DOC-IN-A BOX: ADAPTATION AND FINE TUNING OF AN OPEN-SOURCE LARGE LANGUAGE MODEL TO SUPPORT AUTONOMOUS MEDICAL OPERATIONS

Human Research Program
Science Integration Office

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Martin Garcia[1], Giovanni Marchetti[2], Ali Al[3], Jay Lemery[4,5]

[1] NASA Johnson Space Center, Houston, TX.
[2] Google, Inc.
[3] KBR, Inc., Houston, TX.
[4] University of Colorado School of Medicine, Boulder CO.
[5] IPA, NASA Johnson Space Center, Houston, TX.

"Expanding the Boundaries of Space Medicine and Technology"

Disclosure Information

2025 AsMA-UHMS Annual Scientific Meeting

I will not discuss off-label use and/or investigational use in my presentation

I have no relevant financial relationships to disclose.

Agenda

- Background
- Objective
- Approach
- Challenges and Limitations
- Lessons Learned

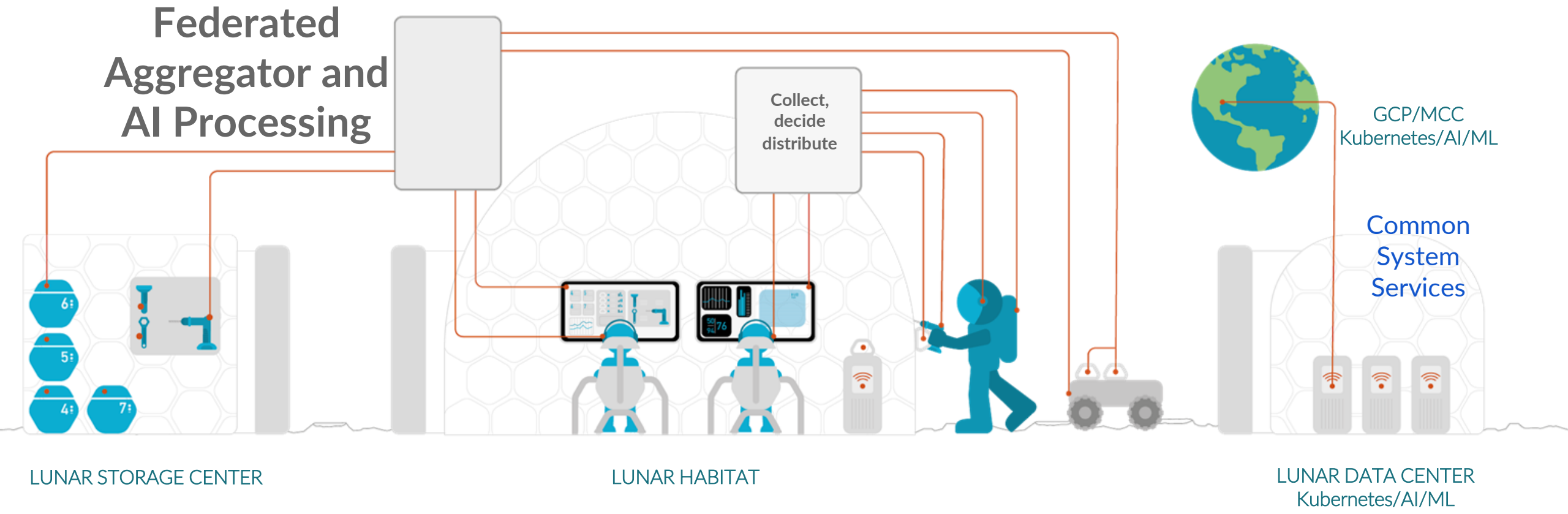
Background

EIMO Constituent Components

- **Earth Independent Medical Operations (EIMO)**
  - Paradigm Shift Critical for Success
  - Leverage Artificial Intelligence Methods/Tools
- **Clinical Decision Support System**
  - Serious Constraints on Data Transmission
  - Expanding on-board (wearable) informatics
  - Integrate Training
  - Management of Medical Supplies & Resources
  - Task Load Balancing
- **Large Language Model Development**
  - Utilize Open-Source Models
  - Strong Industry Partners (Space Act Agreements)
  - Quantify Performance (OSCE's)
  - Containerize model for use at the "Edge"

Lunar Command & Control Interoperability (LuCCI)

