National Aeronautics and Space Administration

Task Load Management

To Progressively Enable EIMO

EIMO TIM5

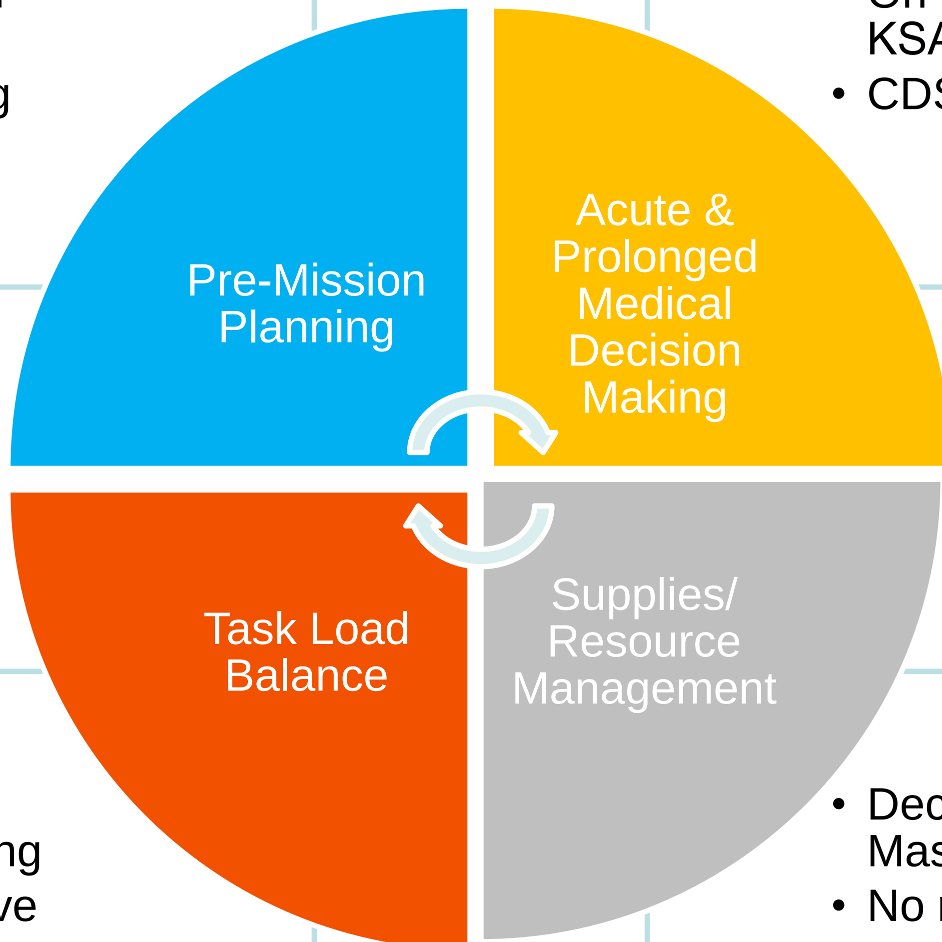
21 May 2024

Earth Independent Medical Operations (EIMO)

EIMO Components

- Medical Model
- Training

- On-board KSA's
- CDSS*



- Task Switching
- Cognitive Load

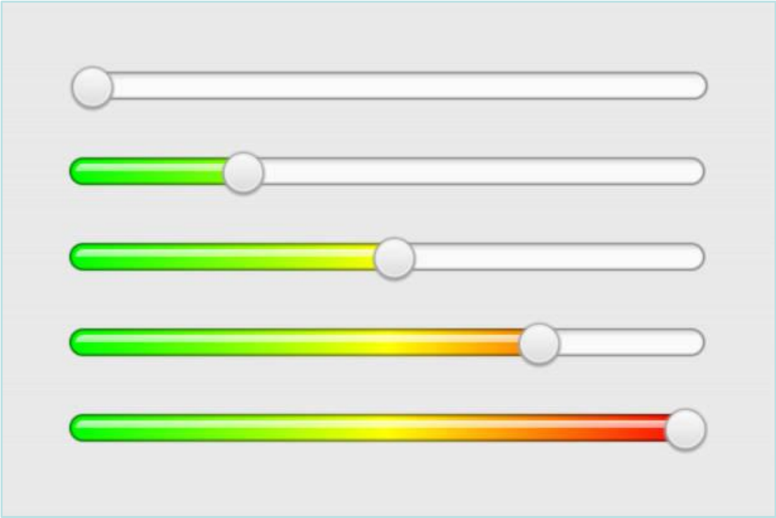
- Decreased Mass/Volume
- No re-supply
- Trade Space

