



The Role of AI in JSC Engineering

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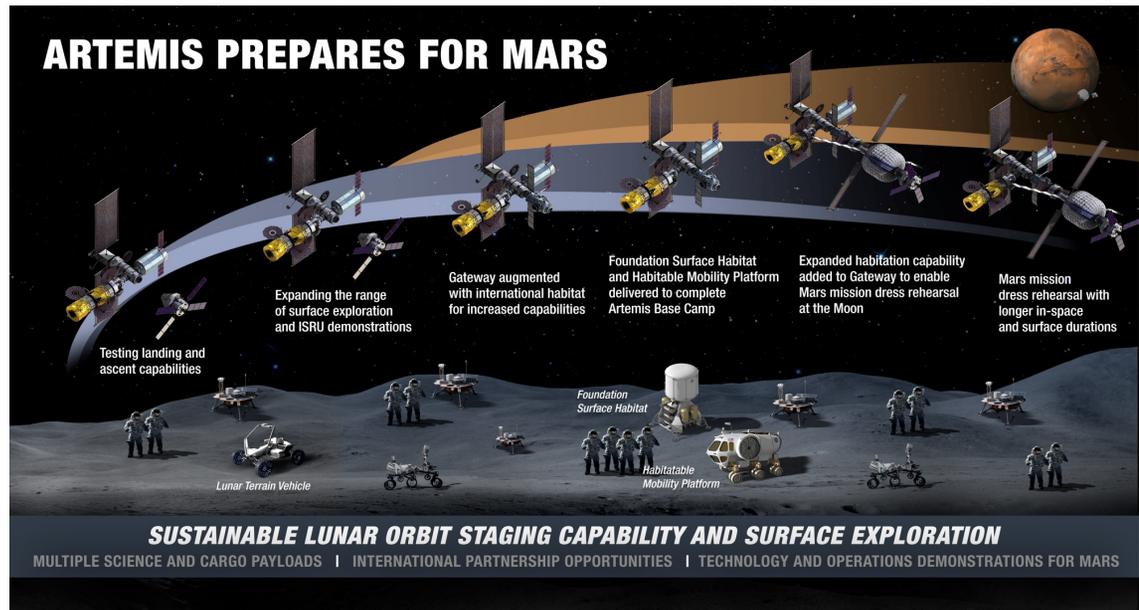
NASA / JSC



Introduction



- NASA Human Spaceflight Program has always been pushing the technology boundary and extending human space travel beyond LEO.
- AI is changing the game like never before.
 - Process vast amounts of data
 - Learn from experience
 - Make critical decision in microseconds.
- Current AI advancements in human space exploration
- Emerging AI technologies in facilitating and enhancing human efforts to explore missions





AI/ML Capabilities and Interests within JSC Engineering



- **Digital Assistants**
 - Console Operations, System Manager Support, Test Conductor, etc.
- **Software Development & Testing**
 - Automated software testing and bug identification
 - Automated test case generation from specifications
 - NASA NPR and Software Engineer Handbook compliance checking
 - Identification of redundant, conflicting, or incomplete specifications
- **Data Analysis & Predictive Systems**
 - Real-time anomaly identification in system telemetry
 - Operational anomaly classification with explainable AI
 - Temporal pattern recognition and forecasting
 - Component failure prediction and maintenance scheduling
 - Remaining useful life estimation of critical components
- **Computer Vision & Object Recognition**
 - Camera-based position and orientation detection
 - Real-time tracking of objects and people
 - EVA tools and ISS/EVA instruments identification
 - Medical instruments and human anatomy recognition
 - Geological feature classification



AI/ML Capabilities and Interests within JSC Engineering



- **Training & Procedure Development**
 - Automated procedure development from historical data
 - Task sequence enhancement and optimization
 - Context-aware instruction generation
 - Creation of procedures from video content
 - Procedural generation of 3D objects for XR applications
- **Human Performance & Interface Systems**
 - Biometric-based cognitive state determination
 - Trainee engagement level monitoring
 - Brain Computer Interface (BCI) capabilities
 - Natural communication interfaces for human-robot interaction
- **Structural & Mechanical Engineering**
 - Structural design algorithms
 - Multi-objective optimization for weight and performance
 - Vibration analysis for early failure detection
 - Acoustic signature and thermal anomaly monitoring