Extend the power of the cloud to surface systems

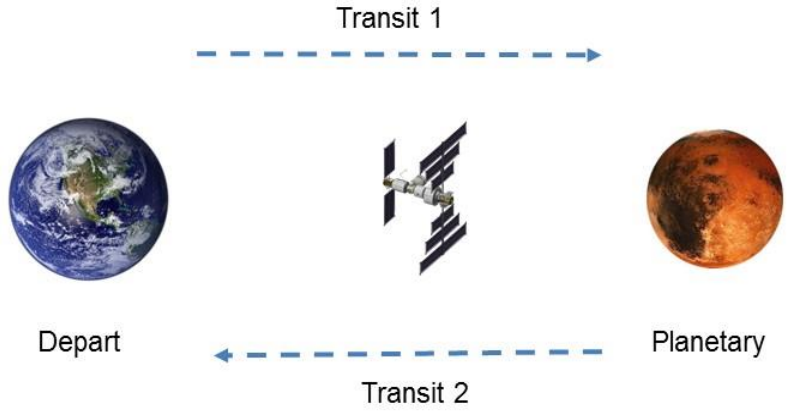


The LuCCI prototype will extend the open sourced capabilities of the Cloud onto remote isolated locations like the lunar surface to define a loosely coupled, hardware independent, highly automated hosting platform

Objective

To develop and test a multi-modal, agentic artificial intelligence system to support Crew Medical Officer decision-making in autonomous environments enabling Earth Independent Medical Operations.

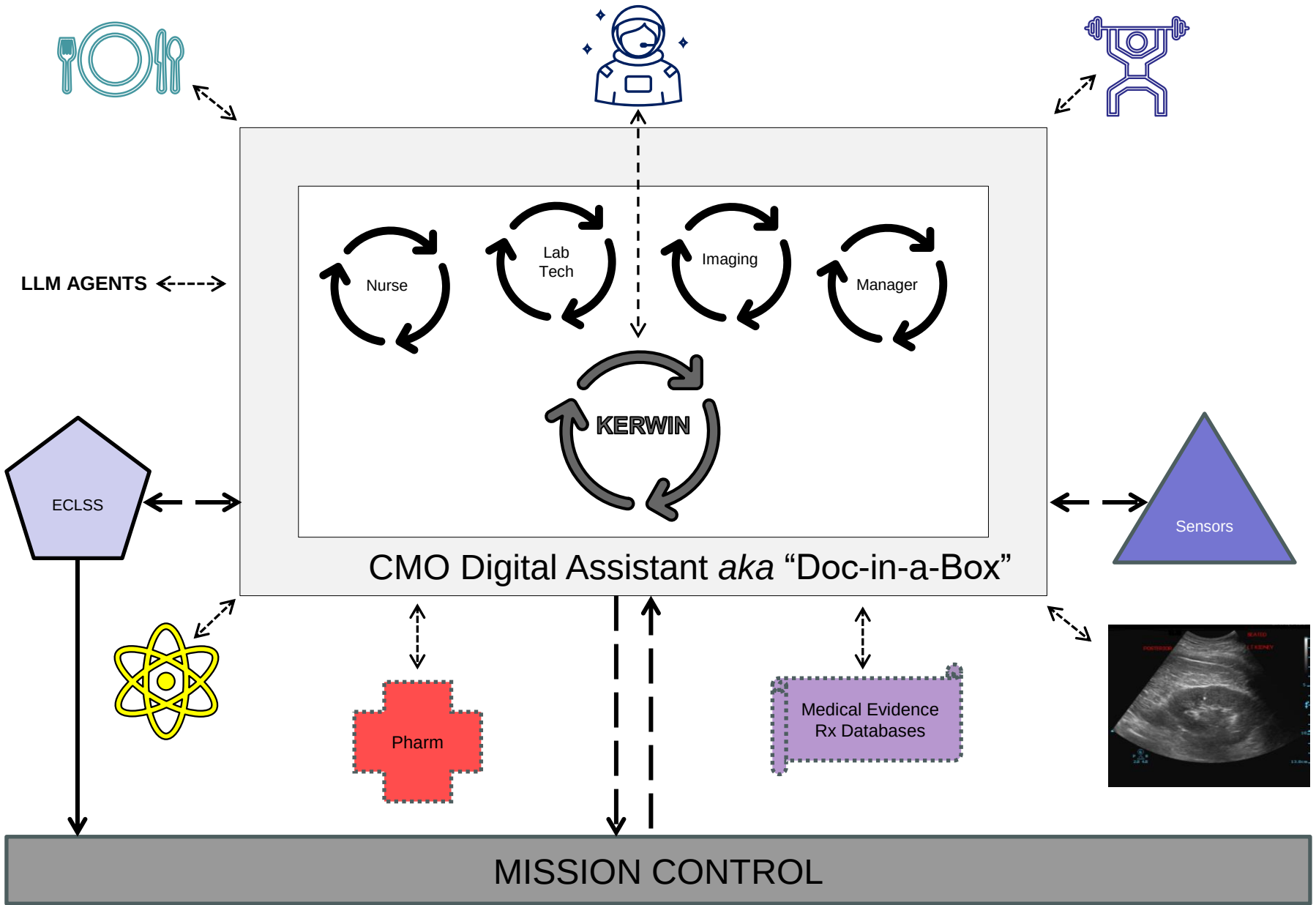
Why is this necessary?



