

A New Suit for New Missions

By Paul Nation

Jacob's Jets Test Branch

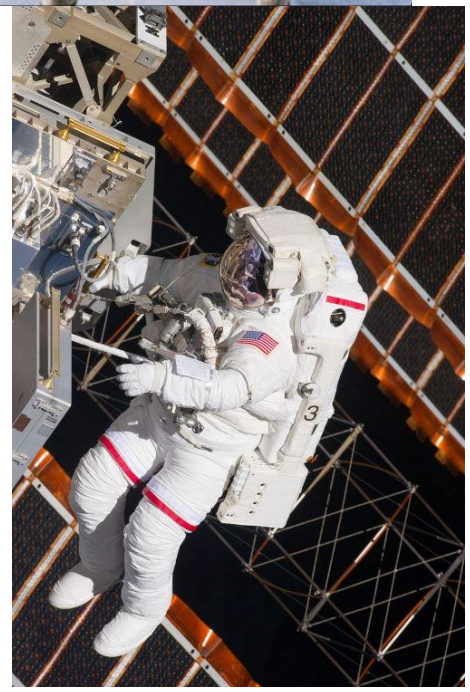


Space Suit History

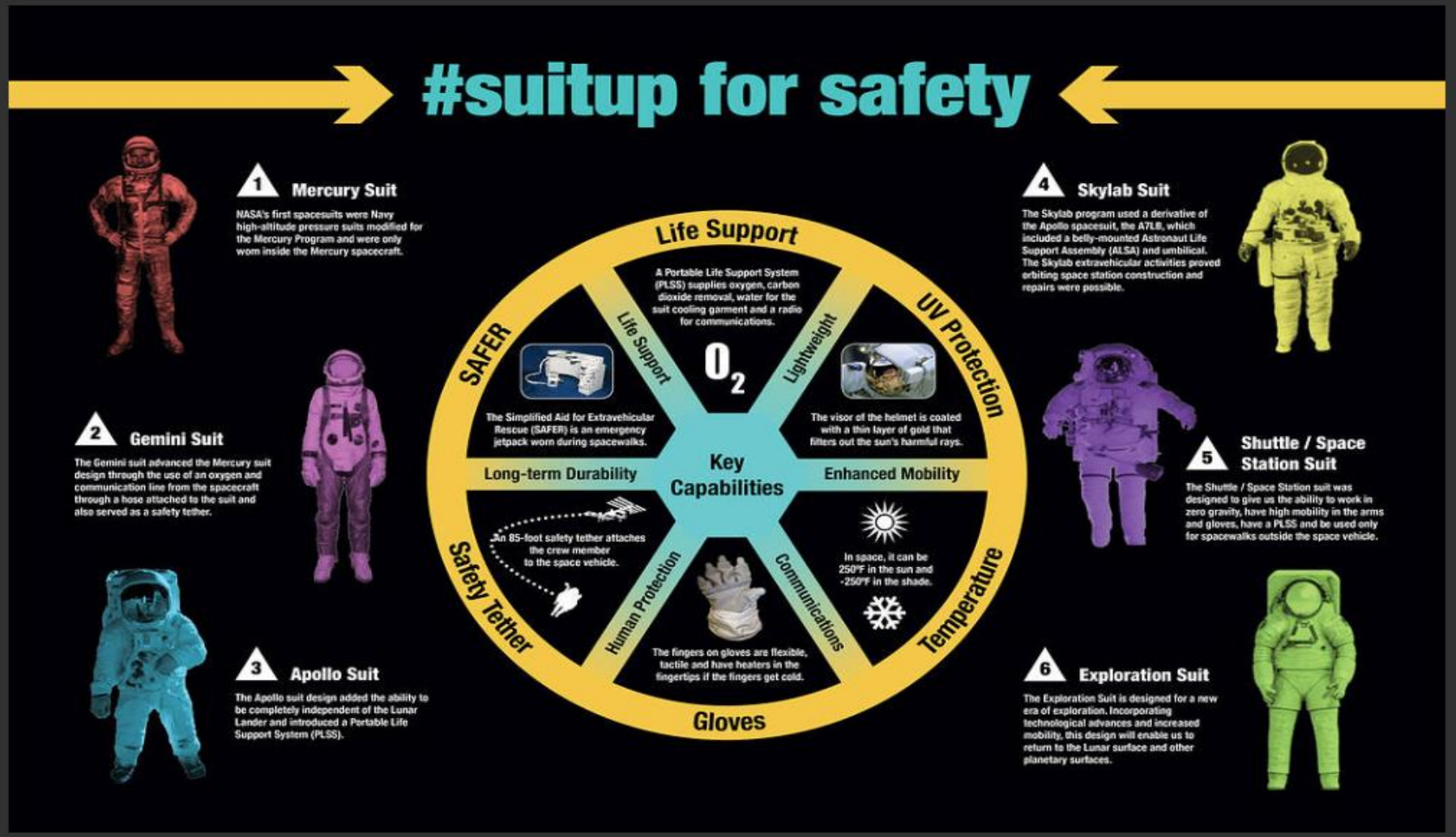
- Mercury Program (1961-1963)
  - Space suit derived from 1959 US Navy Aviation suit design-Suit worn inside Spacecraft
- Gemini Program (1961-1966)
  - 9 Space Walks (EVAs-Extra Vehicular Activities)
  - Gemini suit was designed to develop spacewalk techniques/technologies
  - Did not include PLSS-Life support via Umbilical
- Apollo Program (1961-1972) A7L & A7LB
  - 21 total spacewalks on surface of the moon
  - 160+ hoursSpent by Astronauts exploring lunar surface
  - Changes to Suit Block 2 following Apollo 1 fire-
    - Cabin pressure to 60% oxygen & 40% nitrogen at 14.7psi
    - Nylon used in Block 1 suits replaced with Beta cloth-non flammable highly melt resisteant fabric woven from fiberglass and coated with teflon
  - Development of first PLSS for autonomous work
- SkyLab (1973-1979)
  - 10 total spacewalk outside lab
- Space Shuttle (1972-2011) EMU & Launch/Entry
  - 82 total spacewalks outside shuttle airlocks
  - 8 hrs:56 minutes time of longest by Jim Voss & Susan Helms in2001
- International Space Station (1998-Present)
  - 184 total number of spacewalks outside of ISS