AI/ML Capabilities and Interests within JSC Engineering



- **Materials Engineering**
 - Corrosion issue identification and classification
 - Multi-agency learning database for metallic corrosion
 - Material property prediction and optimization
- **Life Support Systems**
 - Environmental parameter monitoring (temperature, pressure, oxygen, CO2)
 - Automated parameter adjustment and optimization
 - System degradation monitoring and early warning systems
 - Resource management and consumable usage optimization
- **Navigation & Flight Systems**
 - Flight path optimization for fuel efficiency and safety
 - Real-time trajectory adjustments
 - Hazard detection for landers and rovers
 - Terrain feature classification and path planning
- **Robotics & Autonomous Systems**
 - Self-directed task execution with decision-making algorithms
 - Operational boundary recognition
 - Obstacle recognition and navigation plan



AI Community Connections



- **Agency Wide Engineering Working Group**
 - NASA HQ AI Leadership is sponsoring the group
 - Will be chaired along with HQ for Agency wide AI Initiatives
 - Focus on Engineering specific activities

- **Other JSC Partnerships in work**
 - Flight Operations Directorate (FOD) – Use of our MERAIDA application in the control center
 - Human Performance Directorate – Development of a Medical Assistant



Flight Software Mission Evaluation Room AI Digital Assistant (MERAIDA)



OBJECTIVE:

To provide fault diagnosis, troubleshooting, decision-making support for the Flight Software Mission Evaluation Room (FSW-MER) console operators

SOLUTION SELECTED:

Use A.I. capabilities to develop a digital assistant that has access to various Orion information sources, understands user queries, provides quick, accurate information retrieval to support the decision-making process



Mission Control Center



MER AI Digital Assistant Team (MERAIDA)

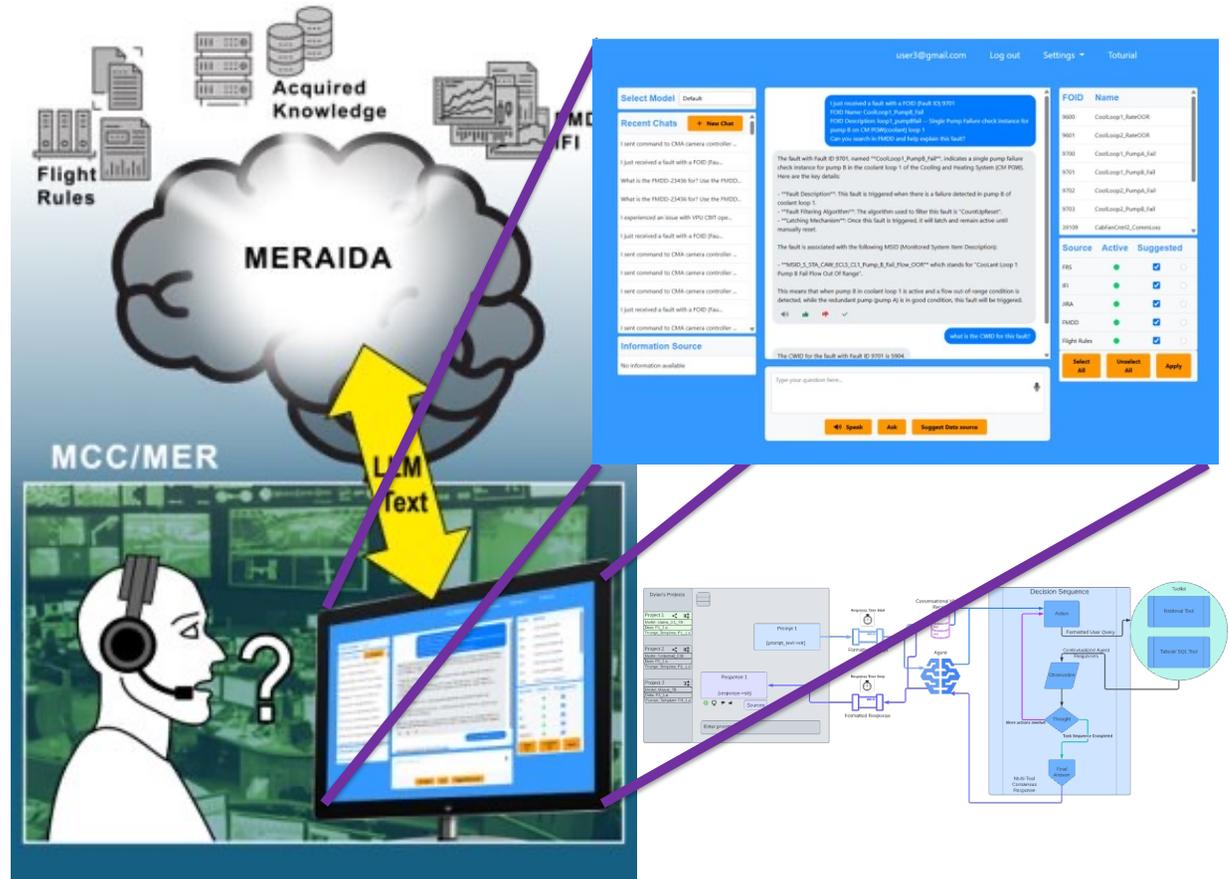




Mission Evaluation Room - Artificial Intelligence Digital Assistant (MERAIDA)

