National Aeronautics and Space Administration

NASA Human Research Program's Continue Using of AI Technology to Mitigate Exploration Medical Risk

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Our Vision

To be the pioneering force that seamlessly integrates advanced Artificial Intelligence into the fabric of space operations, empowering space professionals with intelligent tools and unparalleled insights to accelerate discovery, enhance mission success, and unlock new frontiers in space exploration and utilization.

We are not just testing technology...
we are building the digital infrastructure to Mars.

Our Approach

Our approach combines a strong foundation in validated, expert-approved solutions with innovative AI capabilities.

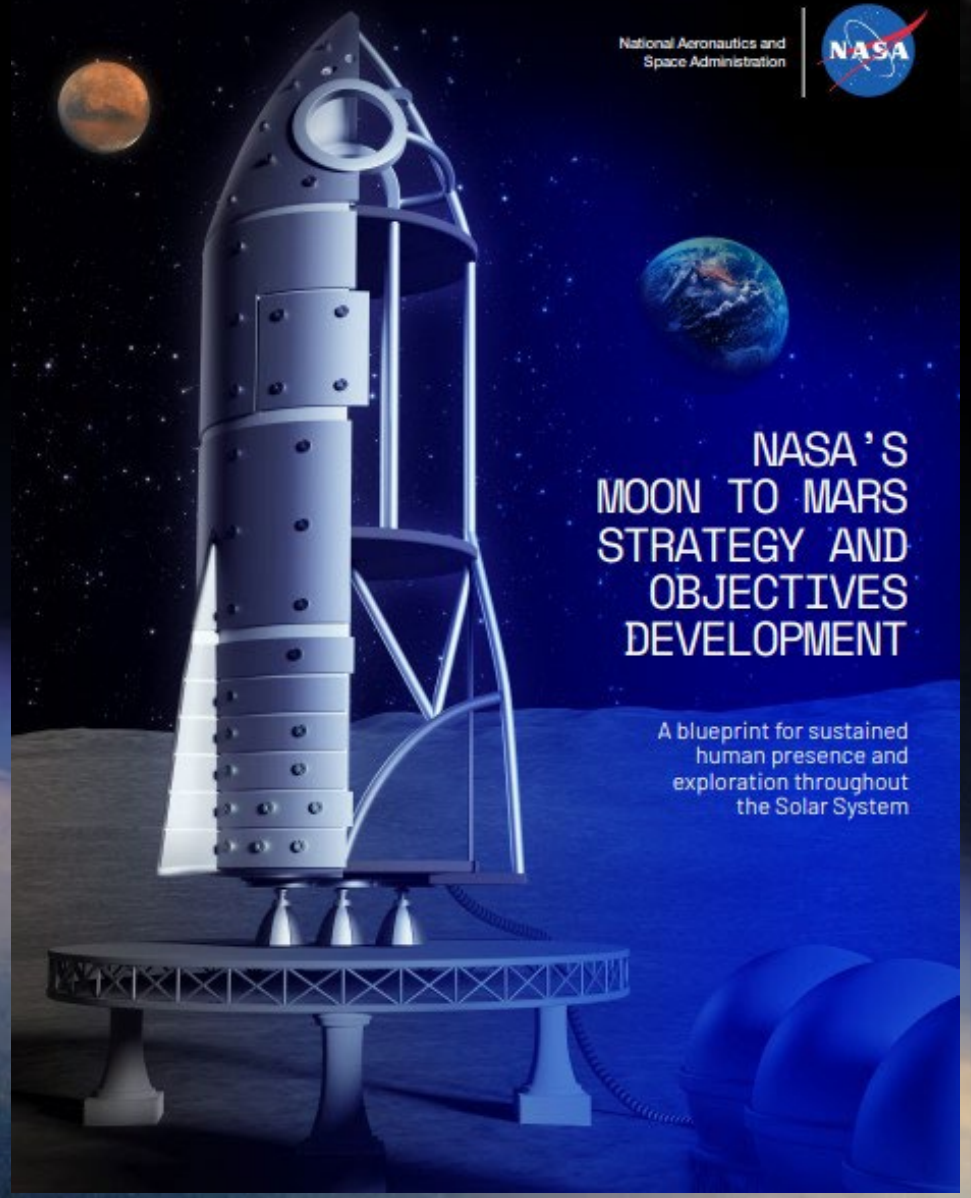
- We **actively use AI models** not only to generate content but also to help customers explore and develop new ideas.
- We **build solutions** that meet high standards of quality and practicality by ensuring SMEs test and approve results.
- We **draw upon past success, failures and achievements** to inform and build solutions for future, groundbreaking missions, including those to the Moon and Mars.
- We **facilitate access to AI models**, making advance intelligence accessible, enabling broader application and problem-solving.

HRP AI Strategy Roadmap

Legend
*Agency infrastructure and tools
**AI Resources (TBD)
*** HHPD AI Resources (TBD)