A Progressive Approach

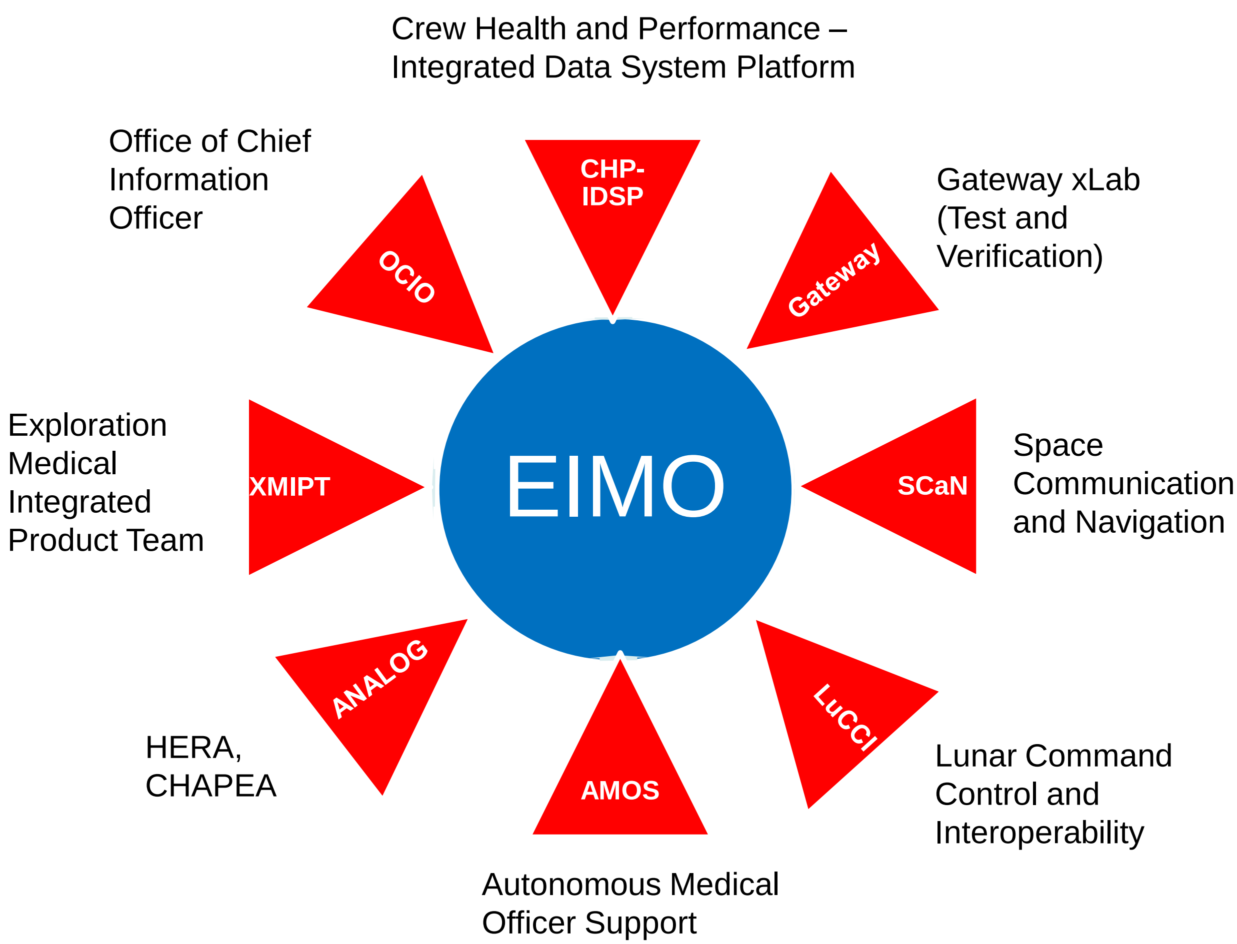
On-board care will ***increasingly become the responsibility*** of the astronauts for primary management.

Terrestrial assets will continue to be paramount in pre-mission screening and planning, as well as health maintenance and prevention activities.

New capabilities and systems that enable progressively more robust and resilient systems and crews will ***reduce risk and increase probability* of deep space exploration mission *success***.