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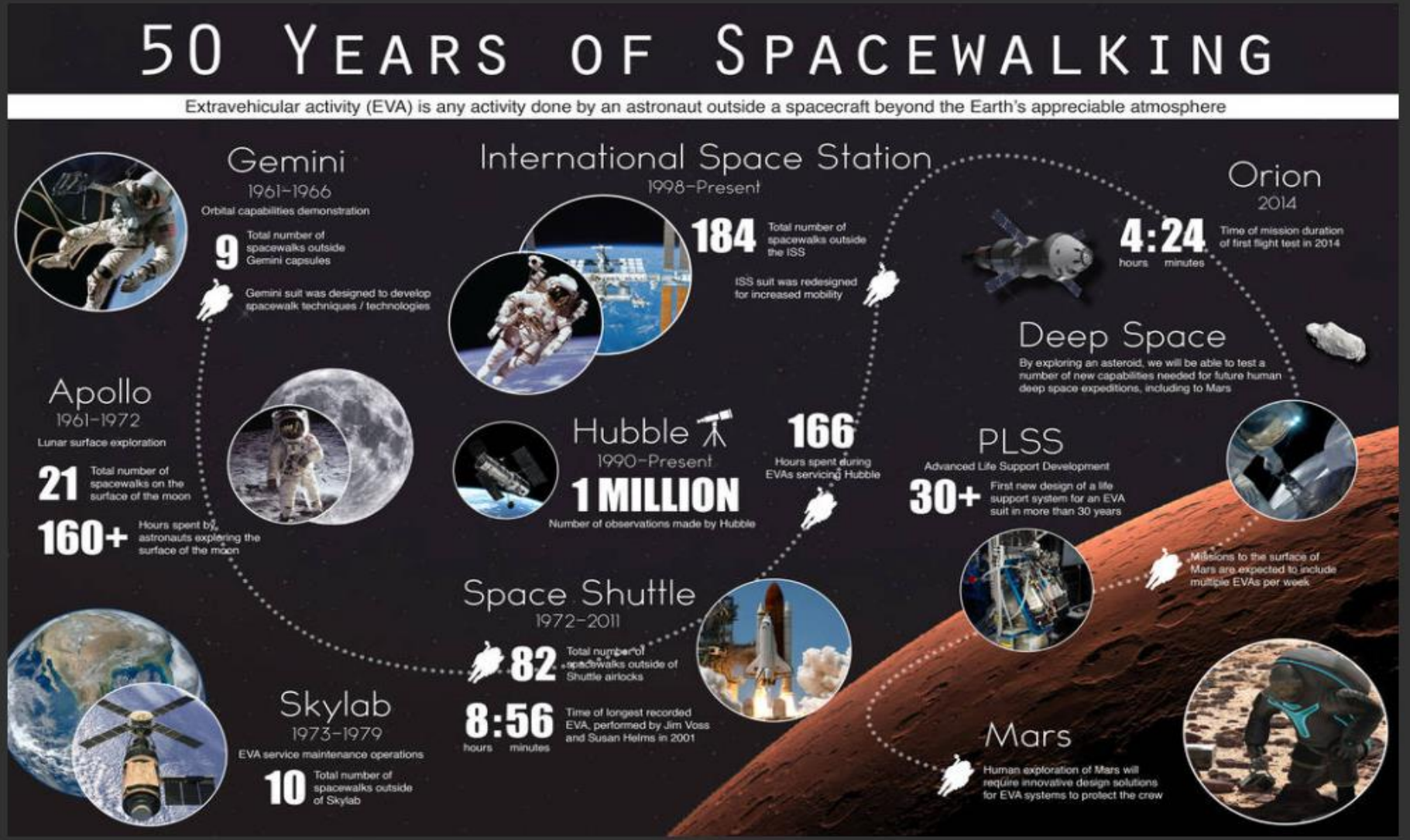


EVA 50th Anniversary Monthly Themes - February - Safety in Space

#SuitUp with NASA for the #JourneytoMars. Find out more at http://www.nasa.gov/suitup

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50 Years of Spacewalking

#SuitUp with NASA for the #JourneytoMars. Find out more at http://www.nasa.gov/suitup