	Proof of Concept		Foundation Building		Advancing Analytics/Operationalize
	FY24	FY26	FY27	FY28	FY29 – FY30
Strategy	Space Act Agreements (SAA), InterAgency Agreement (IAA)				
Policy/ Agreements	Development of AI Policy/Mgt Plan ***				
	Socialize Earth Independent Medical Ops/ Artemis & Mars Duration Effects on Human Physiology/ Artemis Risk Mitigation for Vehicle Atmospheres, Computational Injury & Anthopometrics Model, Exploration Exercise Countermeasures, Individual Variabilities in Response to Spaceflight, and Sensorimotor Countermeasures				
Culture/ Buy-in	LEADERSHIP AI TIM Initial Outreach with Directorates/ Programs/ Stakeholders				
	AI Data Readiness Initiative – Collaboration with other Agencies (NIH, DoE, DoL, HHS, NSF, etc.)				
	Training – Technical		Training – Culture		Review Data Readiness, Outreach, Training
HRP Infrastructure	Tool Development/ Demos	Identify EIMO/HRP Lab Infrastructure Requirements		HRP Lab Infrastructure	
		Tool - Adv Space Computing w/ Prototype/Resources** Initial AI Experimentation & Incubation/DS & Analytics Resources**		Continued build out of HRP Infrastructure to encompass all key stages of the lifecycle	
	Data Curation (Data Cleaning/ Structuring for more advanced uses)				
Data Engineering	Tools Development/Resources** - Beta rel		AI Generated Dashboard applications *		AI Data Engineering Pipleline/Infrastructure*
		Data Pipeline integration Modeling/Simulation Tool Cap.		Initial HRP Lab, AI Platform and tools*	
	Data Pipleline Synthetic Data Generator	AI Data Engineering Resources**		AI Experimentation & Incubation/ DS & Analytics Resources**	
Foundational Technologies	NASA Cloud/Premise AI Platform Agency: MCP APPDAT/ Insight/ Federate Search to support **CUI SP-HLTH/SP-PRVCY (EMR, IMPALA, LSAH)**				Recommend AI Platform* Recommend Tech Foundation * Recommend COTS
Prototype Solutions	Identify requirements to support prototype	Method Condition from PubMed using AI COTS		COTS - TBD	
		AI Verification/Validation Method /Approaches and Dev Knowledge Graph		Initial integration On-board medical devices	Expand on foundational capabilities to conduct predictive analyses and natural language processing.

How to leverage AI to Accelerate M2M Objectives?



Recurring Tenets

RT-3:	Crew Return: Return crews safely to Earth while mitigating adverse impacts to crew health.
RT-5:	Maintainability and Reuse: When practical, design systems for maintainability, reuse, and/or recycling to support the long-term sustainability of operations and increase Earth independence.

Human and Biological Science (HBS)

HBS-2^{LM}:	Evaluate and validate progressively Earth-independent crew health and performance systems and operations with mission durations representative of Mars-class missions.
HBS-3^{LM}:	Characterize and evaluate how the interaction of exploration systems and the deep space environment affect human health, performance, and space human factors to inform future exploration-class missions.

Transportation and Habitation (TH)

TH-8^{LM}:	Develop systems that monitor and maintain crew health and performance throughout all mission phases, including during communication delays to Earth, and in an environment that does not allow emergency evacuation or terrestrial medical assistance.

Operations (OP)

OP-1^{L}:	Conduct human research and technology demonstrations on the surface of Earth, low-Earth orbit platforms, cislunar platforms, and on the surface of the Moon, to evaluate the effects of extended mission durations on the performance of crew and systems, reduce risk, and shorten the timeframe for system testing and readiness prior to the initial human Mars exploration campaign.
OP-2^{LM}:	Optimize operations, training, and interaction between the team on Earth, crew members on orbit, and a Martian surface team, considering communication delays, autonomy level, and time required for an early return to the Earth.
OP-6^{L}:	Evaluate, understand, and mitigate the impacts on crew health and performance of a long deep space orbital mission, followed by partial gravity surface operations on the Moon.
OP-7^{LM}:	Validate readiness of systems and operations to support crew health and performance for the initial human Mars exploration campaign.

Our AI Focus – Digital Assistants

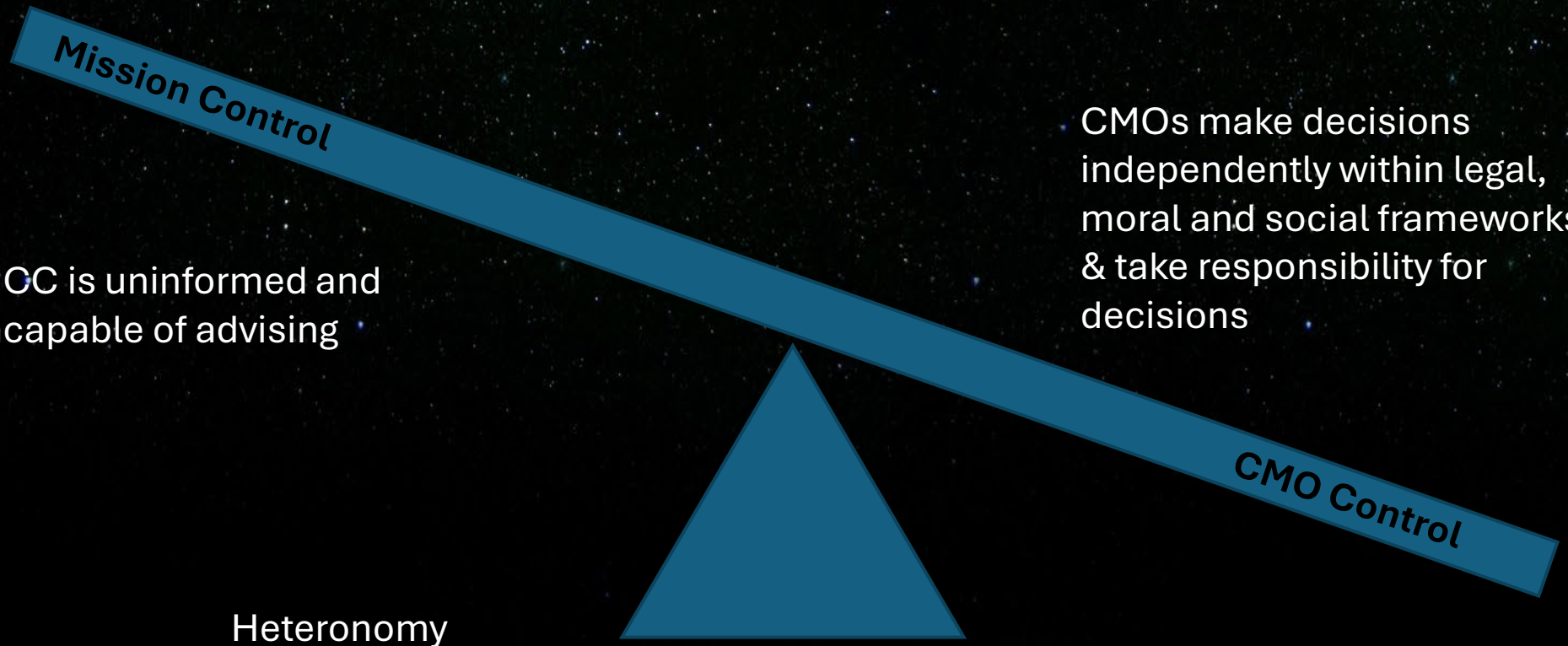
Digital Assistant (DA): a powerful workforce multiplier that consists of collaborative AI agents performing tasks from commands.

