the extraction of water from the frozen lunar regolith are challenges that once mastered will help address societal challenges and spur growth in markets on Earth. The development of autonomous systems that can operate on the lunar ~~-~~and Martian surfaces and in orbit will push the technological frontier, supporting current trends in autopilot cars, trucks and trains - but with exceptional quality control and robust engineering - designed to operate in the most difficult environment known to human kind.

Critical Decisions and Milestones:

Lunar Surface

2018

- Decision to procure commercial lunar payload services for NASA payloads starting as early as 2019~~in 2019~~
- Establish the Lunar Discovery and Exploration Program in SMD. This initiative will feature several programs, including Commercial Lunar Payload Services (funding for end-to-end delivery of payloads to the lunar surface starting in 2020) ~~and~~ potentially a new Discovery-class 500 kg lunar lander(s?)
-
- Decision to develop human-class lunar lander capability for demonstration mission in 2024.
- Decision to develop and launch *Discovery*-class NASA lunar resource and science rover mission in 2022
- ~~Decision to procure commercial lunar payload services for NASA payloads starting in 2019.~~
- Decision to begin human lunar surface architecture and mission analyses to support Americans on the lunar surface no later than 2029.

2020

- Potential development of 500 kg-class lunar landers focused on resources and other scientific discovery, ~~focused on~~ mobility and sample return, as well as other scientific objectives that will also incorporate capabilities that also feed forward to the human-class lander efforts.
- Based on early results of human-class lunar lander development and on the results of the human lunar surface architecture analyses, begin capability stimulation, development and/or procurement of other elements required for human lunar surface return (e.g., human cabin and ascent vehicle, retro-braking stage, extended Orion service module).

2021

- Based on results of commercial lunar payload services for NASA lunar payloads, plan to either procure commercial launch services for 2026 resource and science rover mission or conduct mission development and operations in-house.

2022

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- Based on results of 2022 NASA lunar resource and science rover mission, plan to either accelerate development of ISRU systems or maintain baseline R&D effort.

2024

- Based on results of human-class lunar lander capability demonstration missions, status of other human systems (including Moon Ship/Port, other possible mission enhancements, retro-braking stage, launch vehicle availability) make decision on date and method of human lunar surface return and the mission objectives.

Post-2024 Decisions

- Based on results of the cost of lunar surface access, viability of higher-power systems and ISRU as revealed by exploration and science missions and technology investments, and on private-sector and international demand for lunar surface access, determine the nature of a sustainable American human presence on the lunar surface and associated infrastructure development projects.

Lunar Orbit

2018

- Decision to develop Moon Ship and decision on international partnerships and Moon Port configuration. The Moon Ship will also provide broad science research and technology demonstration opportunities from cis-lunar space, including lunar surface (e.g., lunar sample return, telerobotics, etc), astrophysics, heliophysics, and Earth science. (Add/Highlight in earlier text)

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2020

- Based on status of launch vehicle development, decide on Moon Port/Ship logistic resupply missions, conduct the uncrewed SLS/Orion first flight (Exploration Mission 1, or EM-1) in 2020 to the lunar vicinity.
- Initiation of scientific payload development for Moon Ship, by competitively assessing the most suitable and impactful scientific analysis.
- Conduct science and commercial activity using 13 co-manifested cube sats launched as secondary payloads on this mission. (Add/Highlight in earlier text).
- Decision on acquisition approach for remaining elements of Moon Ship (complete by 2021).
- Establish a lunar communications network to better enable robotic and human exploration activities on the lunar surface

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2022

- Emplace power-propulsion (including communications) element (PPE) around the Moon. The development of this first strategic element will incorporate innovative procurement and partnering strategies, capitalize on U.S. commercial communication satellite capabilities, demonstrate high-power solar-electric propulsion technology, and provide the critical functionality for the rest of the Moon Ship.
- Perform science and technology activities, for example, lunar sample return and the operation of lunar robotic and in-space systems.
- Conduct a crewed flight – EM-2 – sending Americans around the Moon by June of 2022.

2024

- Based on status of crew capsule development and operations, decide on need for further investments to increase options for return to Earth from lunar orbit

Post-2024 Decisions

- Based on human lunar surface return plans and scope, and decision on human Mars orbital mission architecture for the 2030s, determine need and viability of developing and emplacing propellant depots in lunar orbit.
- Payload Delivery Mass and Fairing Capability Evolution on SLS Block 1, 1B, and Block 2 Building on the initial Block 1 and 1B designs for SLS, the performance and fairing volume for future SLS crew and cargo missions will be decided. This involves a booster replacement approach and future work on upgrades. The size of the payload fairing will also significantly shape the rest of the architecture.
- Study the Effects of the Deep Space Environment on Moon Ship and its ability to serve as a platform to assemble payloads and systems robotically or with humans, that could be used for human and scientific exploration.
- Orion Capability Upgrades - New engines for Orion's Orbital Maneuvering System-E engine need to be developed. Designs will be shaped by future service module development approaches. Other possible applications and upgrades under assessment.
- Flight Rate Support for Europa and Other Payloads. Decisions to augment the SLS flight rate need to be laid out five years in advance of the added flight. Additional cargo flights on the manifest will influence future hardware plans. These decisions need to be weighed against the availability, capability, and cost of commercial launch options.

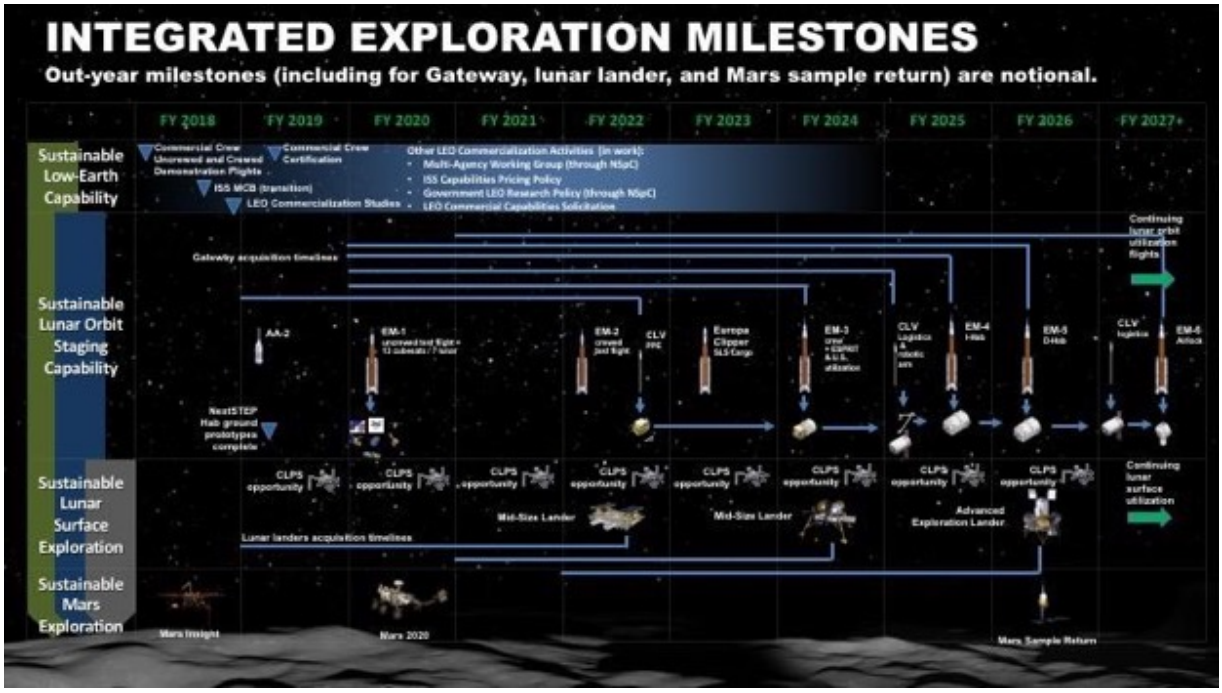


Figure 3: NASA's Exploration Campaign

Section 3: Living in Space Prepared America for this Moment: A Key Inflection Point

With the International Space Station program, NASA has led an unprecedented global partnership of humans living and working in space for the past 17 years – a milestone achievement for human civilization. As the Agency shifts its focus beyond low-Earth orbit, this hard won experience and mastery of specialized capabilities will be instrumental in enabling us to continue to live and work in space for the millennia to come. The American-led port around the Moon combined with continued U.S. access to commercial platform(s) in low-Earth orbit will ensure we will continue to advance American leadership in opening up the heavens to further human and scientific development.