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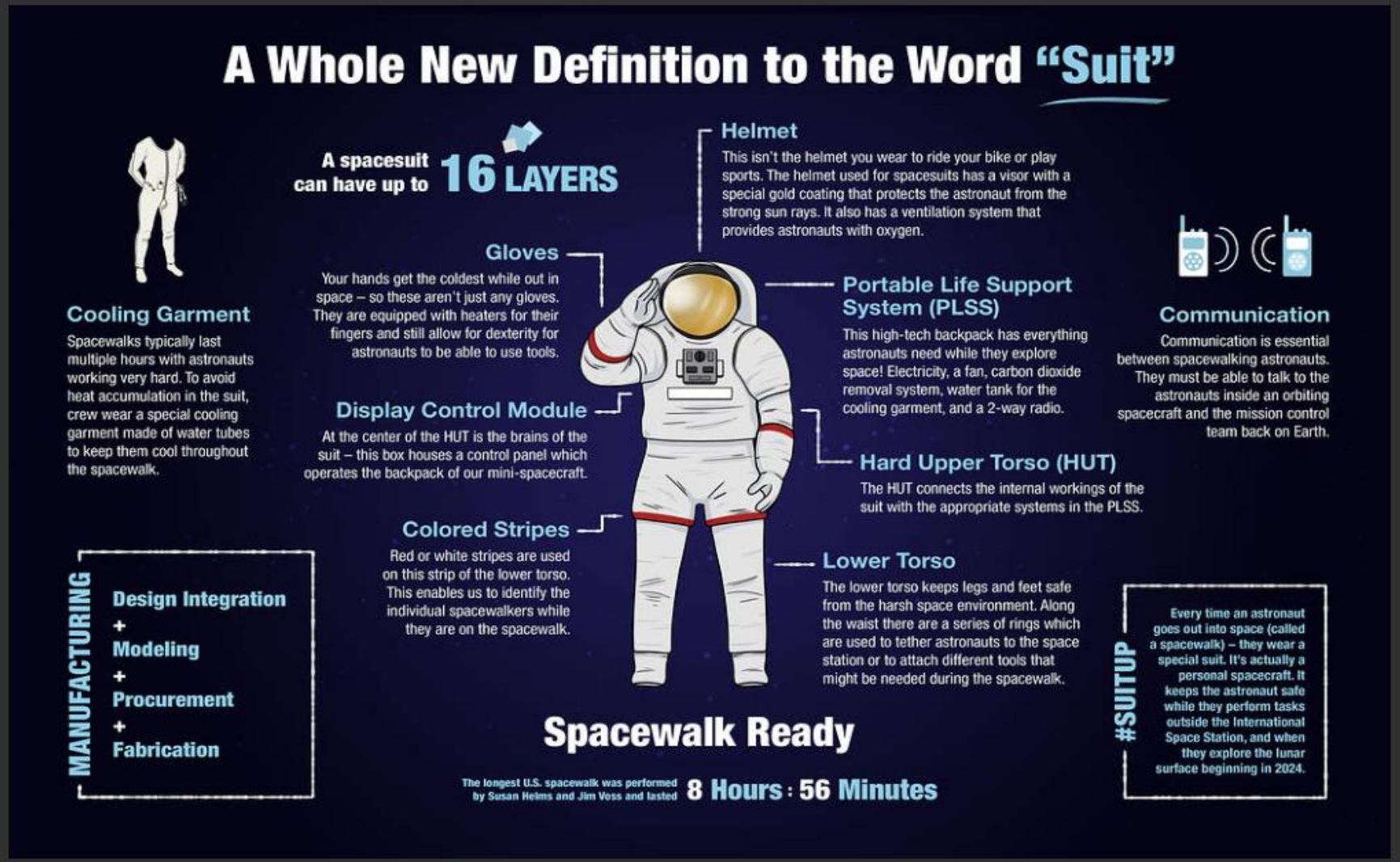
Existing Space Suit-EMU (Extra-Vehicular Mobility Unit

- Developed by ILC Dover (suit) & Hamilton Sundstrand/Collins Aerospace (PLSS)
- Used during Zero-G spacewalks (EVA's) during Shuttle & ISS
- Developed during 70's/80's
- Issues with age of suit impacts to current ISS missions
  - Water in helmet on EVA #23 in 2013-Luca Parmitano Near-drowning
  - May 2022 additional water leaks causing stop use of existing EMU
- Current EMU suits mobility issues-Waist/Brief/Hip mobility; Legs/knees
  - Not ideal for Lunar work
- Desire to have multiple methods of Donning/Doffing-
  - Use of Back Hatch to attach to outside Rover-Dust mitigation
- New Artemis SLS & Orion Capsule for Lunar missions needing new suit
  - New mission to Polar/Permanently shadowed regions-Extreme Lower temps
- New Suit needed for future Mars missions