Commands can be given through text, voice, or other modes.

DAs leverage artificial intelligence (AI), natural language processing (NLP), machine learning (ML) and computer vision (CV) to take user requests, learn from interactions and provide personalized and accurate responses.

1. **Help mitigate human space flight risk** while moving from LEO to Long Duration Exploration Planetary Missions
2. **Deliver disruptive, game-changing solutions** by enabling autonomous systems
3. **Prioritize high-impact activities** by focusing on high-value technology, tools and resources
4. **Enhance decision-making, mission planning and execution processes** within a demanding space-related environment

Total Autonomy (Comms Blackout)



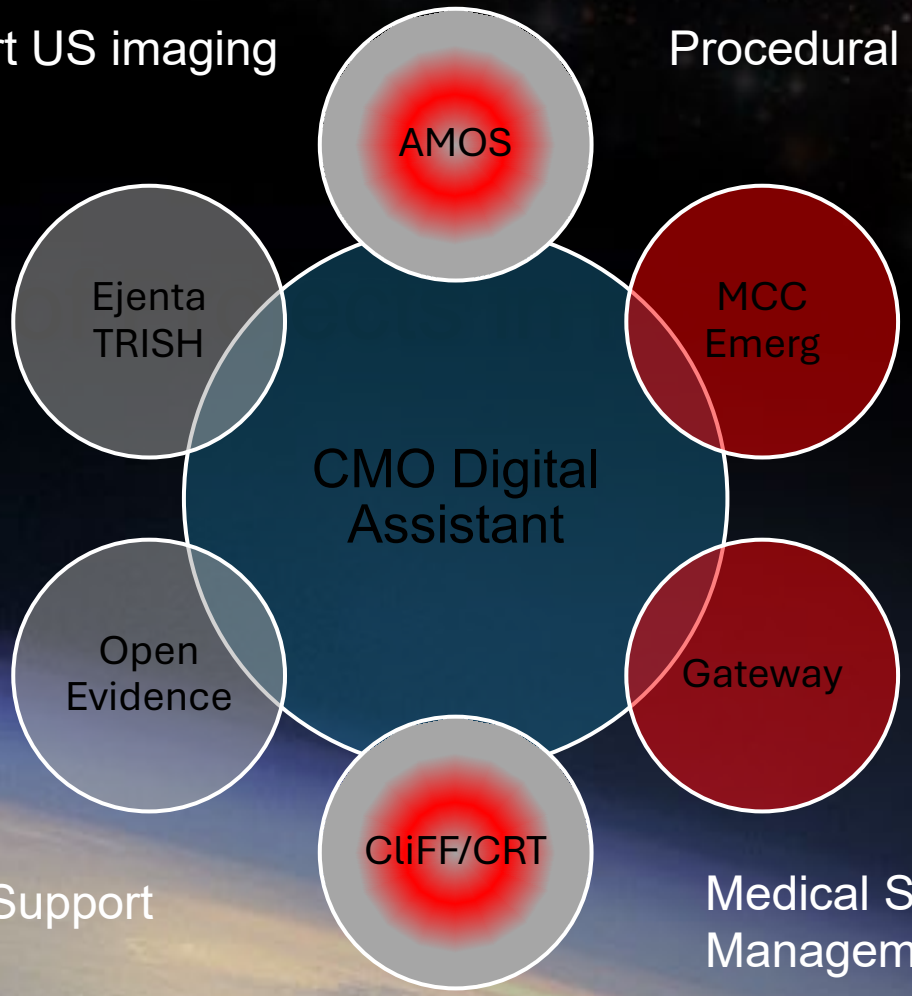
MCC is uninformed and incapable of advising

CMOs make decisions independently within legal, moral and social frameworks & take responsibility for decisions

Heteronomy

Autonomy

Interoperability of Projects in Portfolio



Diagnostic support US imaging

Procedural support US imaging

Multi-vector data streams

Procedural support & situational awareness (Emergency)