In order to prepare for sustained human expeditions and eventual settlement beyond the littoral region of space close to Earth, America and her partners must first conduct breakthrough research and tests the advanced technologies necessary for long voyages and stays away from Earth. Long-duration exploration-class human missions, including Mars-duration missions of up to 1,100 days, introduce new and increased concerns for human safety, health, and performance. On the ISS, NASA is conducting scientific research needed to supply the evidence base for both technological and operational countermeasures to best address these risks. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS (and potentially other future platforms) as a permanently- crewed testbed prior to deploying these capabilities beyond low-Earth orbit (LEO).

Low-Earth Orbit – Time to Transition

Unlike the temporary and limited focus of the Apollo effort, NASA is building forward from the ISS in a manner to inform and feed a sustainable lunar surface and orbit architecture. The ISS is an experiential testing ground and the only microgravity laboratory of its kind, enabling discovery and development of advanced robotics, communications, medicine, agriculture, and environmental science. The Station has been an excellent platform for several Earth and space science instruments that leverage the unique infrastructure by mounting high-priority scientific investigations with strong appeal throughout the community.

Ongoing operations and research on ISS encourage development of a robust LEO economy in which U.S. private industry matures the ability to provide goods and services – such as commercial crew and cargo transportation systems – for customers beyond NASA and other Government users. By 2025, NASA needs a rich base of on-going activity to emerge that allows it to shift its resources to purchasing services from commercial providers and shifting its focus and resources to the lunar elements of the Campaign.

NASA is examining the policies and laws associated with commercial enterprise using national infrastructure such as the ISS and its laboratory facilities. What is needed to allow a movie director to one day produce entertainment on the Station? What is needed to enable a astronaut tourist dock to the facility and stay the night? Can biotech, materials or manufacturing companies install equipment to produce the next blockbuster pharmaceutical breakthrough, the highest-quality optical fiber or 3D-printed tools for space travel?

In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational by 2025. This stimulation seeks to both jumpstart supply-side products and services, but more importantly, strengthen overall demand and interest in utilizing a commercial platform in LEO. It is vitally important that a broad customer base emerges in the next few years to supplant NASA's historically central role in the LEO economy.

Enabled by NASA's support for commercial cargo and crew providers, U.S. companies will, by no later than 2020, transport astronauts to low Earth orbit and rendezvous with ISS. Once this capability is demonstrated, it opens up significant new opportunities for commercial space flight. U.S. companies could become the first to provide commercial access to space for paying customers from the U.S. and around the world. The commercial possibilities are endless, from tourism to training for deep space missions, it could also enable highly-trained and discipline-specific scientists and engineers to design drugs or construct spacecraft in the unique microgravity environment.

U.S. commercial cargo and crew companies may face competition from foreign providers. Specifically, nations with human spaceflight capability including Russia and China may offer their own services on a mercantile basis. Backed by the resources of a nation-state, these efforts may present stiff and non-market competition to entrepreneurial U.S. companies. Beyond commercial crew, China plans to launch its own space station beginning as early as 2019. Upon completion, it will represent the extension of China's military operations onto a human habitation platform in low Earth orbit. For purposes of diplomacy and commerce, it may also offer an alternative to the ISS and emerging commercial platforms. Faced with state-backed competition, the innovation and efficiency of SpaceX, Boeing, Northrup Grumman, Nanoracks and other U.S. companies will be tested. As we work to help enable their success, they will strengthen the power of free market capitalism over other forms of economic organization.

Specific transition activities include:

- Expand the partnerships in LEO to include new companies and new nations, including working with commercial partners to support new international astronaut visits.
- Expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services, including for continuing scientific exploration in low-Earth orbit.
- Pursue other efforts to enable this shift away from direct government funded support of the ISS. For a fuller assessment of the transition of LEO, please refer to the recently published *NASA ISS Transition Report*: https://www.nasa.gov/sites/default/files/atoms/files/iss_transition_report_180330.pdf

Critical Decisions and Milestones

2018

- Complete 13selected LEO Commercialization Studies
- Decision on Commercial LEO Development (FY19 funding request)
- Decision on ISS Commercial and Private Astronaut Use Policy

2019

- Based on results of completed LEO Commercialization Studies, competitive selection of funding/logistical support for commercial module and/or free-flyer space station development
- Work with Commerce and State, in particular, to spur greater use of ISS and interest in LEO development overall. Identify and eliminate regulatory barrier to enable more commercial activity. Identify and implement incentives for LEO efforts. Examine funding models like the Aviation Trust Fund that may aid the development of on-going non-ISS commercial space activities and platforms.

2022

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2026 (Gerst-when is the latest date or necessary date to decide this?)

2024

- Based on status of commercial module and/or free-flyer space station development and emerging commercial activities on ISS, decide whether or not to extend ISS operations to 2028

Post-2024 Decisions

- Based on status of commercial module and/or free-flyer space station development and emerging commercial human spaceflight activities in LEO, decide on appropriate the appropriate NASA and overall governmental support to ensure on-going NASA requirements in LEO, as well as, ensuring permanent U.S. citizen presence in LEO.

Section 4: Vistas of Unending Opportunity and Discovery - Mars and Beyond

The first human landing on Mars – audacious in its complexity – will be an achievement recalled with awe for thousands of years. As part of the "Eagle Rising" Campaign in response to SPD-1, this voyage will be able to occur in 2030s. Key components of this part of the Campaign are already underway and include long-duration human spaceflight on the ISS, advanced life support systems in cislunar orbit and, continuing to lead and advance the world in science missions beyond LEO, including a civilization first round-trip voyage to Mars. The U.S. will embark on the first round-trip return from another planet, Mars, launched by 2026. This mission will bring back samples with a focus on proving the existence of life beyond Earth.

Overall, the Exploration Campaign focuses on a transformative approach that includes development of technologies and systems capabilities that enable a series of human and robotic lunar missions that are extensible to destinations beyond the Moon including Mars. NASA continues to maintain leadership in the robotic presence on and around Mars. The InSight mission is on its way to Mars now and will land in November to conduct research into the interior of Mars. The Mars2020 rover is continuing to make excellent progress and will be launching in July 2020. The planning for the return of samples from the Martian surface in the next decade are well under way. Research on Mars ~~continues to~~is paving~~e~~ the way ~~for eventual human exploration of the red planet.~~ for human exploration and utilization of the red planet. This strategic implementation approach allows low-cost investments with significant scientific and engineering gains down the line.

Commented [CSW(11]: My input incorporated

For example, Mars robotic missions have enabled the U.S. to master the incredibly complex task of entry, descent, and landing (EDL) for one-metric-ton payloads (similar to the size of a compact car), gathered data about radiation in transit and on the surface of Mars, investigated the Martian atmosphere and weather, and shown there exist significant water reserves. In the near-term, NASA's Mars 2020 mission will measure atmospheric entry conditions and surface dust, and demonstrate production of oxygen from atmospheric CO_2 while selecting and encapsulating samples for potential return to Earth. Future ~~lunar~~ robotic pathfinders will investigate and map destinations prior to human missions, collect surface samples, characterize potential landing sites, and test technologies necessary for future robotic and human systems.

~~Expand American~~Expand American Leadership at Mars and Beyond

NASA's Mars Exploration Program (MEP) missions are built upon the science priorities recommended by the community and the National Academy of Sciences over the past two decades. The discoveries made by each unique set of instrumentation on the individual missions complement each other, and collectively build the world's knowledge base for Mars exploration. These missions have revealed a planet of diverse mineralogy indicating a water-related environment, that Mars could have supported life in its past, the massive loss of the Martian atmosphere through time, thick deposits of ice beneath Mars' surface, the presence of methane and other organics, and a still dynamic planet today.