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Spacesuit 101

A Whole New Definition to the Word "Suit" #SuitUp

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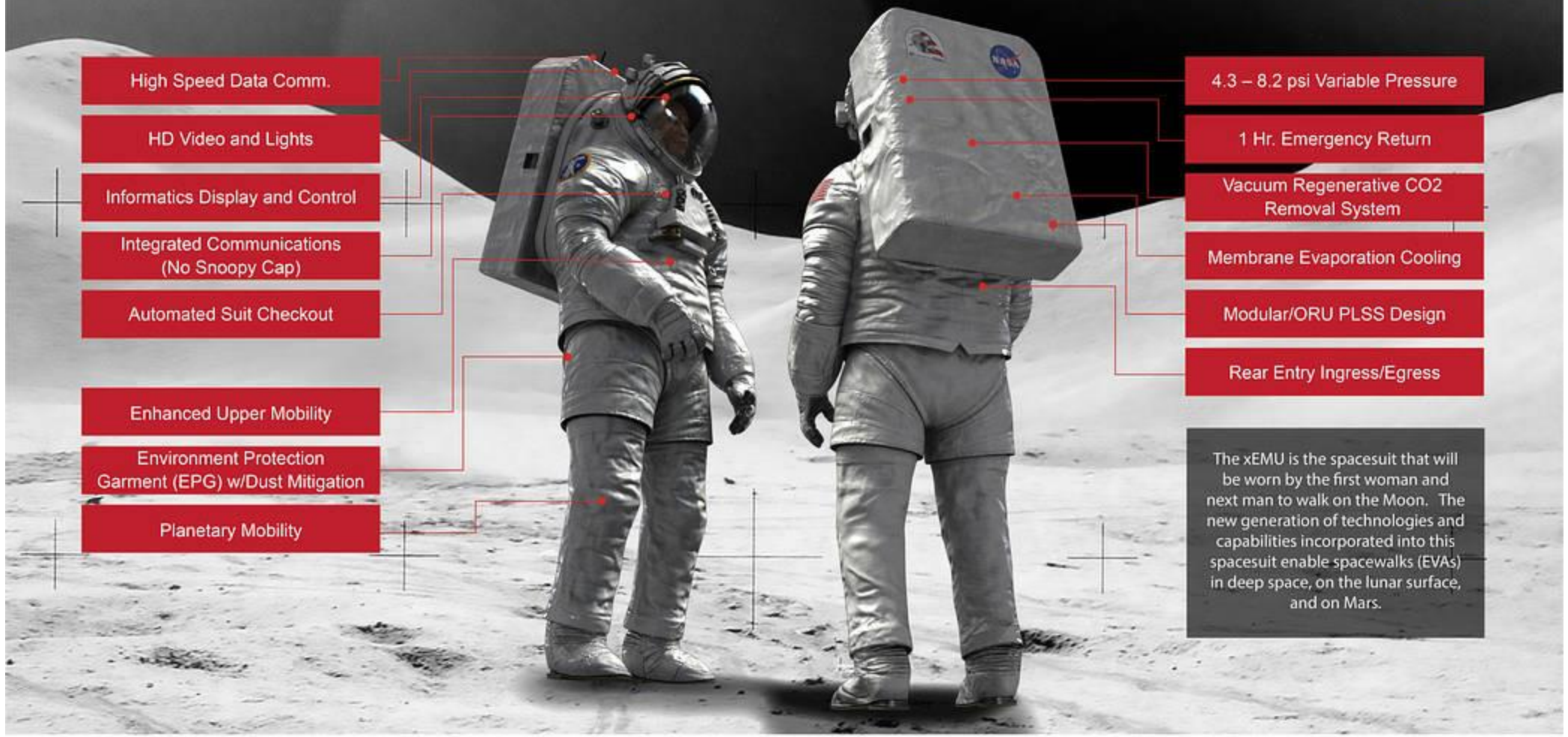
Challenges of Mobility with Suit & PLSS

- Likelihood high of falling/due to weight/mass size of PLSS
  - In New mission in Permanent shadowed region danger
  - Astronauts falling on the Moon, NASA Apollo Mission Landed on the Lunar Surface - Bing video
- Additional issues of fine lunar dust being stuck to lunar suits and need to keep capsules/living areas free of the dust
- 2 Main problems with Prior Apollo suits
  - Zippers & Cables causing issues
  - During Apollo Moonwalks, metal braided cables tended to fray and zippers (which sealed air into the suits) got clogged with lunar dust and didn't work very well
- Next Generations space suits will have to learn from prior lunar struggles.
  - Problem of extreme cold and need for multilayer insulation.
  - Use of heaters in boots, gloves as concept

EXPLORATION EXTRAVEHICULAR MOBILITY UNIT (xEMU)

National Aeronautics and Space Administration

NASA



- High Speed Data Comm.
- HD Video and Lights
- Informatics Display and Control
- Integrated Communications (No Snoopy Cap)
- Automated Suit Checkout
- Enhanced Upper Mobility
- Environment Protection Garment (EPG) w/Dust Mitigation
- Planetary Mobility

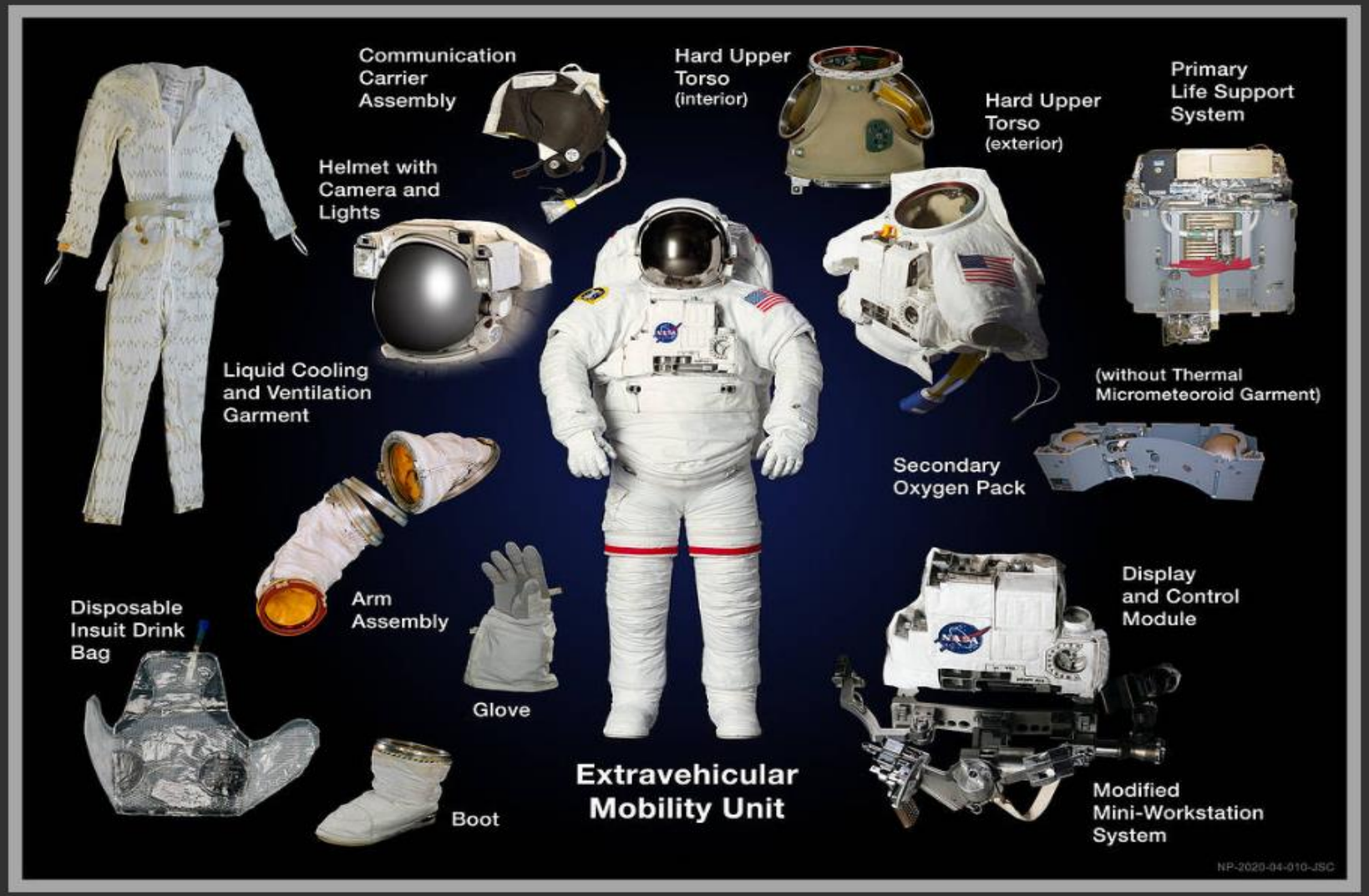
- 4.3 – 8.2 psi Variable Pressure
- 1 Hr. Emergency Return
- Vacuum Regenerative CO_2 Removal System
- Membrane Evaporation Cooling
- Modular/ORU PLSS Design
- Rear Entry Ingress/Egress