EIMO Intersects Within NASA



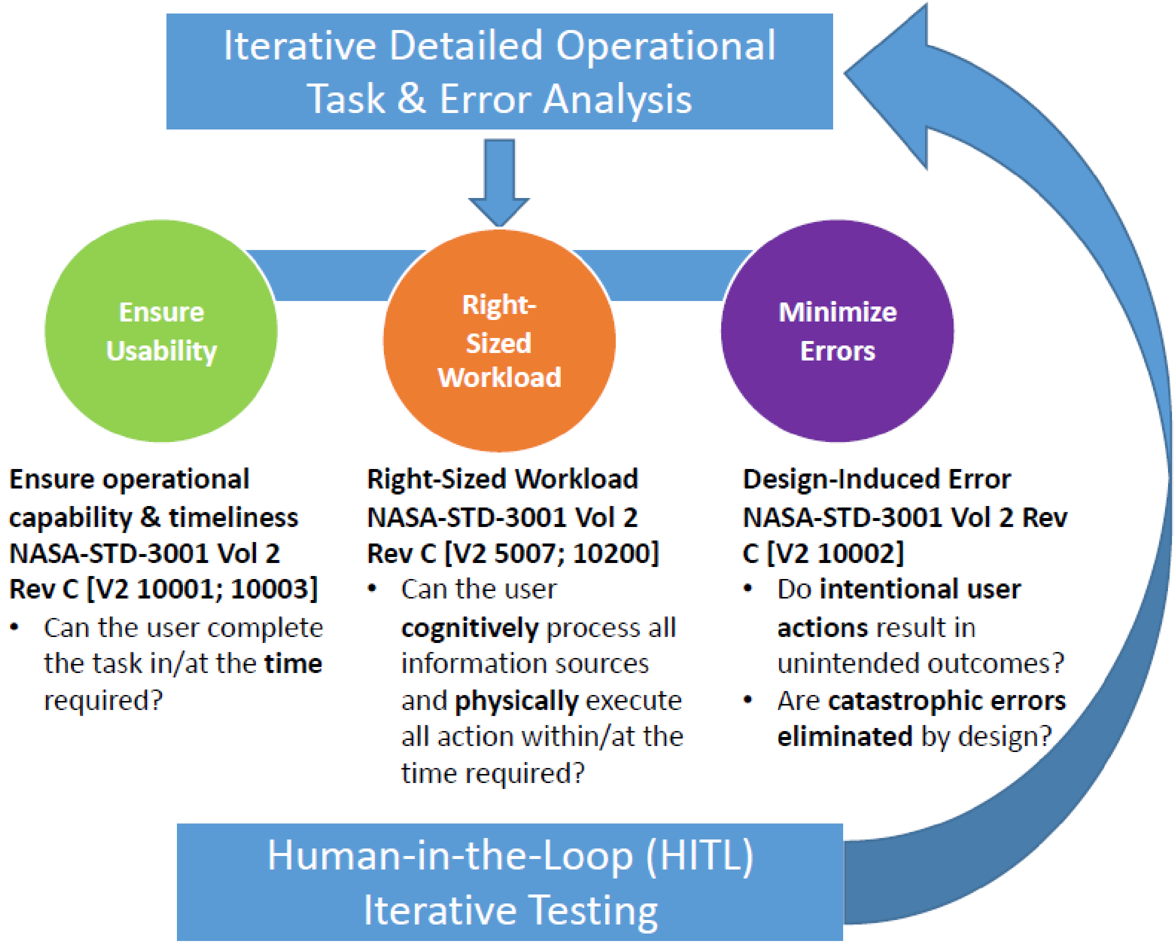
Purpose of Task Load Management (TLM) TIM

The purpose of the TIM is to identify, prioritize and plan forward work on EIMO

From the perspective of potential stakeholders, what are key considerations pertaining to task load management needed to **enable EIMO**?

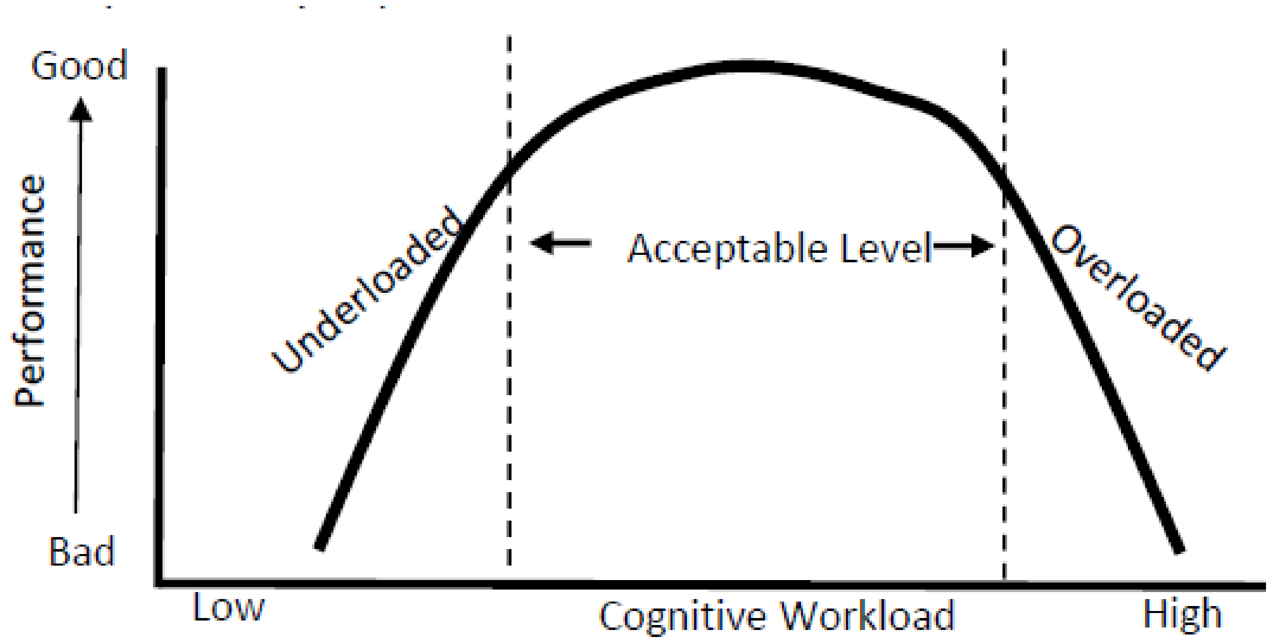
- Task over-loading
- Task under-loading
- Cognitive dissonance
- Automation

Analytical Approach



NASA-STD-3001,Technical Brief, Cognitive Workload, 15 Dec 2021.