An important part of the Exploration Campaign's Mars and beyond goals include:
Maintain and grow U.S. leadership at Mars with a rover in 2020, as a first step of a sample-return strategy, searching for past life and demonstrating ~~oxygen production~~the production of fuel and other resources that enable human exploration. Use this mission as a building block for a subsequent round-trip robotic mission with the historic first launch off another planet and sample return through the lunar Moon Ship and the broader exploration architecture. This mission will serve as a critical precursor to an eventual series of crew Mars missions starting in the 2030s that will culminate in a surface landing

Mars and Other Deep Space Objectives

Mars continues to inspire. In 2018, scientists revealed the possible existence of a vast lake of water deep below the Martian surface. Such a discovery, if confirmed, is significant because water is one of the most important ingredients for life in the Universe and this may bode well for one day finding life on the planet. Later in 2018, NASA will land the InSight lander, a sophisticated analysis into the geology of the Red Planet.

A subject of the 2011 Planetary Science Decadal Survey, Mars Sample Return (MSR) is one of NASA's highest flagship priorities for future missions and is relevant to the human exploration initiative as well. Such a mission would be the first interplanetary roundtrip mission demonstrating an epic achievement for humankind. Many of the current missions are operationally necessary for completing MSR, including:

- Mars 2020, which will collect and document a cache of scientifically compelling samples for eventual return to Earth;
- Mars Reconnaissance Orbiter (MRO) and Mars Atmosphere and Volatile Evolution mission (MAVEN), which serve as part of the Mars surface operations communication architecture; and
- Mars Science Laboratory (MSL), from which the operational experiences and analytical data are informing Mars 2020 mission planning.
- Two high-visibility technology demonstrations as part of Mars2020, to demonstrate autonomous flight in a different word – a first for humanity, and a first demonstrator focused on generating breathable Oxygen from Martian's thin atmosphere.

As stated earlier, an MSR mission is being evaluated that will leverage international and commercial partnerships, and through it assert continuing US leadership throughout, by. ~~It will also~~ filling a leadership void in an emerging geo-strategic question facing American leadership at Mars and beyond. There is mutual interest in pursuing cooperation on MSR activities with the European Space Agency (ESA), among others. NASA and ESA recently signed a letter of intent to mutually develop a joint MSR plan and to complete the studies needed to reach the level of technical and programmatic maturity required to pursue an effective MSR partnership.

In addition to the numerous rovers and landers currently on the Martian surface, the MEP currently operates three orbital spacecraft at Mars that are capable of communications relay for our landed missions. Additionally, NASA has an agreement with ESA for communication services from the ExoMars/TGO and Mars Express spacecraft.

NASA is working to address future communications requirements, and is conducting studies to identify future space-based relay communication and navigation architectures for Earth and Mars that are infused with technologies under development to support NASA missions beyond 2022. The Agency recently asked industry for inputs with regard to commercial solutions and this dialogue is ongoing. Given the expected increased data rates (for downlink) required by the science and eventual human assets at Mars, relay between the Earth and Mars will need to be enhanced. Evolving space communication systems will transform future NASA mission capabilities.

Move up/Weave In or Appendix -
Exploration Research & Technology - Focused and in Support of the Campaign

The Agency is working to mature exploration technologies and systems in preparation for these cislunar Moon Ship and deep space missions. Exploration Research & Technology (ER&T) is developing advanced power and propulsion technology, including 13 kW SEP Hall thrusters, power processing units, and associated hardware supporting Moon Ship power and propulsion needs and potentially extensible to the needs of deep space architectures. ER&T is also advancing promising transformative technologies across other technology focus areas, including next-generation environmental control and life support systems; ISRU; cryogenic fluid management and long term storage; fission power systems; advanced communications, navigation and avionics; in-space manufacturing and on-orbit assembly; advanced materials; EDL; autonomous operations; and research to enable humans to safely and effectively operate in various space environments. High-TRL technologies will be applied to near-term missions, while the Agency invests in low-TRL technologies to address challenges of future exploration missions. Wherever possible, these technologies are also being infused into science missions, most prominently those to Mars.

NASA has mapped the capabilities necessary to explore the Mars system to the development phases, along with current and planned missions and technology investments by NASA's mission directorates. A high-level summary of this mapping appears in Figure X below and is used to identify and guide budget planning activities as well as Agency architecture strategies.

(b) (5)

Exploration Capability Evolution

= Current HEOMD Activities
= Current STMD Activities
= Current SMD Activities
= Needs analysis under... be funded in future ye...

	Mission / Demand Areas	ISS	Cis-Mars Robotic	Cislunar Short Stay	Cislunar Shakedown	Lunar Surface	Mars Orbit	Mars Surface
Working in Space and On Mars	In Situ Resource Utilization		Exploratory ISRU & Atmosphere	Exploratory ISRU Regolith	Exploratory ISRU	ISRU Propellant Production	Exploratory ISRU	Operational ISR... High Power
	Surface Power					Kilopower		Kilopower & High E... Energy Storag...
	Habitation & Mobility	Long Duration with Resupply		Initial Gateway Capability	Deep Space Transport Habitat	Surface Habitat	Deep Space Transport Habitat	Rover & Habitat/Lab
	Human/Robotic & Autonomous Ops	System Testing	Earth Monitored	Crew-tended	Earth Monitored Robotics & R&D	Human/Robotic Exploration	Autonomous Rendezvous & Dock	Autonomous Rendezvous & Dock
	Crew Productivity	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments	Science Experiments
	Exploration EVA	System Testing		Limited Duration	Limited Duration	Surface EVA	Full Duration	Frequent EVA
	Reconnaissance		Landing Site			Prospecting Sample Return	Landing Site	Sample Return
Staying Healthy	Crew Health	Long Duration	Dust Toxicity	Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Environmental Control & Life Support	Long Duration		Short Duration	Long Duration	Long Duration	Long Duration	Long Duration
	Radiation Safety	Increased Understanding	Surface Radiation Environment	Forecasting	Forecasting Shelter	Forecasting Shelter	Forecasting Shelter	Forecasting & Surface Enhanced
Transportation	Ascent from Planetary Surfaces		Sub-Scale MAV			Lunar Ascent Stage	Sub-Scale MAV	Human Scale MAV
	Aggregation, Refueling, & Resupply	Resupply		Refueling	Resupply	Refueling		
	Entry, Descent & Landing		Sub-Scale/Aero Capture			Auto. Precision Landing	Sub-Scale/Aero Capture	Human Scale EDL
	In-space Power & Prop		High Power	Medium power	High Power		High Power	Very High Power
	Beyond LEO: SLS & Orion			Initial Capability	Initial Capability	Initial Capability	Initial Capability	Full Capability
	Commercial Cargo & Crew	Cargo/Crew	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity	Opportunity
	Communication & Navigation	RF	Deep Space Optical	RF & Initial Optical	Optical	Optical	Deep Space Optical	Deep Space Optical

Long-term Strategies

There are a number of long-pole technology challenges related to lunar and Mars space exploration that we recognize will need concerted and sustained efforts to surmount. As an initial step to guide on-going development efforts, we formulated the following strategies:

(b) (5)

- Spacesuit Evolution Strategy - Existing spacesuit designs on the ISS will need to be evolved and replaced for lunar surface and deep space missions, requiring significant development and testing.
- Nuclear Propulsion for in-Space Transportation - Whether to use nuclear propulsion for future exploration missions in the 2030s and beyond will need to be determined, as this will affect the design of many future engineering systems.
- Communications and Data Relay Strategy - Securing and building upon data relay and communications infrastructure will be needed prior to some missions. NASA will consider commercial providers for this service.
- Role of ISRU to Sustain Operations - Beyond testing ISRU technologies, planning for how ISRU will support human exploration activities through consumables and propellants will affect the rest of the architecture.
- Logistics Strategy - The choice of how to pre-position payloads on the lunar and Mars surface prior to human landing will strongly drive future flight rate and other system development needs.
- Maximizing Science Return with Humans on the Surface - Humans will provide the ability to perform science quickly and flexibly. A strategy for research approaches and instruments needed to support science activities will be a core part of achieving maximum science returns from human exploration.
- In-Space Propulsion Strategy - The choice of in-space propulsion has significant systems impact on the overall human Mars architecture, including ISRU, and commonality with lander propulsion.
- Reconnaissance/Technology Development Strategy - Such a strategy will consider the need for pre-emplacement of equipment and materials, as well as the need for reconnaissance and technology development/verification to inform construction of ISRU and lander systems.
- ISRU Strategy - To validate the performance of ISRU systems in the operational environments of the Moon or Mars, testing of these technologies on the actual lunar or Martian environment may be necessary. (Repetitive)

Critical Decisions and Milestones

2019

- Decision on Mars robotic round trip mission (Sample Return) implementation and architecture and target launch date (2026, or 2029, ~~2031~~)
- Decision on Mars-forward technology investment R&D portfolio in ER&T
- Prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for the exploration of Mars and other deep space destinations (on-going).
- Develop standards for human long-duration deep space transportation vehicles (on-going).