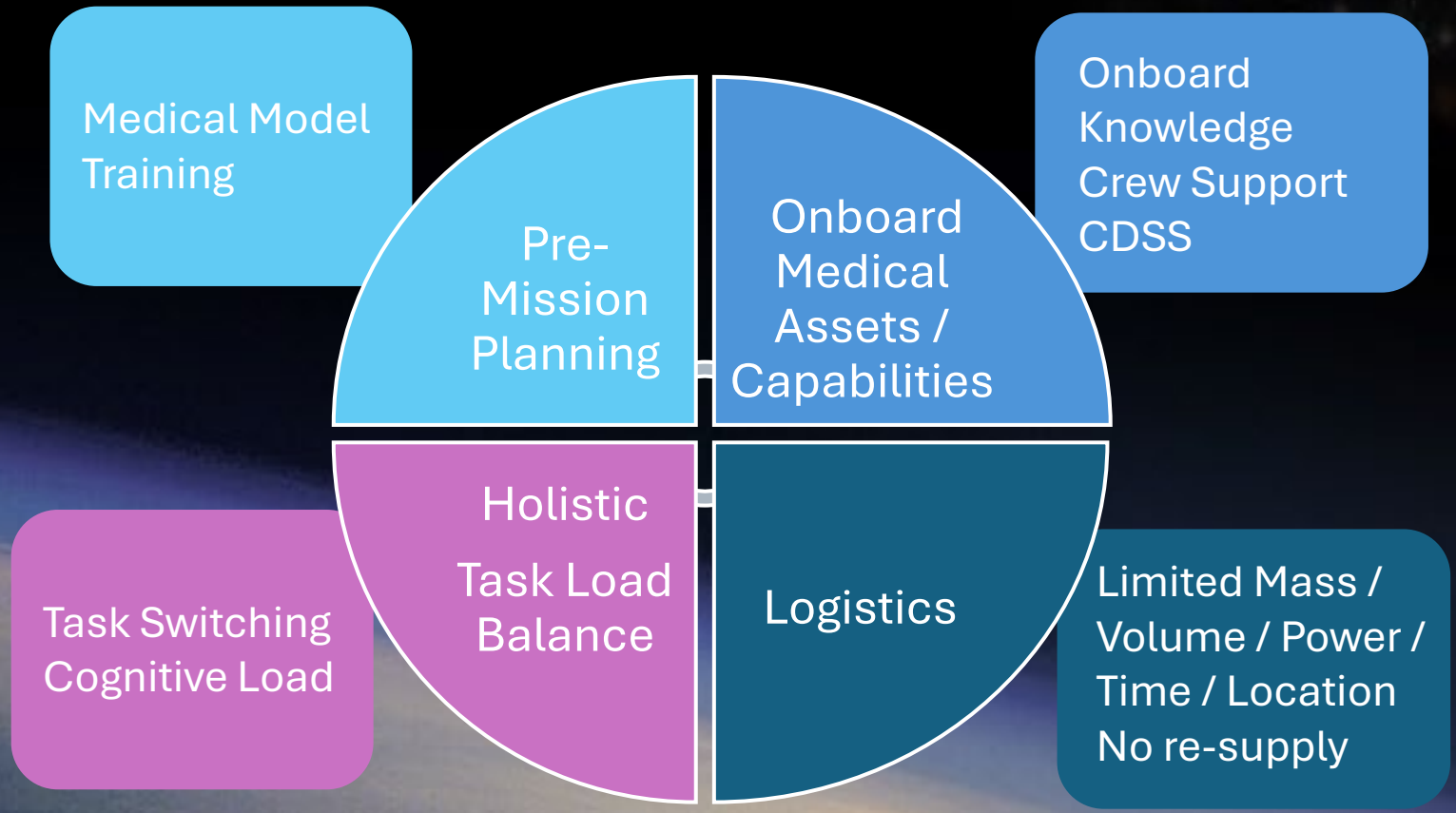
Knowledge/Evidence Base

ECLSS situational awareness (pCO2, pO2, RH, Temp)

Clinical Decision Support

Medical Supply & Resource Management

Four Earth Independent - DA Features



- **Earth Independent Operations**
  - Paradigm Shift Critical for Success
  - Leverage Artificial Intelligence Methods/Tools
  - Logistics
  - Simulations
- **Clinical Decision Support System (CDSS)**
  - Serious Constraints on Data Transmission
  - Expanding on-board (wearable) informatics
  - Integrate Training
  - Task Load Balancing
- **Large Language Model Development**
  - Utilize Open-Source Models
  - Strong Industry Partners (Google, Microsoft, UpToDate, HP/RedHat)
  - Quantify Performance (OSCE's)
  - Containerize model for use at the "Edge"