The xEMU is the spacesuit that will be worn by the first woman and next man to walk on the Moon. The new generation of technologies and capabilities incorporated into this spacesuit enable spacewalks (EVAs) in deep space, on the lunar surface, and on Mars.

ARTEMIS

EVA SPACESUIT TECHNOLOGY AND DESIGN

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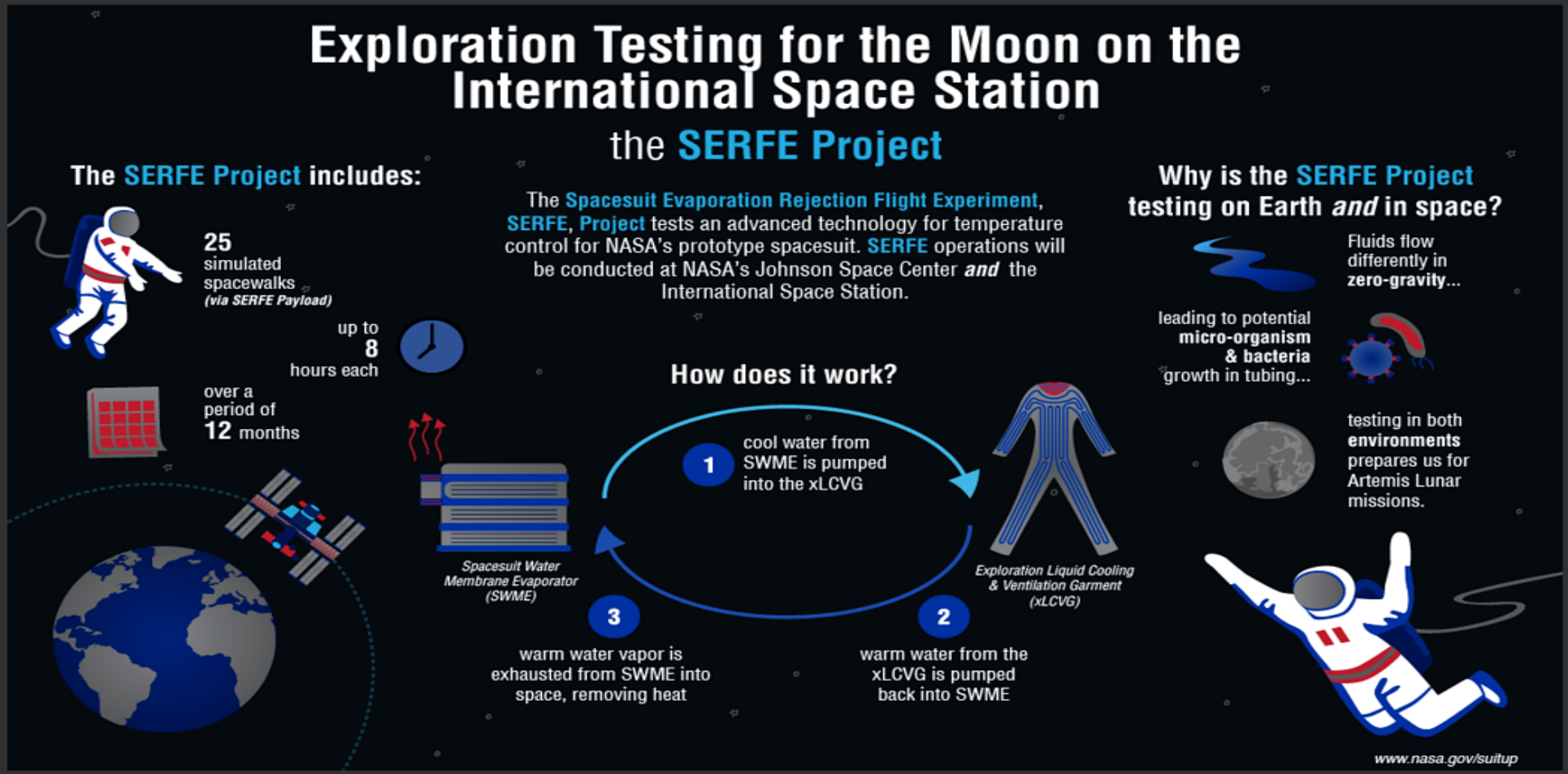