Medical System Data Types

- Vital signs, images (*e.g.,* ultrasound), notes, labs, etc.
- Cabin atmospheric parameters, water and air monitoring, radiation, exercise performance, exercise device parameters, nutrition

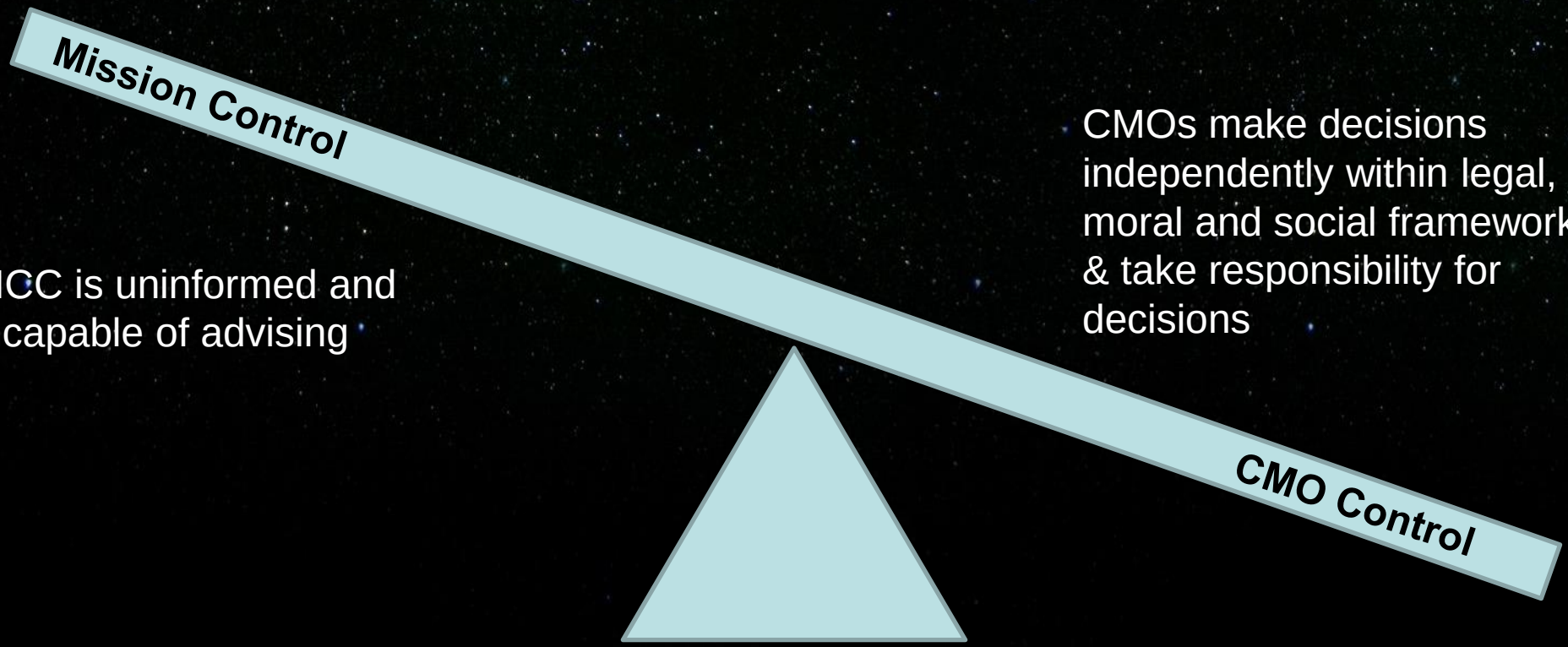
Approach


LLM AGENTS
Nurse
Lab Tech
Imaging
Manager
KERWIN
CMO Digital Assistant *aka* “Doc-in-a-Box”
ECLSS
Sensors
Pharm
Medical Evidence
Rx Databases
MISSION CONTROL

Challenges and Limitations

- **How to make LLM be operable at the Edge**
  - OpenBio 70B parameter model ⇒ Mistral 24B model
  - Add interactive voice capability, image processing
- **Ruggedized, portable HPE Edgeline EL8000 Converged Edge System**
  - Interoperability with Spaceborne Computer 3 (SBC-3) hardware specification
  - Augmented with GPU compute (NVIDIA A100 AI accelerator)
- **Provides on-premise cloud computing capabilities**
  - Container hosting (via RedHat OpenShift)
  - Managed AIML workloads (via RedHat OpenShift Data Science)
  - IoT Platform stack
- **Use cases include:**
  - Secure IoT applications utilizing data not rated for cloud platforms
  - Hosting containerized applications
  - Lunar surface system integration and test / LuCCI
- **Funded by NASA Digital Transformation**

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

Lessons Learned

- Modest sized LLM's perform quite well, providing accurate, concise answers without hallucinations
- Validation of performance using OSCE's with 77-88% accuracy *vs*. physician
- Agentic structure provides a high performing, scalable architecture

Questions?