Optimal Workload Key to Performance



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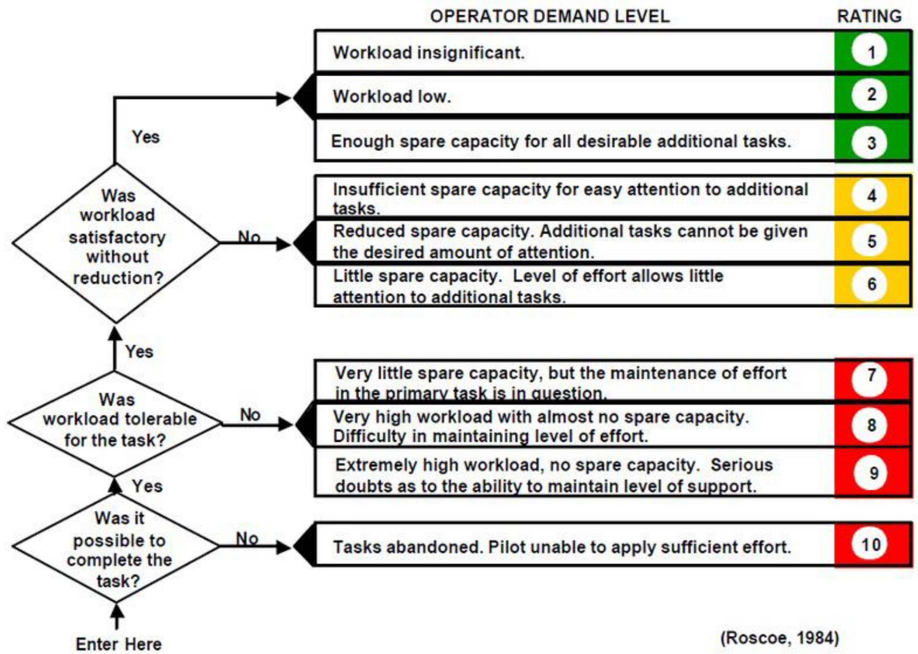
Tools for Assessment

NASA Task Load Index (TLX)

RATING SCALE DEFINITIONS

Title	Endpoints	Descriptions
MENTAL DEMAND	*Low/High*	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	*Low/High*	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	*Low/High*	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
EFFORT	*Low/High*	How hard did you have to work (mentally and physically) to accomplish your level of performance?
PERFORMANCE	*Good/Poor*	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
FRUSTRATION LEVEL	*Low/High*	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Bedford Workload Scale