2021

- Based on results of Mars 2020, MOXIE payload, and helicopter performance, modify Mars-forward technology investment R&D portfolio in ER&T

2024

Commented [ZTH(15]: To be consistent with 19 budget.

- Based on results of investment in Mars-forward technology investment portfolio, Moon Ship development and operations, launch vehicle and crew vehicle development and operations, decide on architecture of human Mars orbital mission and begin associated systems development.

Post-2024 Decisions

- Based on results of robotic round trip Mission, cislunar operations, and progress of Mars-forward technology investment R&D portfolio, determine set of technology investments and timeline required to achieve human landing on the surface of Mars.

Section 5: Enabling Initiatives, Reforms, and Organizing to Win OR How NASA Will Change to Achieve Mission Success

(placeholder for discussion only at this point or update based on decisions?)

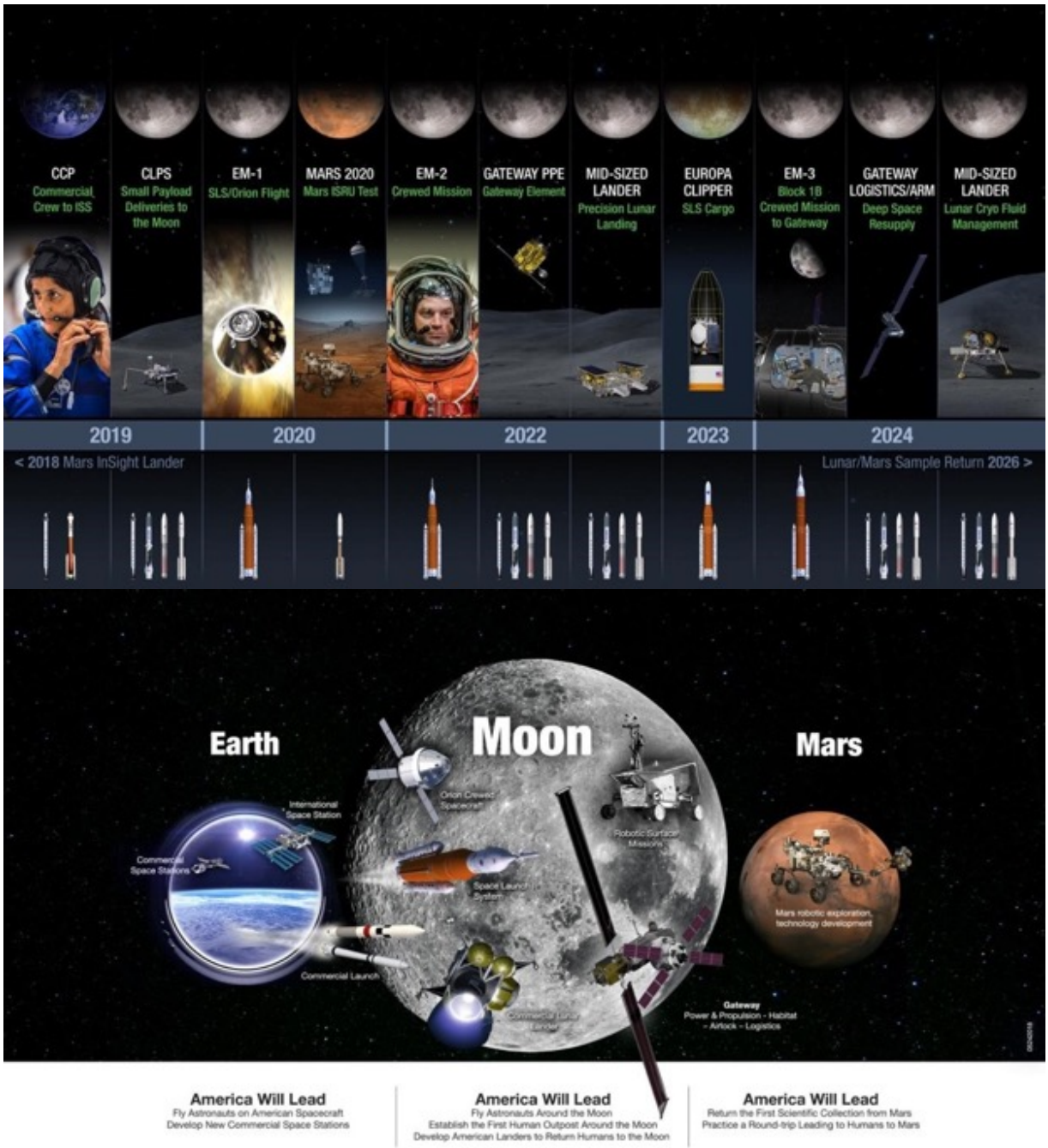
To achieve extraordinary success, NASA must consider extraordinary changes from streamlining our organization and management to becoming even more efficient and effective. The "Eagle Rising" Campaign does not assume or require Apollo levels of funding, but instead seeks resources that match a sustainable growth commensurate with inflation over time. As part of a revised acquisition strategy, we also intend to leverage and partner for up to 30% in some key areas.

On the organization and management fronts, NASA will continue to focus on greater strategic workforce planning and development. Our workforce is essential to our mission – we intend to keep training engineers and scientists to ensure America has a national spaceflight capability.

Lastly, NASA recognizes the need for SMD/HEOMD/STMD lunar exploration integration and is looking at different ways to align and focus the Campaign elements. The Agency has already initiated a federated, core Team for the lunar portion of the Exploration Campaign that consists of AA and DAA level participation working with A-suite orchestration. NASA is looking at formalizing this approach thru the establishment of a senior leadership coordination group reporting to the Administrator, Deputy Administrator, or Associate Administrator. In support of this overall Agency effort, a Deputy Associate Administrator for Exploration in the Science Mission Directorate was established in June 2018.

Commented [CSW(16]: My input incorporated

Formal realignments and larger organizational changes are under active consideration at this time and will be presented, if/when adopted, to the Congress as part of our mandated reporting responsibilities. On the ISS and LEO transition front, NASA is also examining how to most effectively organize to lead in this key Exploration Campaign initiative.


CCP
Commercial Crew to ISS
CLPS
Small Payload Deliveries to the Moon
EM-1
SLS/Orion Flight
MARS 2020
Mars ISRU Test
EM-2
Crewed Mission
GATEWAY PPE
Gateway Element
MID-SIZED LANDER
Precision Lunar Landing
EUROPA CLIPPER
SLS Cargo
EM-3
Block 1B Crewed Mission to Gateway
GATEWAY LOGISTICS/ARM
Deep Space Resupply
MID-SIZED LANDER
Lunar Cryo Fluid Management
2019
2020
2022
2023
2024
< 2018 Mars InSight Lander
Lunar/Mars Sample Return 2026 >
Earth
Moon
Mars
International Space Station
Commercial Space Stations
Commercial Launch
Orion Crewed Spacecraft
Space Launch System
Robotic Surface Missions
Gateway
Power & Propulsion - Habitat - Airlock - Logistics
Mars robotic exploration, technology development
America Will Lead
Fly Astronauts on American Spacecraft
Develop New Commercial Space Stations
America Will Lead
Fly Astronauts Around the Moon
Establish the First Human Outpost Around the Moon
Develop American Landers to Return Humans to the Moon
America Will Lead
Return the First Scientific Collection from Mars
Practice a Round-trip Leading to Humans to Mars

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For JB Approval / Stem Event WH Press Release and Space Force Message

From:	Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>, Powers, Megan K. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=POWERS, MEGAN K 670907028CD2>
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Sent:	June 25, 2018 5:04:08 PM EDT
Received:	June 25, 2018 5:04:08 PM EDT

Please see both of the proposed quotes below. Neither of these require action until tomorrow. The OSTP press release will highlight this evening's event and will come out tomorrow.