Earth Independent Medical Operations: FY25

Crew Medical Officer Digital Assistant

LLM AGENTS

Nurse

Lab Tech

Imaging

Manager

Behavior Health

KERWIN

SANS/ OCT

EJENTA

Microsoft AI

Teams of AI Agents

Google AI

AMOS

MISSION CONTROL

Flight Surgeon Digital Assistant
Bio-Medical Engineer Digital Assistant

Earth Independent Medical Operations: FY26

LLM AGENTS

Crew Medical Officer Digital Assistant

Nurse

Lab Tech

Imaging

Manager

Behavior Health

KERWIN

SANS/ OCT

Teams of AI Agents

KINTSUGI

AMOS

ESA EWW

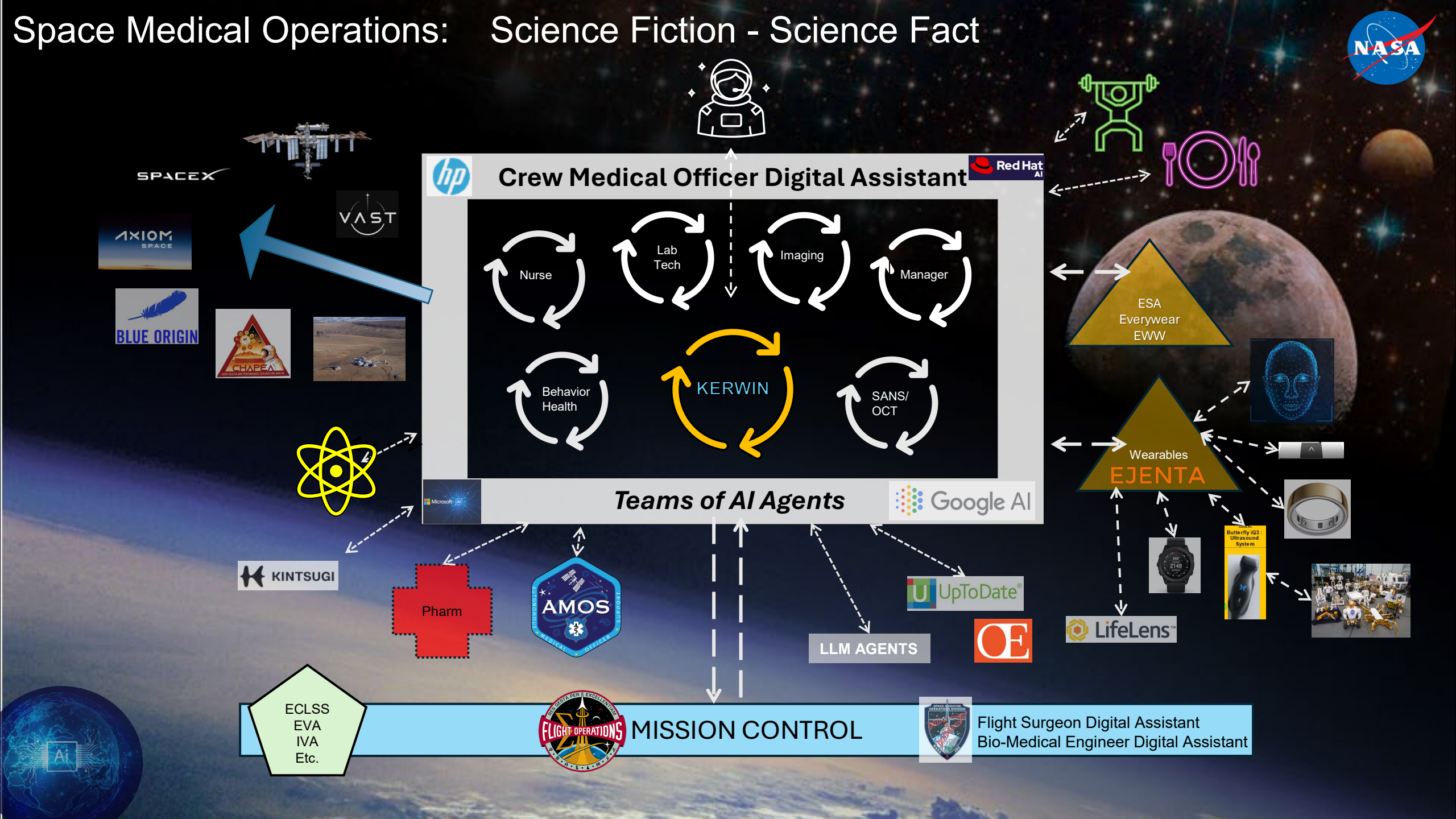
EJENTA

LifeLens

MISSION CONTROL

Flight Surgeon Digital Assistant
Bio-Medical Engineer Digital Assistant

Space Medical Operations: Science Fiction - Science Fact



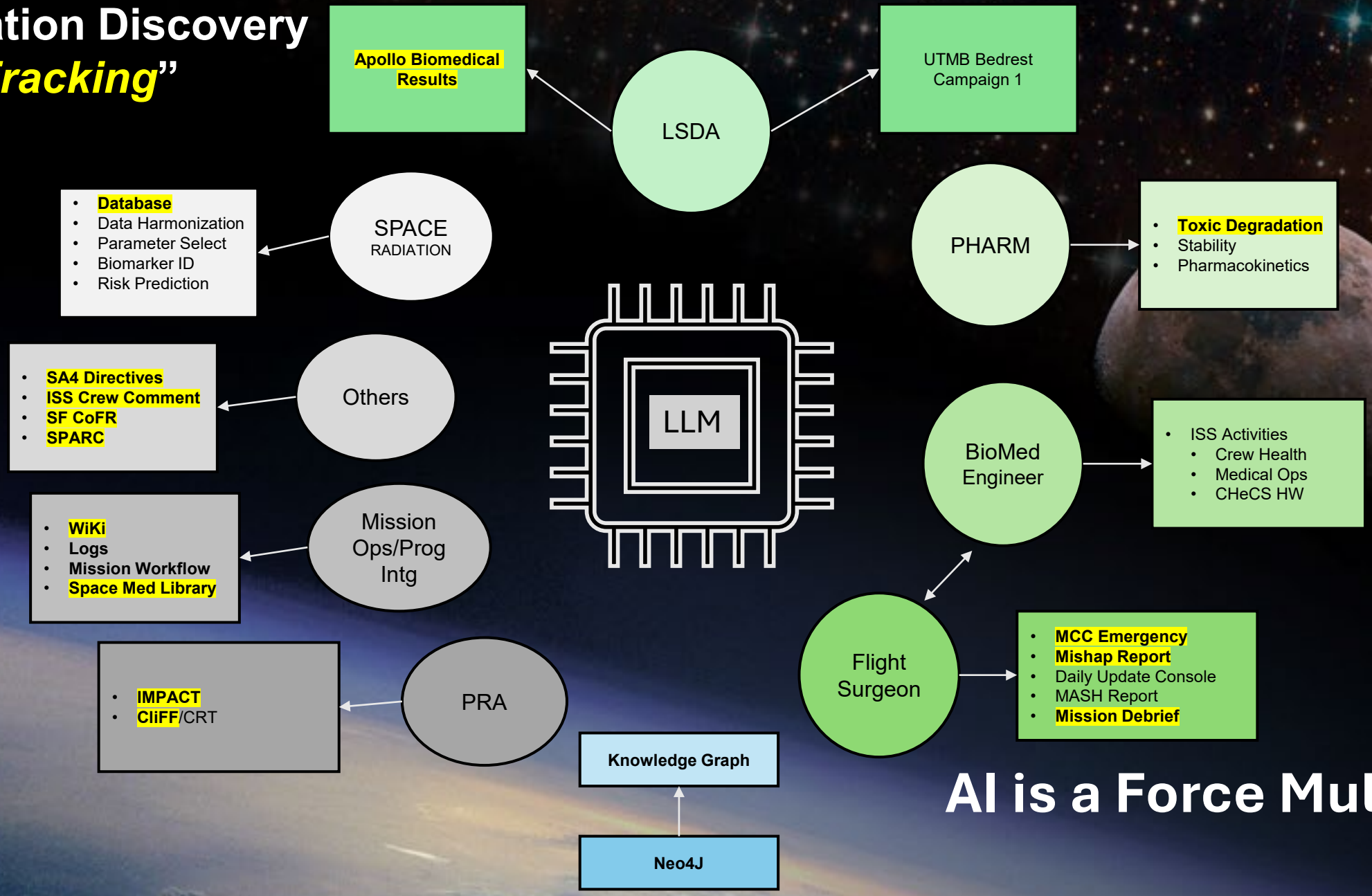
Our AI Focus – Document Solutions

AI Document Solutions, also known as Data Fracking, encompass software and methodologies that utilize artificial intelligence to automate, improve, and optimize document-related processes.

The core purpose of an AI document solution is to deliver valuable insights by making data-reliant tasks more efficient and accurate.

1. **Document Generation** **"Help me create a document"** Leverage enterprise data and advanced natural language processing (NLP) models to create documents
2. **Intelligent Document Processing** **"Help me process documents"** Capture, transform, and process documents with disparate file formatting
3. **Intelligent Search** **"Help me find something in documents"** Search and retrieve relevant information