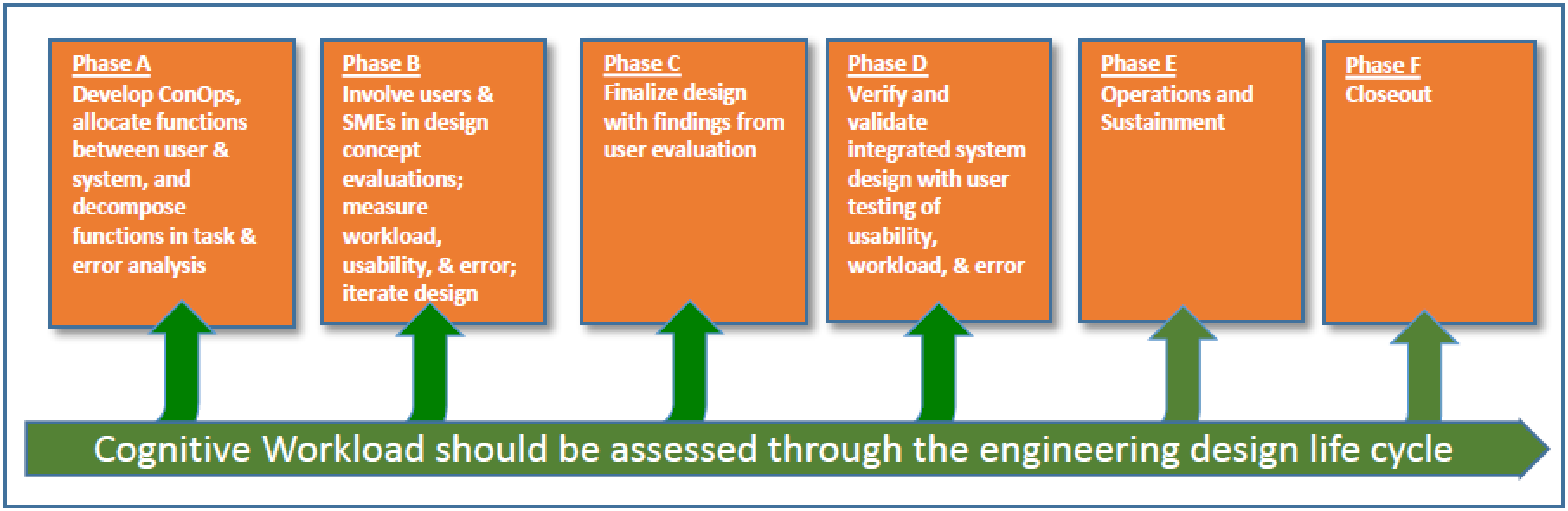


Development

Verification

NASA-STD-3001,Technical Brief, Cognitive Workload, 15 Dec 2021.

Early and Continuous Assessment



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Topic 1:

What are current task/mission contributors to crew workload/overload and what contributors are expected in future spaceflight missions?

TLM Topic 2

Topic 2:

What individual/team factors can contribute to performance errors and how can these be measured?

Topic 3:

What measures/tool(s) could be used to assess and manage task load for crew on exploration class missions?

Topic 4:

What medical procedures occur today that you expect will change in the exploration mission scenario? Which of these are expected to be more burdensome on the crew?

Topic 5:

How can we reduce the burden to the crew in future exploration class missions?

Topic 6:

Striking a balance in workload is critical to maintenance of high performance, low error rates and prevention of fatigue, frustration and poor situational awareness. What tool(s) are most effective to assess and manage task load for crew on exploration class missions?

TLM Topic 7

Topic 7:

What parameters can be passively monitored to determine if crewmembers are hurried, anxious or bored resulting in attention deficit? Should a baseline be established to determine off-nominal performance and if so, how much baseline information is needed to create a sensitive, predictive and reliable system?

Topic 8:

The Bedford Workload Scale has been selected by NASA as the workload verification method for several program workload requirements and will likely be applicable for EIMO. Under what circumstances, if any, should the Bedford Workload Scale rating be modified to support tasks needed to enable EIMO?

Topic 9:

Vehicle and habitat environments are noisy and filled with multiple alert modalities. NASA3001 states that when users are required to monitor multiple displays important events should occur in all displays and color/flashing alerts should be used sparingly & judiciously. Since the proposed solution for Clinical Decision Support System (CDSS) includes a voice interactive interface, how would the system be optimally designed to provide levels of distinction for notifications based on importance, e.g., routine, elevated, critical, that are intuitive and resistant to habituation?

Topic 10:

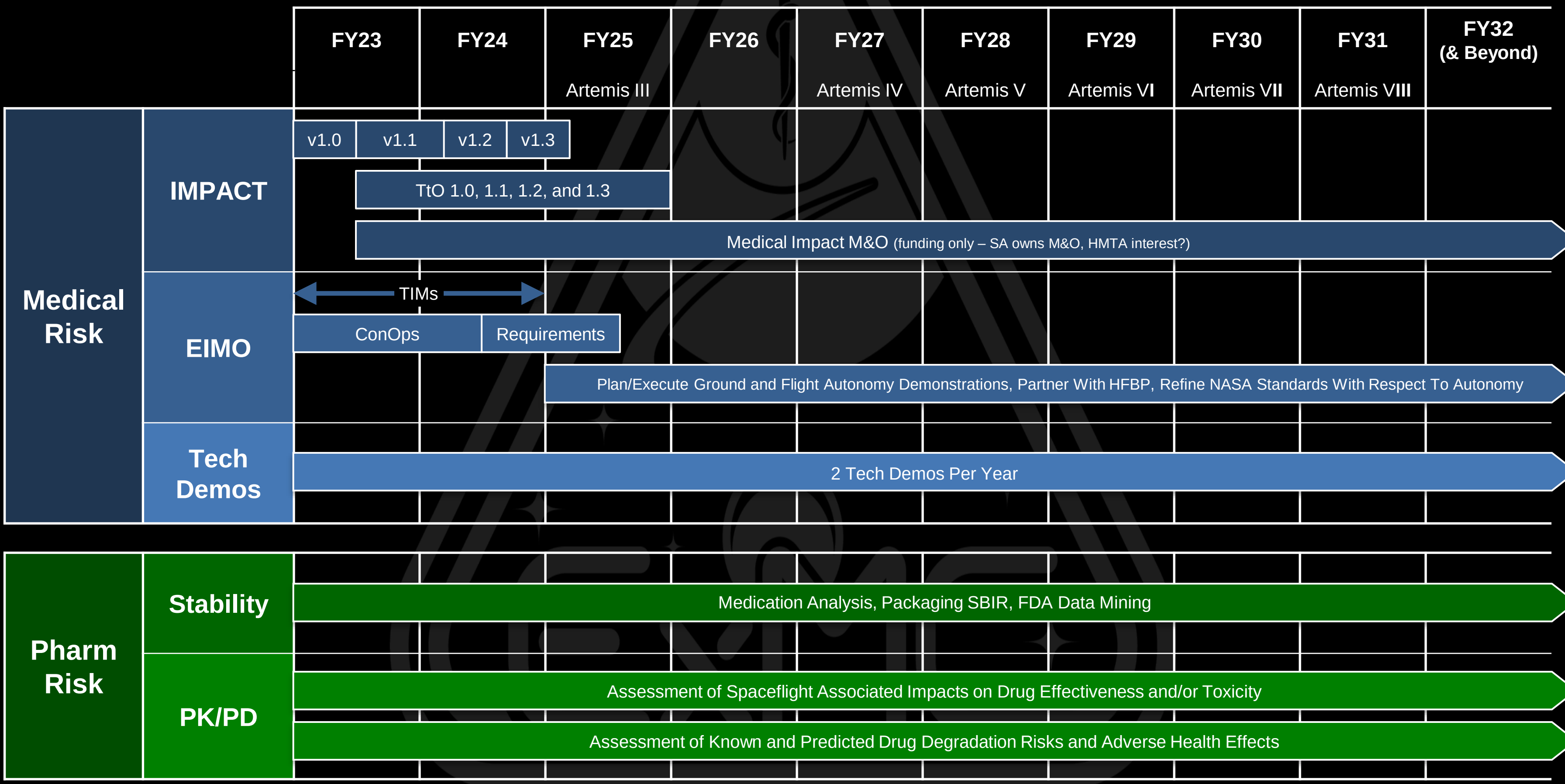
Design of a CDSS to enable EIMO decision making by CMOs will require human-in-the-loop (HITL) simulation/testing throughout the development lifecycle. To assure that the system is intuitive and informative across the expected range of knowledge, skills and abilities for prospective CMOs (no medical background to physician level), how can the output be structured to efficiently advise without under-/over-loading?

Topic 11:

Numerous challenges to behavioral health are expected during a Mars mission that individually and/or cumulatively could impact a crew member’s ability to effectively manage cognitive load. What countermeasures will be most effective and what would in-mission application of the preferred countermeasures look like? What metrics could be tracked to determine success?