OSTP Press Release – Due to OSTP by 10am Tuesday

"NASA is proud that its missions provide so many opportunities for STEM engagement with students at all levels. We look forward to taking America back to the Moon and Mars with the strong direction of the President's space policy directives and inspiring generations to come with the spirit of our nation's accomplishments and leadership in space. Our work and our engagement with millions of students through live downlinks with astronauts aboard the International Space Station and frequent interactions with students around the world are helping influence a new generation of exploration leaders to make their own giant leaps."

- Jim Bridenstine, NASA Administrator

[EXAMPLE:] "This event is the first time an administration has asked for this level of state input when developing a Federal STEM education strategy. Bureaucratic, top-down approaches to STEM education can often yield wonderful ideas, but it's at the state and community level where this momentum needs to happen. State leaders should have an active voice in what kinds of programs will work in their communities, and where they need the power of the Federal government to help drive success in this field. STEM education is critical to preparing our students for the jobs of the future. We must do everything we can to ensure Federal, state, local, and tribal governments, community organizations, and private industry partners are united behind this common effort for the future of our Nation."

– Dr. Jeff Weld, Assistant Director for STEM Education, OSTP

[EXAMPLE:] "At present, less than half of our K-12 schools offer a single Computer Science class – a troubling reality considering the increasingly important role of technology skills in our modern economy. This Administration is addressing this gap aggressively. Last September, the President signed a memorandum directing the Secretary of Education to prioritize STEM and computer science education and allocate a minimum of 200 million dollars of annual grant funding toward high quality STEM and Computer Science education. We call on State leaders to apply for these grants and help put our children on pathways towards in-demand and lucrative careers!"

– Ivanka Trump

Message to the Workforce – Tentatively for Release Tuesday June 26, 2018

Last week, President Trump directed the Department of Defense and Pentagon to immediately begin the process necessary to establish a 6th branch of the Armed Forces, the Space Force. The Space Force will protect our national interests in space by organizing, training, and equipping a cadre of service members whose main priority would be protecting American interests in space.

I want to be clear that as the Department of Defense begins the development of a Space Force, NASA will continue to bring the world life-changing science and discoveries. Since its creation almost 60 years ago, NASA has been a civilian space agency dedicated to peaceful exploration, discovery, and research. Space is vital to the well-being of the United States, so it's critical to safeguard American interests that operate there, including NASA spacecraft and the International Space Station. The Space Force will not be a part of NASA but will serve to protect our space-related activities so that we may continue leading the world in space exploration.

As we move ahead to the Moon and Mars, I want to be sure to keep you updated with the full picture of American space policy as it is unfolding through the National Space Council.

Megan Powers

Press Secretary

NASA HQ

Megan.K.Powers@nasa.gov

Cell: (b) (6)

Desk: 202-358-2268

Matt Grinney

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[redacted]

EXPERIENCE

The Office of the Vice President of the United States, Washington, DC — August 2017 – Present
Associate Director of Speechwriting

- Provide strategic communications advice to the Vice President to advance the administration's top priorities.
- Led the development of several of the Vice President's remarks on space policy, including speeches at the first two meetings of the National Space Council, the 34th Annual Space Symposium, and the Pentagon outlining the administration's vision for the United States Space Force.
- Co-manage the drafting and editing of the Vice President's speeches on a wide variety of topics – from defense policy to economics to international affairs – by soliciting and synthesizing input and feedback from the Vice President and his senior staff, policy experts, and national security advisors.
- Travel regularly with the Vice President across the country to shepherd his remarks from draft to delivery.
- Formulated key messaging themes on tax reform, culminating in the passage of the Tax Cuts and Jobs Act.

The U.S. Department of Health & Human Services, Washington, DC — March 2017 – July 2017
Speechwriter, Secretary of Health and Human Services

- Wrote op-eds, talking points, and speeches that informed the Department's messaging strategies during the new administration's first 100 days and laid the foundation for the Secretary's positions on key issues, ranging from the opioid crisis to health-care reform.

The United States Senate, Washington, DC — April 2014 – March 2017
Communications Advisor, U.S. Senator Mike Lee

- Developed and implemented a communications strategy critical to the Senator's re-election in 2016.
- Wrote speeches, white papers, newsletters, and press releases, as well as op-eds that were published in *The Wall Street Journal*, *National Review*, *Deseret News*, and *The Washington Times*.

The Heritage Foundation, Washington, DC — January 2013 – April 2014
Research Assistant, The Center for Principles and Politics

- Authored blogs and a policy *Backgrounder*; managed an array of research projects for the Center's Director.
- Organized and helped oversee two of Heritage's flagship educational programs on Capitol Hill.

The University of Texas at Austin, Austin, TX — August 2010 – May 2012
Teaching Assistant, The Department of Government

- Hosted office hours and graded papers, tests, and homework for hundreds of undergraduate students.

United States House of Representatives, Washington, D.C. — August 2009 – July 2010
Staff Assistant, U.S. Congressman James Clyburn, Democratic Majority Whip

- Assisted the Congressman's whip operations; managed front office activities and the internship program.

EDUCATION

The University of Virginia, Darden School of Business — Expected Graduation: May 2020

- MBA Candidate in Darden's Executive program for working professionals.

The University of Texas at Austin, M.A. Political Science — August 2010 – May 2012

- Completed four semesters of PhD-level courses in international relations and political theory.

Emory University, B.A., Political Science — August 2004 – August 2008

- Honors: Dean's List, Political Science Honor Society, Spanish Honor Society

ASSOCIATIONS

James Madison Fellowship — May 2014 – March 2017

- Educational program for senior-level Hill staff co-hosted by The Heritage Foundation and The Kirby Center.

Lincoln Fellowship — August 2015

- A week-long educational program with young professionals from across America consisting of daily seminars on American politics and political thought, led by visiting scholars at the Claremont Institute.

Message to the Workforce: Space Force

From:	Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>, Powers, Megan K. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=POWERS, MEGAN K 670907028CD2>
To:	Bridenstine, James F. (HQ-AA000) <james.f.bridenstine@nasa.gov>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>
Sent:	June 26, 2018 6:52:52 PM EDT
Received:	June 26, 2018 6:52:53 PM EDT

Message to the Workforce – Tentatively for Release Tuesday June 26, 2018

Last week, President Trump directed the Department of Defense and Pentagon to immediately begin the process necessary to establish a 6th branch of the Armed Forces, the Space Force. The Space Force will protect our national interests in space by organizing, training, and equipping a cadre of service members whose main priority would be protecting American interests in space.

I want to be clear that as the Department of Defense begins the development of a Space Force, NASA will continue to bring the world life-changing science and discoveries. Since its creation almost 60 years ago, NASA has been a civilian space agency dedicated to peaceful exploration, discovery, and research. Space is vital to the well-being of the United States, so it's critical to safeguard American interests that operate there, including NASA spacecraft and the International Space Station. The Space Force will not be a part of NASA but will serve to protect our space-related activities so that we may continue leading the world in space exploration.

As we move ahead to the Moon and Mars, I want to be sure to keep you updated with the full picture of American space policy as it is unfolding through the National Space Council.