4. **Process Transformation** **"Help me do things better"** Harness AI to accelerate, innovate and improve existing processes
5. **Digital Mining** **"Help me find correlations"** Identify trends and patterns to improve my work

Information Discovery
"*Data Fracking*"

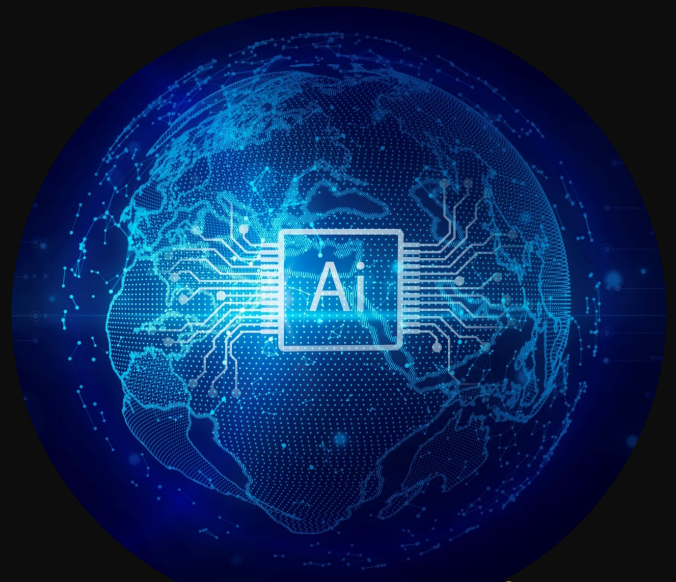


AI is a Force Multiplier

Our Accomplishments and Delivery

Digital Assistants

- Crew Medical Officer (CMO-DA) *Real time demo of working prototype in the SVMF to leadership NASA stakeholders*
- Flight Surgeon (FS-DA) *Working Prototype*
- BioMedical Engineering (BME-DA) *in Proof of Concept*
- Contracting Officer Representative (COR-DA) *in Proof of Concept*



Document Solutions/Fracking

- Clinical Finding Form (CLIFFs) *Multiple Working Prototypes*
- MCO ConOps *Working Prototype*
- Space Radiation *Working Prototype*
- Microfiche Conversion *Working Prototype*
- Apollo BioMed chart conversion *in Proof of Concept*
- Mishap *Coming Soon*
- Significant Incidents *Coming Soon*
- Close Calls *Coming Soon*
- ISS MCC Debrief Tool *Coming Soon*

Data Collections/Curations

- 24 searchable libraries (NTRS, Space Medicine Library, IMPACT,CLiFFs, Hall Library, IMM, MEDPRAT, NASA Procedures, SPARC, NODIS, Space Radiation, Apollo, NIST, HLS, OSDR, EIMO, M2M, MCO, LSAH, CDS, etc.)

Our Collaborators and Contributors

Internal

OCHMO, Med Ops, LSAH, Human Risks, Human Sys Eng&Int, TRISH, MCO, FOD, CAIO, OCIO (HQ, JSC, KSC, LaRC), JSC Engineering (LuCCI, Robotics), JSC SM&A, KSC Med and Env, Multi-Media and PAO (HQ, JSC, LaRC)