The Extravehicular Mobility Unit (EMU)

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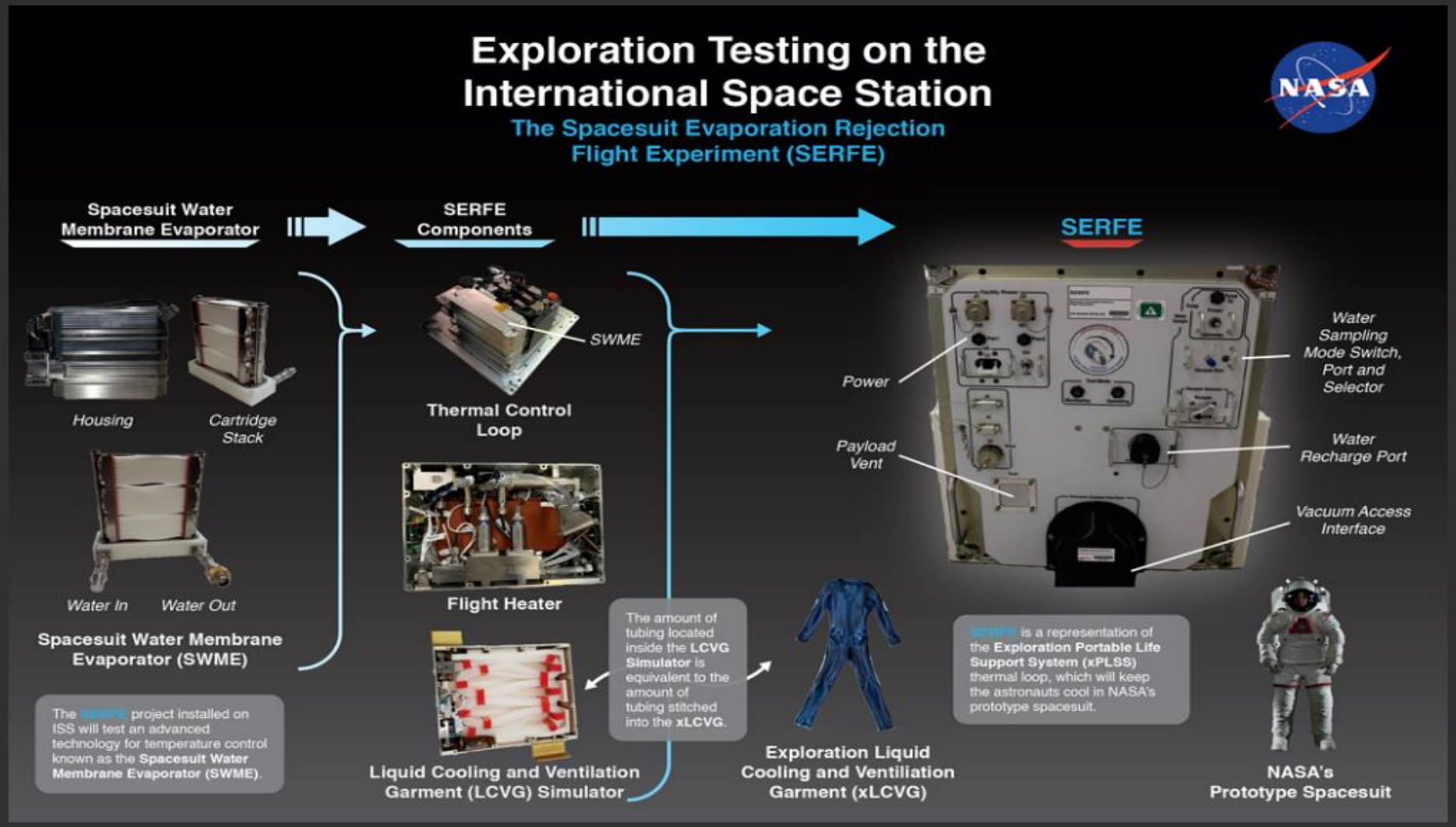


Exploration Testing for the Moon on the International Space Station: the SERFE Project

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Spacesuit Evaporation Rejection Flight Experiment (SERFE)

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NASA Partners with Industry for New Spacewalking, Moonwalking Services



An artist's illustration of two suited crew members working on the lunar surface. The one in the foreground lifts a rock to examine it while the other photographs the collection site in the background.
Credits: NASA

NASA has selected Axiom Space and Collins Aerospace to advance spacewalking capabilities in low-Earth orbit and at the Moon, by buying services that provide astronauts with next generation spacesuit and spacewalk systems to work outside the International Space Station, explore the lunar surface on Artemis missions, and prepare for human missions to Mars.