Megan Powers

Press Secretary

NASA HQ

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Re: JSC TODAY ARTICLES

From: Robert Thompson (b) (6)
To: (b) (6) Eric Berger (b) (6)
Cc: Wayne Hale(NAL) (b) (6), (b) (6), Mark Geyer (b) (6), james.f.bridenstine@nasa.gov <james.f.bridenstine@nasa.gov>, Geyer, Mark S. (JSC-AA111) </O=NASA/OU=JSC/cn=Recipients/cn=238347311>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>
Sent: August 30, 2018 5:31:32 PM EDT
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Hal/Eric

Don't know about the hatch test-look at the date.

I debriefed Gilruth in the motel parking lot. He asked for my thoughts.

I told Gilruth that I felt that Grissom screwed up. Probably hit the plunger by accident. Thought that we should make all reasonable tests and be on with the program.

I later read in Yardleys's history that he thought that Grissom had screwed up. He was working for industry at the time.

After John Glenn's flight, Glenn said that the plunger bruised his knuckle. That proved that Grissom did not screw up.

Eric thinks that Grissom taught NASA that you could get hurt in the ocean. Fake reporting or bloviation.

Let Eric check the date!

Houston has a space policy problem! America will have a Space Force!

Thanks for the dialogue.
Bob

On 8/30/2018 1:57 PM, Hal Doiron wrote:

Bob,
There are several articles of interest in JSC TODAY email from Larry Moon.
In one, Bridenstine mentions reusable rockets like SpaceX's will get us back to the surface of the moon and makes no mention of SLS.
In another by your neighbor, Eric Berger, he discusses an appeal by Texas politicians to have NASA'S new Lunar Lander program managed from JSC.
There is also an historical article about a Mercury explosive hatch investigation. Was this before Grissom's mission?
Hal

Sent from Yahoo Mail on Android

Re: Op-Ed on Space Force

From:	Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>, Powers, Megan K. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=POWERS, MEGAN K 670907028CD2>
To:	Cremins, Tom (HQ-AH000) <tom.cremins-1@nasa.gov>, Bridenstine, James F. (HQ-AA000) <james.f.bridenstine@nasa.gov>, Sherman, Gabe <Gabe.Sherman@mail.house.gov>, Rydin, Matthew M. (HQ-NA000) <matthew.m.rydin@nasa.gov>, Cremins, Tom (HQ-AH000) </O=NASA/OU=JSC/cn=Recipients/cn=HQ007639>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>, Rydin, Matthew M. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Rydin, Matthew M 888091287b00>
Sent:	August 13, 2018 12:16:49 PM EDT
Received:	August 13, 2018 12:16:50 PM EDT

As soon as we are all comfortable with this I will socialize with the White House and they can assist us in placing it.

Best,
Megan

Megan Powers
Press Secretary
NASA
202-557-9558
Megan.K.Powers@nasa.gov

On: 13 August 2018 10:07, "Cremins, Tom (HQ-AH000)" <tom.cremins-1@nasa.gov> wrote:

Jim-

It reads well. In the attached I added some updated economic numbers from Alex and a short suggested paragraph to link America's Exploration Campaign, Space Force and Mahan. **(b) (5)** [redacted]

Below are just longer thoughts on the overall theme in the suggested paragraph – pulled from a longer piece for general consideration/awareness. I think a separate Op-Ed by you building on these additional themes and tied to NASA, etc. would be a great addition to the National dialogue as well. Hope this is helpful!

Tom

Building on the Mahan Theme: (America has a rich history of establishing international guidelines and frameworks through leadership, extension, and creation of opportunities. The origin of Modern naval policy at the beginning of the 20th century is an important component of this heritage. Rear Admiral Alfred Thayer Mahan, who articulated this new maritime philosophy, summarized its objectives as: display the flag, open new markets to U.S. commerce, protect commerce, aid vessels in distress, extend the bounds of oceanography (and other scientific research), clear seas of pirates, and project power. This maritime strategy melded with a geopolitical focus conceived and instilled into the national ethos by President Theodore Roosevelt. Opening up physical frontiers became a means to extend U.S. preeminence globally and to fuel intellectual, economic and human growth. This period of time represented a national shift outwards in a manner that unified the nation beyond the frontier of the American West to the new oceans and

frontiers of the world. Now, as the U.S. moves out from the shores of a new frontier, a very different set of global challenges and opportunities call for attention and leadership. From the past, building on the present – the future calls.)

NASA, as the Nation's civil space organization focused on preeminence in exploration, science and aeronautics contributes to the Nation's security in a number of ways.(1- see below).The Agency plays a unique role in U.S. global engagement and diplomacy. NASA collaborations can serve as a pathfinder for other forms of cooperation with U.S. allies and partners. With other technologically advanced countries, conversations and direct engagement between NASA and technical organizations in foreign governments can help mitigate the risk of strategic surprise; and with potential adversaries in space, engagement through NASA can mitigate the risk of misunderstandings. Initial bi-lateral efforts with Russia allowed insight into strategic enterprises and was a measure to divert dual-use military capabilities and investments towards cooperative civil space efforts. NASA's 20-year plus relationship with Russia remains an enduring element of this early focus on improving international security **(b) (5)**

Also, as the nation continues to facilitate greater access and use of LEO by the private sector, NASA, along with other relevant U.S. entities, lead the movement of exploration and development of space outwards, through the mid-2020s. NASA will need the assistance of other government agencies to establish incentives and reduce barriers for creation of private sector demand as space joins the land, seas, and skies as a domain of commerce.

As part of the campaign to further open up the heavens, this Administration plans to use the American infrastructure being developed in heavy-lift launch and crew systems to project power, extend global partnerships, and establish presence. The need for this type of thrust reflects the changing national security environment in space. This initiative can lead to the establishment of norms throughout the increasingly crowded region from the Earth out to and including the Moon, while also supporting a host of other National objectives and unprecedented missions of exploration and scientific discovery.[i] <http://#_edn1>

American astronauts will visit the region around the Moon starting by 2022 and be able to start living there for periods of time in 2023. Surface landings of Americans will follow. These missions will occur at a time when roughly three-quarters of the world's population will have never witnessed humans at the Moon. These missions will also be tied to another NASA-led initiative of robust robotic activity and partnerships - international and commercial - around the Moon and on the lunar surface also starting by 2020.

The Moon is the Earth's offshore continent, witness plate of our Cosmic past and future. It offers a record of the formation of our solar system, and has resources which may be of importance to long-run human exploration and development. Beyond the Moon, Mars and the solar system call. America leadership will open the sea lanes to an infinite future.

(1)

• First, NASA drives technology and innovation using the country's vast intellectual, economic, and industrial base to contribute to our unique challenges.

• Second, NASA engages and inspires the next generation, in particular the large number

of science, technology, engineering and mathematics (STEM) professionals that support

NASA and other national challenges needing these skills.

• Third, NASA enhances a core strategic advantage of the U.S.: the ability to attract partners and to work with talent globally.

• Fourth, NASA engages new and existing U.S. companies and academia supporting and growing the national industrial base shared by many other government agencies, such as the Department of Defense, Department of Commerce, Department of Transportation, and Department of the Interior.

• Fifth, because of NASA's role in the international community, it can help national security leaders manage global risks.

From: Bridenstine, James F. (HQ-AA000)
Sent: Monday, August 13, 2018 7:12 AM
To: Cremins, Tom (HQ-AH000) <tom.cremins-1@nasa.gov>; Sherman, Gabe <Gabe.Sherman@mail.house.gov>; Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>; Rydin, Matthew M. (HQ-NA000) <matthew.m.rydin@nasa.gov>
Subject: Re: Op-Ed on Space Force

That works for me. Thanks!

Jim

On: 12 August 2018 17:36, "Cremins, Tom (HQ-AH000)" <tom.cremins- <mailto:tom.cremins-1@nasa.gov>1@nasa.gov> wrote:

If there is time, I'd like to get the Boss some fresher Space economy numbers and some suggestions on how NASA's effort to create preeminence beyond LEO in civil and scientific pursuits, as well as our unique role in international engagement that support the National security focus on creation of space dominance. Can I provide some thoughts to all by mid-morning? Or if too late, I will send for future consideration in any case. Thanks!

Tom

On: 12 August 2018 15:48, "Bridenstine, James F. (HQ-AA000)" <james.f.bridenstine@nasa.gov> wrote:

Op-Ed on Space Force.