BACK-UP SLIDES

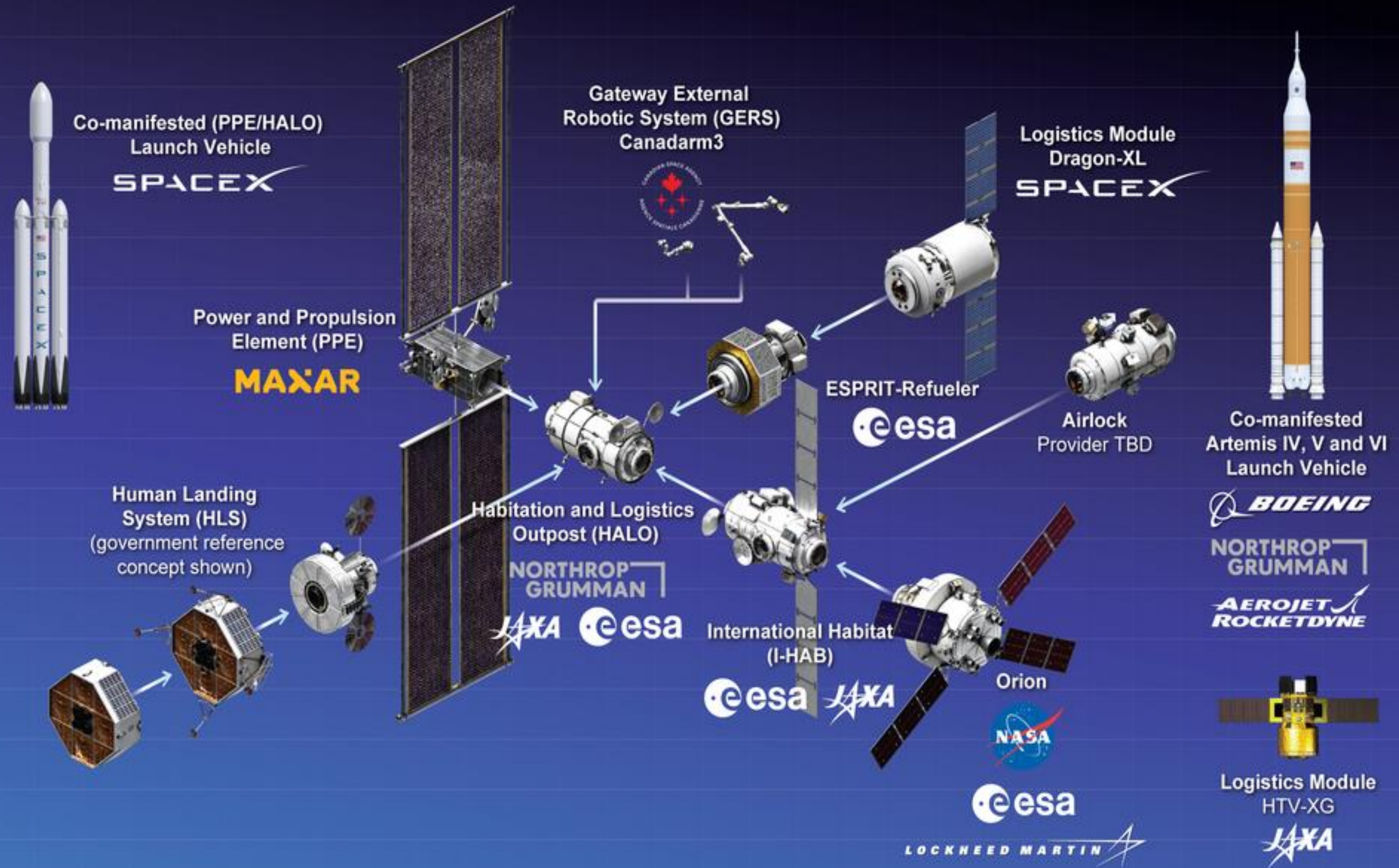
ExMC HSRB Risk Roadmap



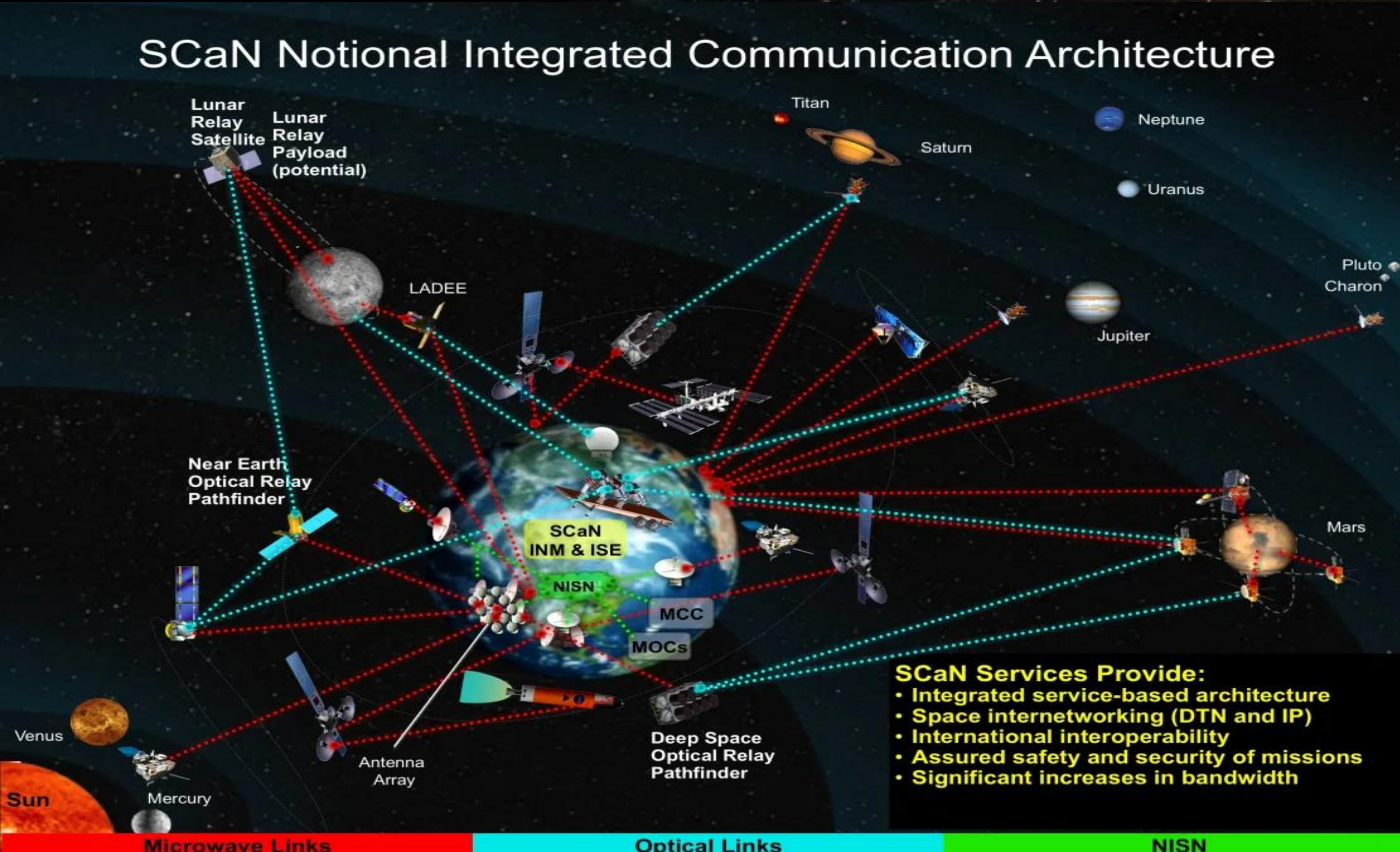
EIMO Roadmap

	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32 (& Beyond)
EIMO	← TIMs → (FY23–FY24) ConOps & Requirements (FY23–FY25)									
Test Environment		Build & Test Federated Labs (FY24–FY26)								