External - *Leveraging industry leaders to deliver "Game-Changing" solutions.*

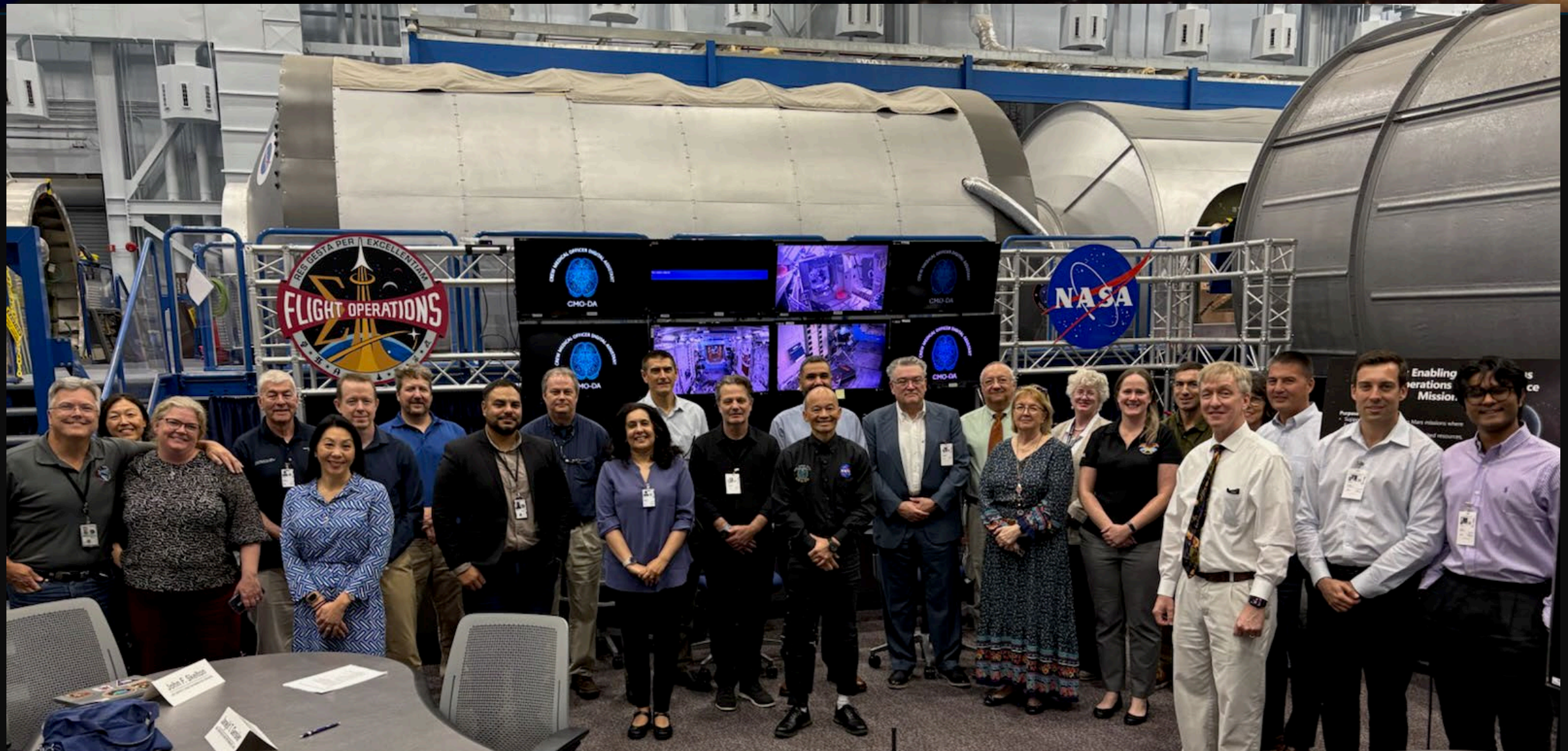
Google AI, Microsoft AI, HPE- ISS Spaceborne, RedHat, LifeLens, Oura Ring, DOD/DOW, DHA, DUPRA, VA, WRAIR, TATRC, TRISH/Ejenta

Strategies/Agreements

Multiple Interagency Agreements (IAA) and Space Act Agreement (SAA)

Crew Medical Officer Digital Assistant (CMO-DA)

Real-time Simulation - Enabling Autonomous Medical Operations



Key Takeaways that Deliver Stakeholder Wins

- Turning science fiction into science fact
- Amplifying human capabilities - enabling faster, smarter, and scalable decisions
- “Bringing AI closer to home” - AI analysis happens right where the data is collected
- Understanding the governance and stewardship of AI adoption
- Developing solid shoulder to shoulder relationships with stellar tech companies (Google, Microsoft, HPE Spaceborne/Redhat, TRISH/Ejenta, NVIDIA)
- Recognizing the vital contribution of early Subject Matter Expert (SME) engagement
- Fail forward. Learn. Succeed

The AI Renaissance is fundamentally reshaping everything

What's Next for HRP-SIO AI Team?

- Support uniquely difficult and ambitious mission endeavors by enabling NASA to extract maximum value from its operational data. This will be achieved creating capability-focused data repositories that improve knowledge discovery, making them searchable through natural language or advanced AI modeling. Access to these extraordinary data sources will be provided using both COTS or custom AI components.

- Commit to confronting complex challenges and delivering trusted solutions for spaceflight or ground operations. The team will search for, and work with, SMEs to achieve mission support objectives.

- Foster customer confidence and acceptance by understanding their needs and consistently delivering valuable, reliable and dependable results.

- Create a challenging and trusted work environment in which team members feel supported, encouraged and valued for contributions made… not only for the team, but for the mission.

We will never stop listening to the data

Core Team

Truong Le, HRP AI Strategist, MS Industrial Engineer – Operational Research with 35+ years software development - 7 years in AI and 15 years in Data Management

Joe Schmid, NASA Flight Surgeon, Lead Medical Operations Orion/Artemis2, CMO-DA Medical Director, First Human Holoported to Space 2021

Ali Al, Lead AI Specialist/Software Engineer, BS Computer Engineering with 13 years software development, 5 years NASA

Aaron Sells, AI Specialist/Software Engineer, BS/MS Computer Engineering, 19+ years in flight software development NASA