Jim

[i] <http://#_ednref1>A number of nations – Russia, China, India, Japan, Europe, and the UAE, and private sector entities –have been or plan to be out beyond GEO within the next few years. In LEO and out to GEO, 1400 satellites exist from over 50 nations and companies pursuing a growing range of applications. This growing diversity of users and uses within cislunar space is giving rise to thorny and cross-cutting issues.

ADMINISTRATOR INVITATIONS/OTHER REQUESTS, current a/o 20 Aug 2018

MONTH	DATE/DOW	ORG/EVENT	FROM	TYPE	LOCATION	COMMENTS
Flex		Cosmosphere and/or Wichita State	Senator Moran	Visit	Hutchinson & Wichita KS	Tom Bush, the Senator's CJS Staffer reaffirms the request for you to visit KS during one of your trips to OK sometime in the coming months. JB is interested and would consider a visit icw a trip home, if feasible. He also noted that Cosmosphere recently rec'd a 600K NASA grant. As an aside, (b) (5) [redacted]
Flex		Spirit AeroSystems	Sam Sackett, Senior Manager, Government Relations	Visit	Wichita KS	As follow up to your convo in London, you are invited to visit Spirit AeroSystems HQ and the National Institute for Aviation Research (NIAR) in Wichita. Spirit and NIAR are both participating members of NASA's Advanced Composites Consortium. (b) (5) [redacted]
Flex		TASM	Tonya Blansett, Executive Director	Museum event	Tulsa OK	TASM would like to host a home-coming or welcome event in your honor at your convenience when you are on a trip home. (Megan W POC) Not sure of current status.
Flex		Camden Spaceport	Congressman Buddy Carter	Visit district	Camden County GA	You are invited to visit when your schedule permits. JB interested when fits w/schedule – suggested winter. Note possible tie-in w/NDIA event, Nov/Dec (see further down).

Flex		Kentucky Science & Technology Corporation	Terry Samuel, President	Visit	Lexington KY	Congressman Barr supports and will join you for this visit. JB interested when schedule works.
Sep/Oct	Flex	Air Command & Staff College	Lt Col Pete Garretson, Faculty Lead	Speech	Maxwell AFB AL? (loc not stated; need to confirm)	You are invited to discuss the importance of going back to the Moon, cis-lunar economy, implications of Space Force, etc. Good to do if schedule works to maintain relationship w/ACSC.
Sep	7/Fri	Wilson Center's Canada Institute	Dr. Laura Dawson, Director	Panelist	DC	You are invited to be a co-panelist with CSA President Laporte and NOAA to discuss US-Canada cooperation in civilian space (communications, Earth observation, scientific research). Recommended by OIIR.
Sep	20/Thu	NASA/AIAA 60th Celebration	Alotta Taylor HQ coordinator	Speech	DC	You are invited to participate in the 60th anniversary evening reception at the Ronald Reagan Bldg & International Trade Center. Accepted.
Sep	22/Sat	National Symphony Orchestra	John Paul LaBarge, Kennedy Center for Performing Arts	Attend	DC	You are invited to attend the 2018 space-themed season opening gala. The event will highlight music's relationship in expressing the vastness and spirit of deep space and space exploration. RSVP by 5 Sep. Nice to do, if schedule permits (non-speaking role).
Oct	19/Fri	University of Colorado – Boulder	Dr. Daniel Baker, Director, LASP	Speech	Boulder CO	You are invited to give the keynote at the 70th anniversary of the Laboratory for Atmospheric and Space Physics. Senator Gardner and Rep Perlmutter have been invited to co-host. Your

						conflicts are travel home 16 – 21 Oct for fall break. Recommend decline; conflict (b) (6) Gabe wanted you to review prior to taking any action.
Oct	20/Sat	Orlando Science Center	JoAnn Newman, President	Speech	Orlando FL	You are invited to speak at the annual Science Center Gala. Event is supported by Sen Rubio – invite was forwarded by his staff. Recommend decline; conflict (b) (6)
Oct	25/Thu	University of Oklahoma	Stephen Cole, HQ Comms	Speech	Norman OK	You are invited to speak at the opening of the new GeoCarb offices event at OU Research Campus (NASA Earth Science mission led by OU). Note – also Homecoming Weekend. Recommend decline and pass to Thomas Z, if available.
Oct	25/Thu	American Astronautical Society	Jim Way, Executive Director	Speech	Huntsville AL	You are invited to be the keynote speaker at the von Braun Symposium luncheon. Recommend accept and travel fm HSV > HOU for ISMS (below).
Oct	26/Fri	Rice University	George Abbey, Baker Institute	Speech	Houston TX	You are invited to deliver the morning keynote for the International Space Medicine Summit. JB inclined to accept – need to confirm and discuss icw von Braun invite (above).
Oct	31/Wed	American Society for Gravitational and Space	Craig Kundrot/HEO	Speech	Bethesda MD	You are invited to give a plenary talk at the ASGSR annual meeting. Tom suggests you consider. A meet/greet will be arranged w/ASGSR President, if desired. Potential

		Research				conflict (b) (6)
Nov/Dec	Flex	National Defense Industrial Association	Forwarded by staff of Rep Barry Loudermilk (GA)	Speech	GA	You are invited to speak at the 4th quarter NDIA space-themed breakfast during the first 2 weeks of Nov or Dec. I believe this is an invite to speak to the GA Chapter, loc TBD. If interested, could tie-in w/Camden Spaceport visit and satisfy request from Rep Carter.
Nov	27/Tue	SpaceCom 2018 Conference	Debbie Conder, JSC for National Trade Productions (organizer)	Speech	Houston TX	You are invited to be a keynote speaker at this 4th annual event. https://spacecomexpo.com for additional info. Not feasible if you travel to JPL for InSight landing. Recommend decline; you will have a future opportunity to do this.
Dec	4-5/Tue-Wed	Defense Strategies Institute	Trina Chiodi, Program Manager	Speech	Alexandria VA	You are invited to be a keynote speaker at the annual Space Resiliency Summit, topic "Effectively Addressing the Challenges of a Contested and Congested Space Environment." Recommend accept.
Jan 2019	7-10/Mon-Thu	American Astronomical Society	Dr. Megan Donahue, President	Speech	Seattle WA	You are invited to address AAS members at the 233rd meeting of the society on 7, 8, 9 or 10 Jan (10 Jan is the AAS preference). Note: Prof. James Lowenthal, VP, is under the impression that you have already accepted – please confirm.
Jan	22/Tue	NASA Human Research Program Investigators' Workshop	Mia Monroe, Event Manager, JSC	Speech	Galveston TX	You are invited to give the opening address at the 2019 Workshop. The HRP IWS is an annual meeting of NASA-funded investigators to present their data to HRP management and the scientific community. Not familiar with this;

						recommend seeking an opinion from Jim Green before responding.
Mar	11-14/ Mon-Thu	Leadership Conference	W. Paul Mexcur, OSMA	Speech	Cocoa Beach FL	The American Society for Quality (ASQ) and NASA OSMA team up each year to host two back-to-back quality leadership conferences. The two programs are complementary and serve to multiply attendance. You are invited to speak at either conference. If interested, recommend speaking to Terry Wilcutt at the next Chiefs meeting for more detail.
Mar	22-23/Fri-Sat	OK National Guard	Wilham Lewis, title unknown	Speech	Norman OK	You are invited to speak at the Adjutant General's Leadership Conference at 0900. You and Michelle are also invited to the Military Ball on 23 Mar. Possible conflict (b) (6) [redacted]
Apr	6-7/Sat-Sun	Northeast Astronomy and Space Forum (NEAF)	Dr. Ken Kremer, NEAF Board of Directors	Speech	Rockland Community College, SUNY (near NYC)	You are invited to present a lecture at NEAF 2019. Prior NASA speakers include Bill Gerstenmaier, John Mather & Jim Green in addition to other science and industry leaders. NEAF is the biggest Astro/Space symposium in the US, attended by >4000 enthusiasts, professionals, educators and students. http://www.rocklandastronomy.com/neaf.html Recommend an opinion from Bill or Jim.
Jun	6-9/Thu-Sun	National Space Society	Bruce Pittman, Senior VP	Speech	Arlington VA	You are invited to speak at the International Space Development Conference (prior convo w/Greg Autry). The 2019 theme is "Back to the Moon to Stay." Recommend accept.