Ground Analog				HERA, CHAPEA (FY26–FY27)						
Flight Analog					Gateway, Artemis (FY27–FY28)					

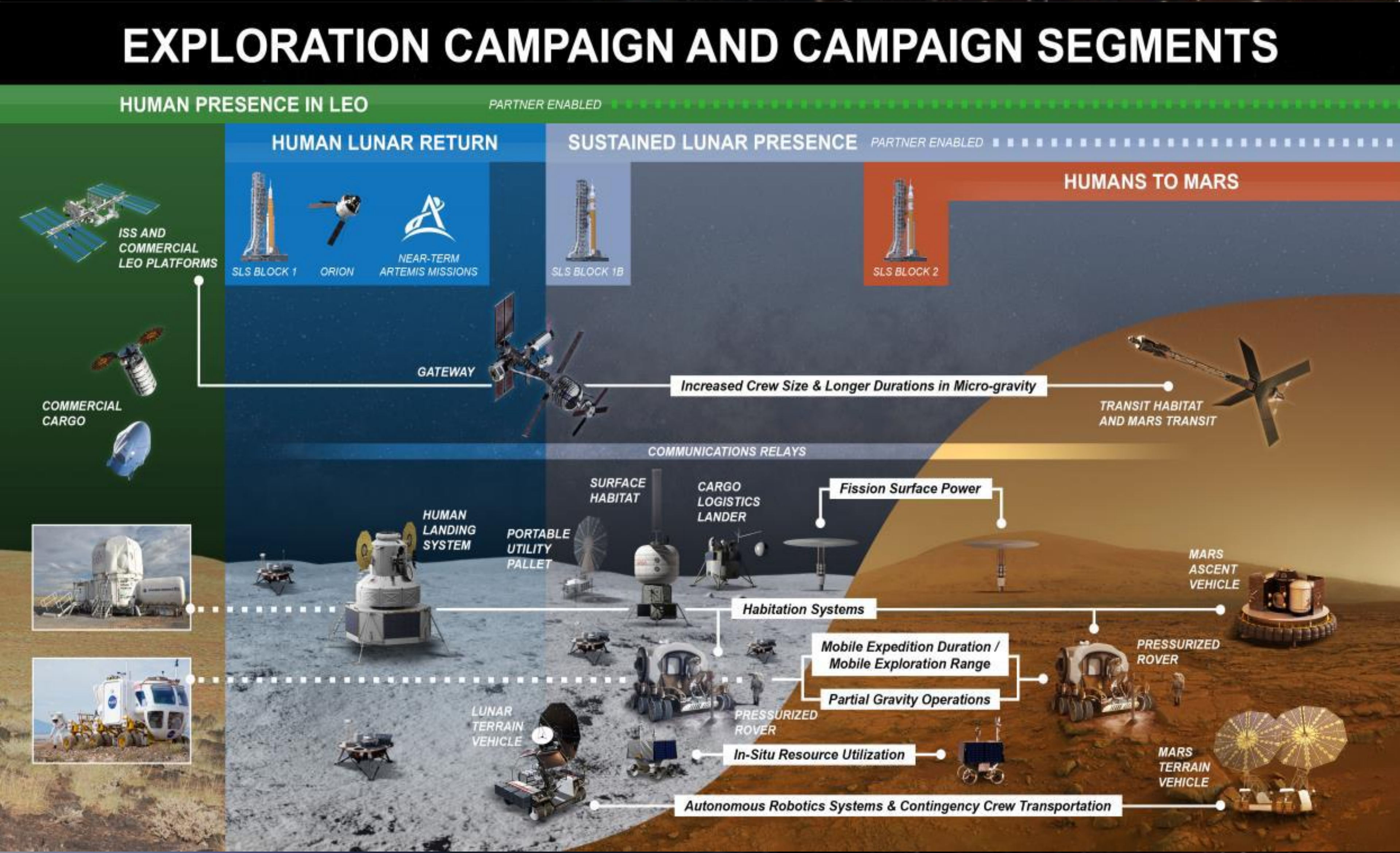
GATEWAY Integrated Spacecraft Configuration



Space Communication and Navigation (SCaN)



Theaters for Exploration



Notional Human Mars Mission Overview

Short Stay, Date-Agnostic (Events = # years before Boots on Mars)