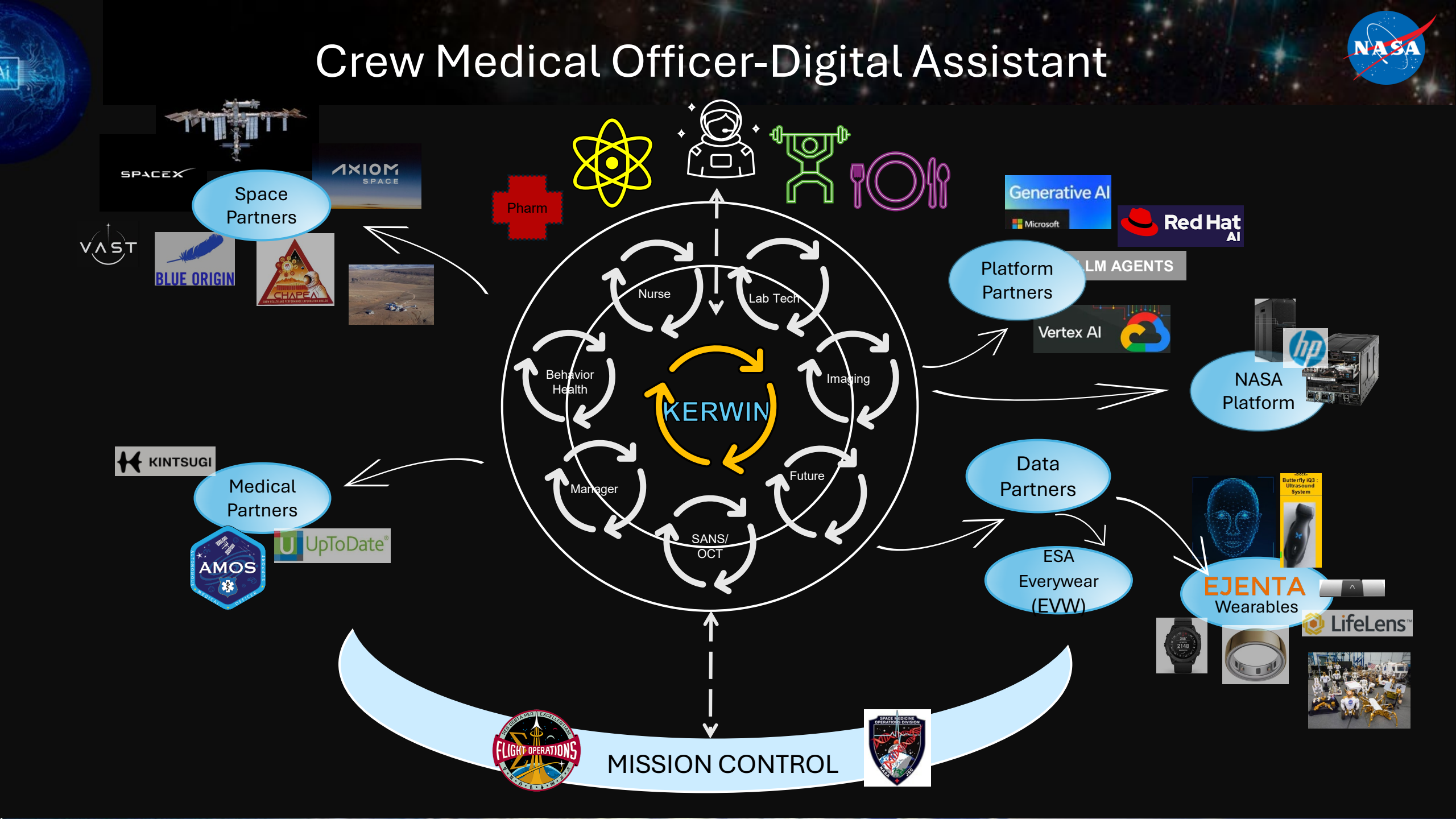
Abul Chowdhury, Lead Software Engineer, 25+ Years at NASA. Specializing in robust, enterprise-grade development.

Carlos De Los Santos, Computer Engineer in Aerospace Technology, BS Electrical Engineering, MS Systems Engineering, 30+ years of Systems Engineering & Integration experience

Maribeth Carpenter, Project Management Azure DevOps, BS Psychology/Computer Science, MBA, 35+ years Operational Project Mgmt, patent in operational behavioral analytics

Backup

Crew Medical Officer-Digital Assistant



NASA Trustworthy AI Principles

Accountably Managed

AI systems shall be trained about AI's nature, realities, and risks on current, accessible, and unbiased materials.

Beneficent

Be lawful, inclusive, equity advancing, privacy protecting, intellectual property rights respecting, having minimized biased among humankinds, and supportive of the wellbeing of the environment and persons present and future

Scientifically and Technically Robust

Meet or exceed the highest levels of rigor and completeness in its design, development, and deployment, must be made in keeping with the optimized use of the scientific method including being replicable, reproduceable, and sound, and must be accurate, precise, and reliable in its functioning

Safe and Secure

AI systems must respect privacy and do no harm. Humans must monitor and guide machine learning processes. AI system risk tradeoffs must be considered when determining benefit of use

Intentional

AI systems must include considerations regarding how to treat people, including refining solutions to mitigate discrimination and bias, and preventing covert manipulation.

Transparent and Understandable

NASA AI models/systems must shall be transparent in its design, development, deployment, and functioning, especially regarding personal data use

Data Collection and Libraries

Current

- Apollo
- CLiFFs
- CoFR
- CDS
- EIMO
- ExMC
- IMM
- Hall Library
- HLS
- IMPACT
- Lockdowns
- MCO
- MEDPRAT

Current

- M2M
- NASA Lessons Learned
- NASA Standards
- NIST
- NODIS
- NTRS
- OSDR
- Space Med Library
- SPARC
- Space Radiation
- Whitelist

Future

- EDS
- FEDS
- *GMIP - ARC
- LSAH
- POWRS
- *PRACA – ARC PART/CPPRACA
- QARC
- SAL
- TRaCM
- eGCAR
- Mission Debriefs
- SPARC DAGS
- HSRB