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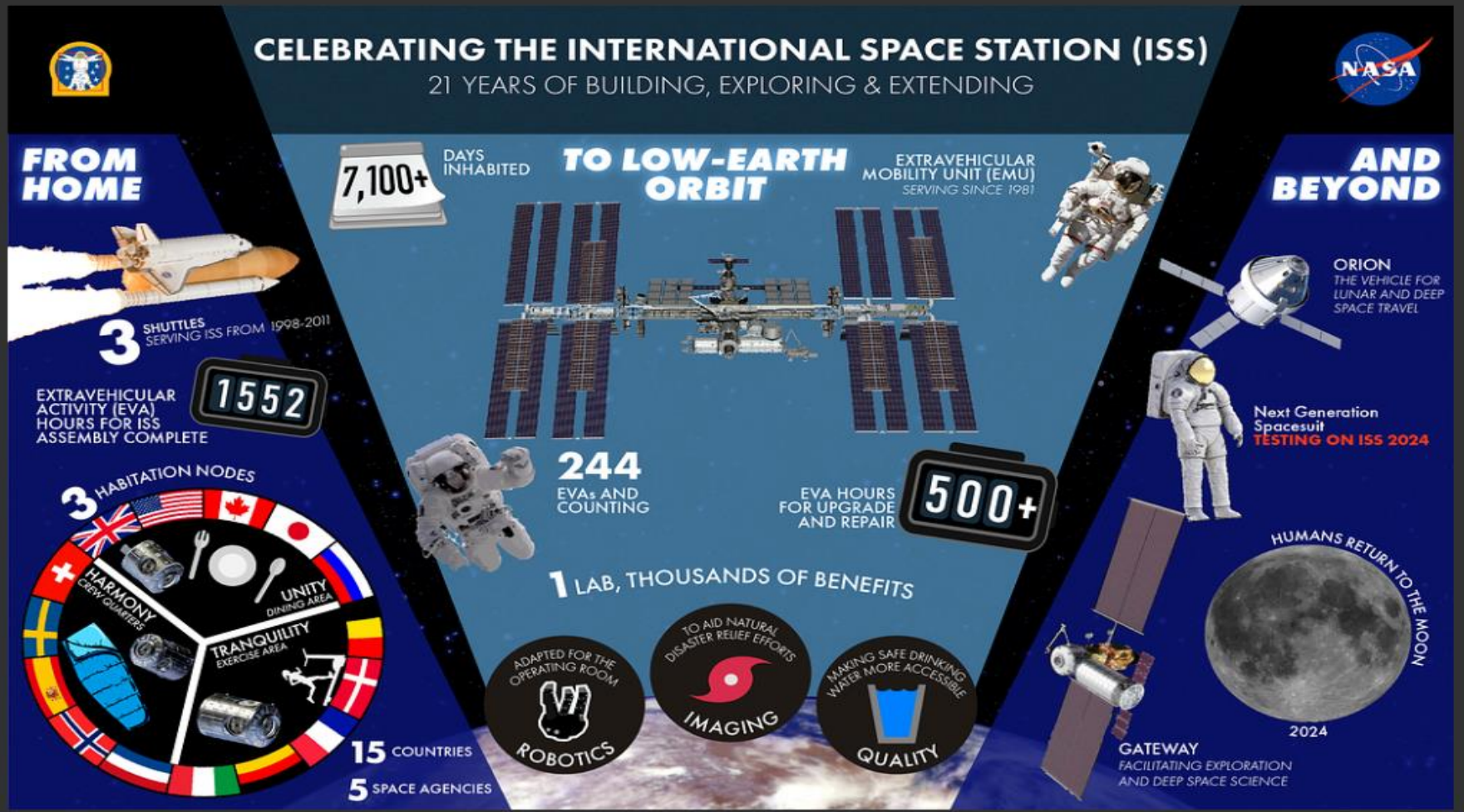


Celebrating the International Space Station (ISS)

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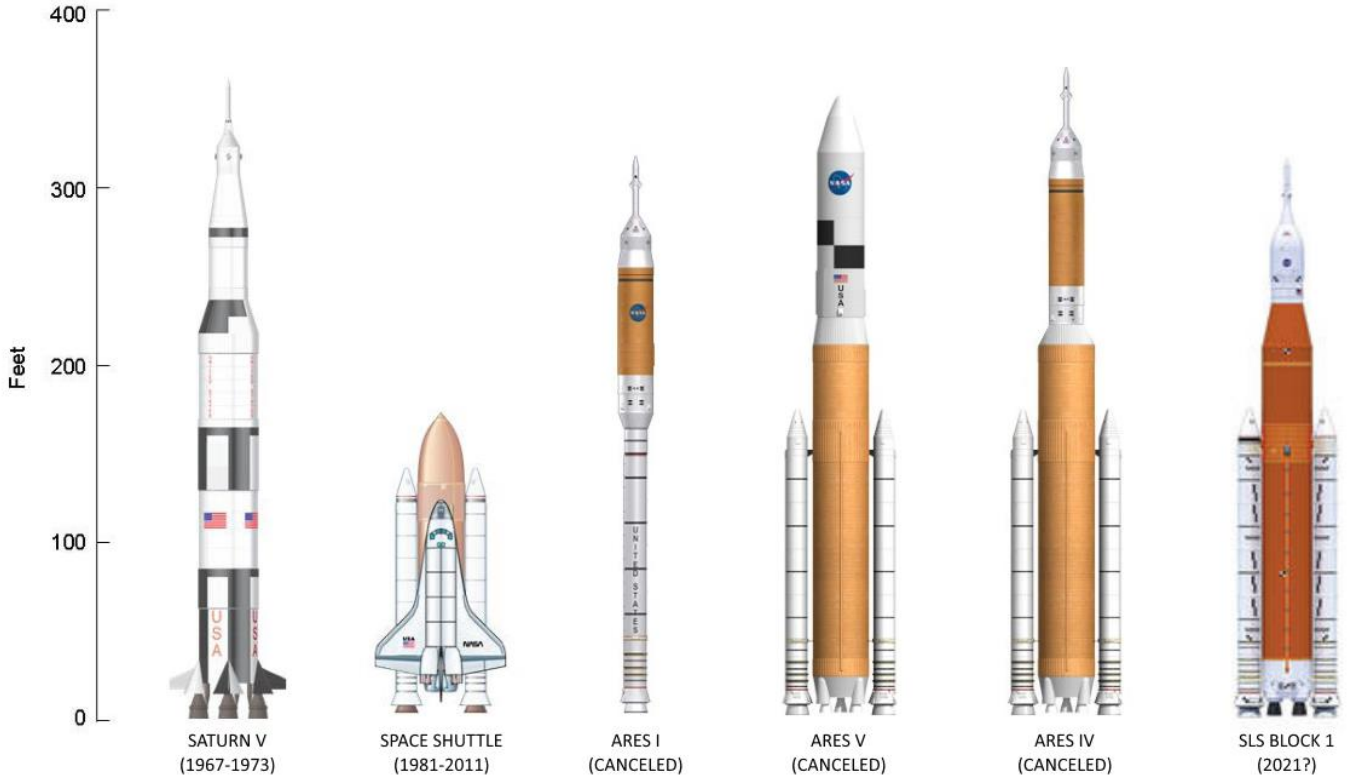
Beyond Space Suits- Artemis completion of SLS1-to begin Launch pad testing