MISC:
Wright Brothers Memorial Trophy Selection Committee. Background: By long-standing tradition, the NASA Administrator is a member of the selection committee (one of 7 people called out in the founding documents) for the Wright Brothers Memorial Trophy. The award dates back to its origins with Godfrey Lowell Cabot, and with the full support and involvement at that time of the Wright family in the immediate aftermath of Orville's death. The nomination packet will be sent out on 20 Aug by the National Aeronautic Association. Strongly recommend you participate as have all prior Administrators. I'll compile the nomination review binder for you.
You have a courtesy visit with Dr. Ellen Stofan, Director, NASM (former NASA Chief Scientist) on 5 Sep. There are 3 current NASM invites from Ellen that she may mention: 1) you are invited to attend the NASM advisory board meeting on 23 Oct (NASA is a member) to discuss topics such as NASM's plan to celebrate the 50th anniversary of Apollo. In the past, attendance at this meeting has been delegated to the NASA Chief of Staff or another OIC. 2) you are invited to attend the reveal of the US Mint's official Apollo 11 commemorative coin at NASM on 11 Oct and introduce Apollo 7 Lunar Module Pilot, Colonel Walt Cunningham, who will speak at the event. Conflict with IAC/Soyuz launch travel; however, you should designate a senior NASA official to speak in your stead. 3) NASM will host the 50th anniversary of Apollo with a program in Washington National Cathedral on 11 Dec; you are invited to speak during the program. Recommend accept – this event is noted on your calendar banner.
For the past 2 years, Christyl Johnson, GSFC Deputy Center Director for Technology and Research Investments, has conducted a "Sustaining Women in STEM Roundtable" focused on finding ways to not only fill the pipeline with more girls and women, but also finding ways to create work environments that will sustain them once they are working in them. Christyl would like you to participate in this year's event focused on hearing from the younger generation -- early career employees, students from universities (and younger), and other visionary thinkers. If interested, I'll schedule time on your calendar with Christyl for a more detailed discussion. Recommend meeting and I'll invite Mike Kincaid to join.

Summarizing our recent meeting

From: terry virts (b) (6)
To: Bridenstine Jim <james.f.bridenstine@nasa.gov>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>
Sent: August 28, 2018 10:34:16 AM EDT
Received: August 28, 2018 10:34:24 AM EDT

Hi Jim- I really appreciate taking the time to meet last week. I wanted to summarize some of the important points about gateway and our future, at least from my perspective.

1) Gateway as its currently conceived, in orbit around the moon, will make it more difficult and expensive to get to the surface, because you'll have to take longer to rendezvous and dock with it, costing prop and consumables.
2) Gateway will take many years and even more billions of dollars, and even after it's built, will still require a multi-billion dollar annual budget to provide very limited, if any, utility in terms of "connecting the dots" between ISS and eventually flying to Mars or beyond.

3) I really agree with and support the president's vision of returning to the moon and using that as a stepping stone to Mars.

4) I think that one way some elements of gateway (a PPE module, hab, airlock, etc) could be used as a valid exploration vehicle, and actually serve a useful "Gemini-like" role in getting us to Mars, would be to put it in an earth-moon cycling orbit. I believe that when we eventually fly to Mars we will re-use the crew transfer vehicle and propulsion (it will have to be nuclear electric), and that vehicle will cycle between earth and Mars. So let's learn how to explore the moon with a cycling architecture. How to launch crews at high velocity to rendezvous with the cycler. etc. It will provide our industrial base and NASA and international partners with a viable program, and actually be useful for future endeavors.

5) A quick word about Orion. Capsules aren't exploration vehicles. They should be simple and small and safe and cheap, and get you from earth to space and back. By putting Orion on SLS, we violate the most important lesson from the Columbia accident, namely "separating crew from cargo." You also hamstring SLS from reaching its true potential, cause it has to waste 50k lbs on Orion. Let SLS be a true heavy lift vehicle, and use all of its cargo capacity for sending vehicles to deep space or extra delta V. Come up with some other capsule (Boeing, spaceX, maybe Orion but doubtful) that has a beefier heat shield and can withstand lunar reentry velocities, but launches on a smaller (and safer) rocket. Keeping Orion on SLS also increases SLS's risk of being cancelled by Falcon heavy or New Glenn, because they are so much cheaper.

6) A quick word about the bureaucracy. I don't mean to be too down on them, but it's important to be frank. The NASA bureaucracy primarily sees its role as protecting itself, I was actually recently told that verbatim. Gateway was born out of a desire to survive the Obama years and they still want to weather this period and just keep a human space program plodding along; this saves everyone's job. Unfortunately it has become a self-licking ice cream cone, and I honestly am getting a constant stream of feedback from lots of people in the space community (human, science, even NASA itself and the press) that they see this also, and appreciate my pointing out some fatal problems with gateway as currently conceived.

7) I think the best return on investment for the taxpayer will be to find a way to get money flowing to companies like spaceX and Blue Origin and others- give them a one paragraph requirements document, a multi-year fixed price contract, and let them go. Find a different program for the civil servants to keep busy on, so they don't disturb the real progress. I hope this doesn't seem crass, but I've been here for 18 years and I honestly think this is the only way to make real progress in exploration. Public / Private partnership, public money and private innovation, where NASA

stays hands off. Unfortunately I am 100% positive that you will never have an innovative or original idea come from within the JSC / NASA establishment, my discussions with folks about gateway over the past year have just cemented that view.

8) Nuclear power is critical- surface nuclear electricity is required for any length of time on both moon and mars. And nuclear electric propulsion is mandatory to get to mars, it's what enables a 1 year mission vs 3 years with conventional propulsion, and getting there and back in 1 year actually makes mars possible. I don't believe a 3 year trip is possible. I was so encouraged to hear support on that realm.

A final note- if you ever need a voice of reason or sanity there at HQ, Al Drew is a great person to talk to. He's a fellow astronaut classmate of mine, has very like-minded views, and is a great sounding board.

Good luck, I'm always here to help in any way I can, with Gateway, Space Force, or anything.

V/R,

TV

(b) (6)
[redacted]

White House Statement on the Space Force

From:	Powers, Megan K. (HQ-NA000) <megan.k.powers@nasa.gov>, Powers, Megan K. (HQ-NA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=POWERS, MEGAN K 670907028CD2>
To:	Jacobs, Bob (HQ-NA000) <bob.jacobs@nasa.gov>, Cremins, Tom (HQ-AH000) <tom.cremins-1@nasa.gov>, Sherman, Gabriel J. (HQ-AA000) <gabriel.j.sherman@nasa.gov>, Bridenstine, James F. (HQ-AA000) <james.f.bridenstine@nasa.gov>, Jacobs, Bob (HQ-NA000) </O=NASA/OU=JSC/cn=Recipients/cn=747738362>, Cremins, Tom (HQ-AH000) </O=NASA/OU=JSC/cn=Recipients/cn=HQ007639>, Sherman, Gabriel J. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Sherman, Gabriel J 895977475423>, Bridenstine, James F. (HQ-AA000) </O=NASA/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=Bridenstine, James F 8724750558df>
Sent:	June 18, 2018 3:56:46 PM EDT
Received:	June 18, 2018 3:56:48 PM EDT

"Today at the National Space Council meeting, the President directed the Department of Defense to immediate begin the process necessary to establish a space force as the sixth branch of the armed forces. The President's National Strategy for Space calls for American leadership, preeminence, and freedom of action in space, and he sees a separate service focused on space as a critical piece of that end state. The National Space Council and other White House offices will work closely with the Department of Defense on successful implementation of the President's direction."—Raj Shah, Principal Deputy White House Press Secretary.

All press inquiries should be directed to the Department of Defense.

Megan Powers

Press Secretary

NASA HQ

Megan.K.Powers@nasa.gov

Cell: **(b) (6)**

Desk: 202-358-2268