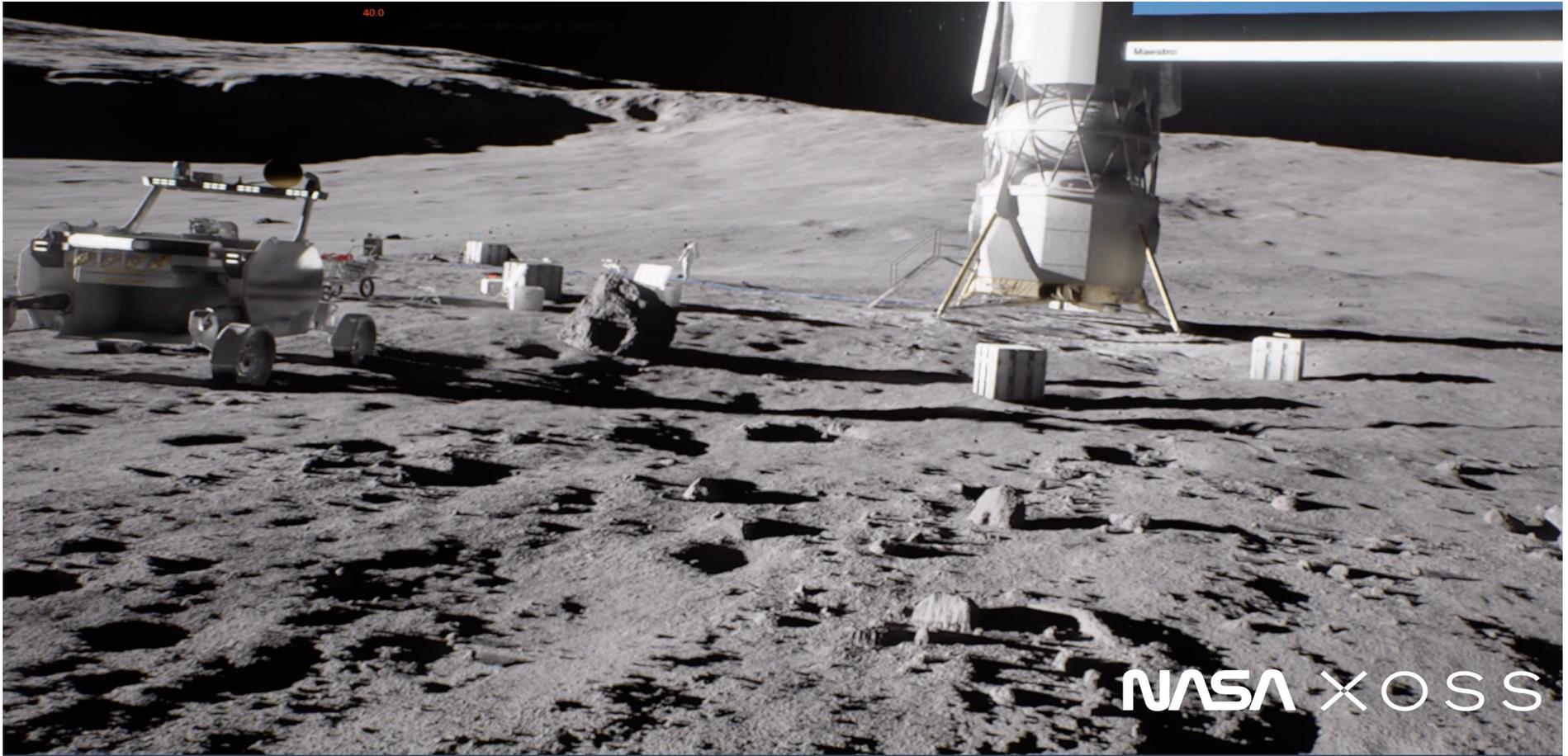


- **Goals:** Develop a digital assistant in the Mission Evaluation Room (MER) that provides support to ingest fault data from Orion and support the decision-making processes
- **Techniques:**
 - Use multiple LLMs that specializing in sentence analysis, multimodal data retrieval and summarization.
 - Vectorize Orion specific content (Flight Rules, Jira Record, IFI Records, FMDD and etc.)
 - Unique architecture & prompt engineering to allow scope control and visibility of information sources
 - Work locally to be independent from the Cloud





Emerging AI Applications for Lunar Surface Operations



NASA X OSS