- SLS1-Replacement of Saturn V to launch for Lunar surface
  - Latest Wet dress rehearsal scrub to repair fuel loading issue
- Expect first unmanned Lunar Mission fall 2022.



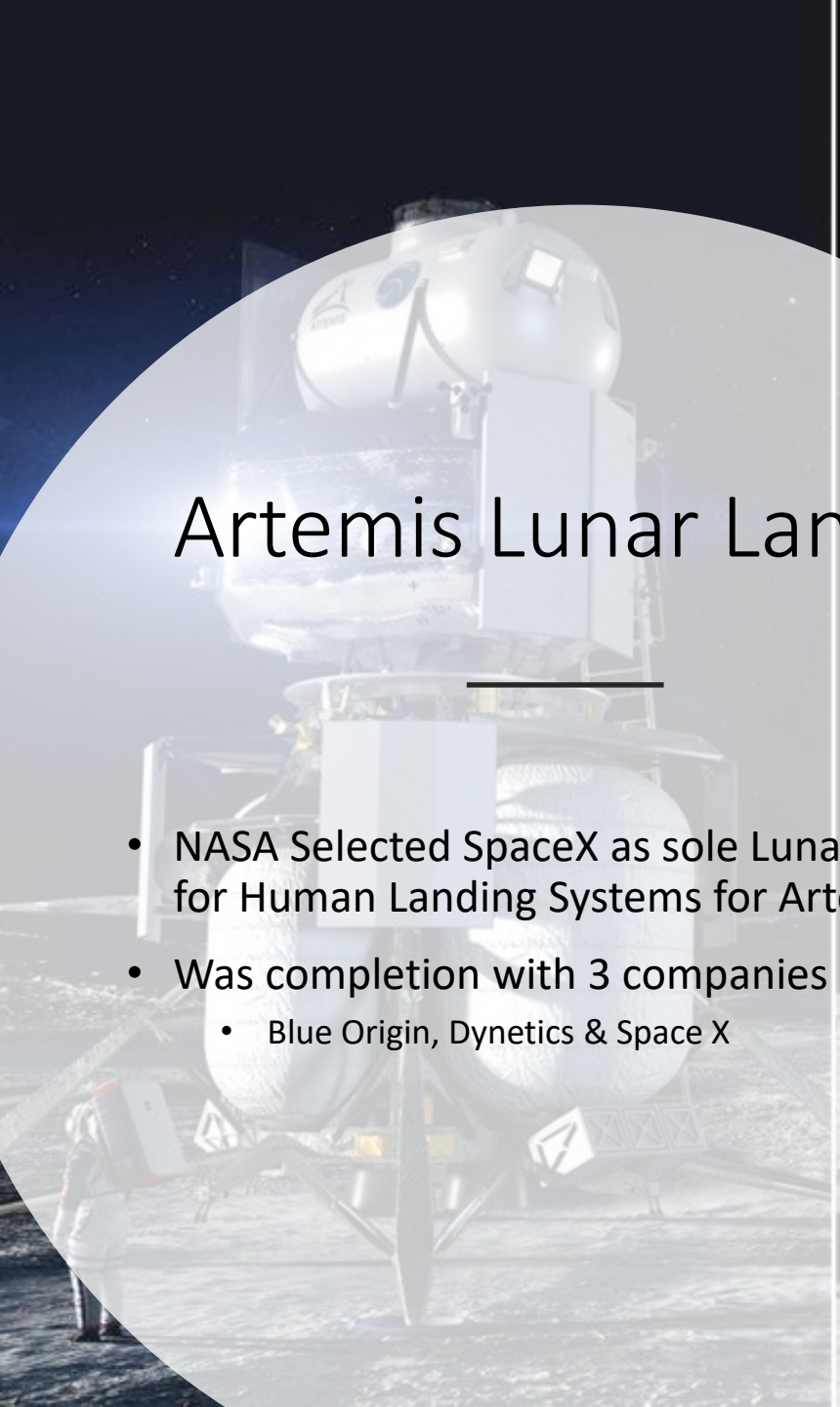
Comparison of Rocket types

- SLS1-Replacement of Saturn V to launch for Lunar surface



Artemis Lunar Lander

- NASA Selected SpaceX as sole Lunar Lander for Human Landing Systems for Artemis-
- Was completion with 3 companies
  - Blue Origin, Dynetics & Space X







Need to set up Lunar bases

- Lunar missions planned for longer durations
  - Need to capture available frozen water to use for Astronaut use/Hydrogen fuel
  - Use of Recycling water-Regen-ECLSS
  - Greater opportunities to explore Lunar surface
  - Discovery of other resources on Lunar surface

