Medical Data Architecture Platform And Recommended Requirements For A Medical Data System For Exploration Missions

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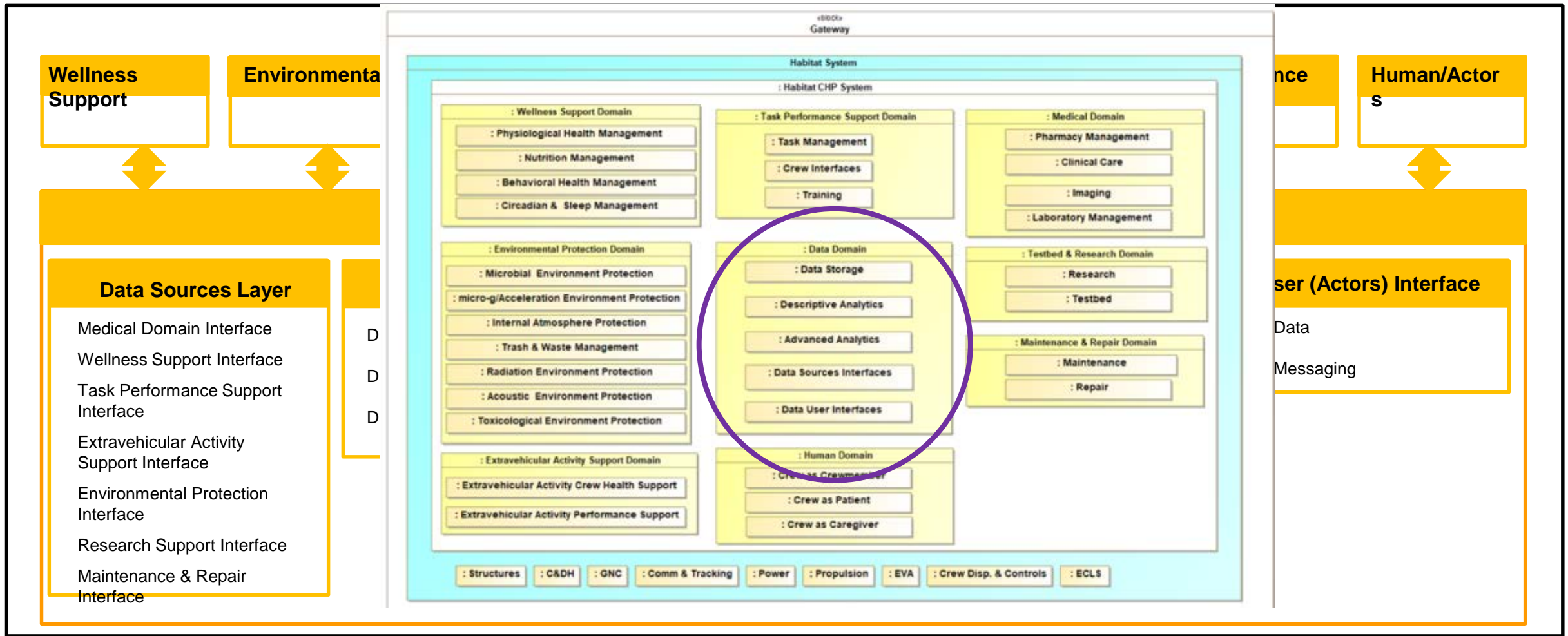**2020 NASA Human Research Program Investigators' Workshop**

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MDA Background

- ExMC seeks to reduce the risk of adverse health outcomes and decrements in performance due to inflight medical conditions.

- The Medical Data Architecture project core focus has been to inform exploration system requirements through prototype platform development that emphasized data collection, management and processing.

- Going forward, the MDA project will focus on expanding the MDA platform to enable advanced capabilities for greater understanding of health and performance that enables crew self-reliance.

Wellness Support

Environmental

 nce

Human/Actors

Data Sources Layer

Medical Domain Interface

Wellness Support Interface

Task Performance Support Interface

Extravehicular Activity Support Interface

Environmental Protection Interface

Research Support Interface

Maintenance & Repair Interface

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ser (Actors) Interface

Data

Messaging

Gateway — Habitat System — Habitat CHP System

: Wellness Support Domain
- : Physiological Health Management
- : Nutrition Management
- : Behavioral Health Management
- : Circadian & Sleep Management

: Task Performance Support Domain
- : Task Management
- : Crew Interfaces
- : Training

: Medical Domain
- : Pharmacy Management
- : Clinical Care
- : Imaging
- : Laboratory Management

: Environmental Protection Domain
- : Microbial Environment Protection
- : micro-g/Acceleration Environment Protection
- : Internal Atmosphere Protection
- : Trash & Waste Management
- : Radiation Environment Protection
- : Acoustic Environment Protection
- : Toxicological Environment Protection

: Data Domain
- : Data Storage
- : Descriptive Analytics
- : Advanced Analytics
- : Data Sources Interfaces
- : Data User Interfaces

: Testbed & Research Domain
- : Research
- : Testbed

: Maintenance & Repair Domain
- : Maintenance
- : Repair

: Extravehicular Activity Support Domain
- : Extravehicular Activity Crew Health Support
- : Extravehicular Activity Performance Support

: Human Domain
- : Crew as Crewmember
- : Crew as Patient
- : Crew as Caregiver

: Structures | : C&DH | : GNC | : Comm & Tracking | : Power | : Propulsion | : EVA | : Crew Disp. & Controls | : ECLS

Core focus of the MDA project is to inform ExMC Systems Requirements definition through:

- Systems Engineering
  - Data architecture design
  - SysML model development
  - Functional requirements development

- MDA Implementation
  - Architecture specifications
  - Interface definitions
  - Prototype integrations
  - Inform requirements

- Demonstration
  - **NextSTEP* integrated Gateway Habitat Testing**
  - iPAS Gateway Habitat integrated vehicle demonstration

*NextSTEP – Next Space Technologies for Exploration Partnerships

NextSTEP Habitat Prototypes

https://www.nasa.gov/image-feature/sierra-nevada-demonstrates-habitation-prototype

https://www.nasa.gov/image-feature/nasa-tests-concept-for-habitation-module-near-the-moon

MDA Systems Engineering

Approach

– Develop Use Cases from:

- Documentation for Medical System and CHP Concept of Operations for Gateway Missions

– Translate Use Cases into a system engineering model via Systems Modeling Language (SysML):

- Activity, sequence, state machine and block diagrams
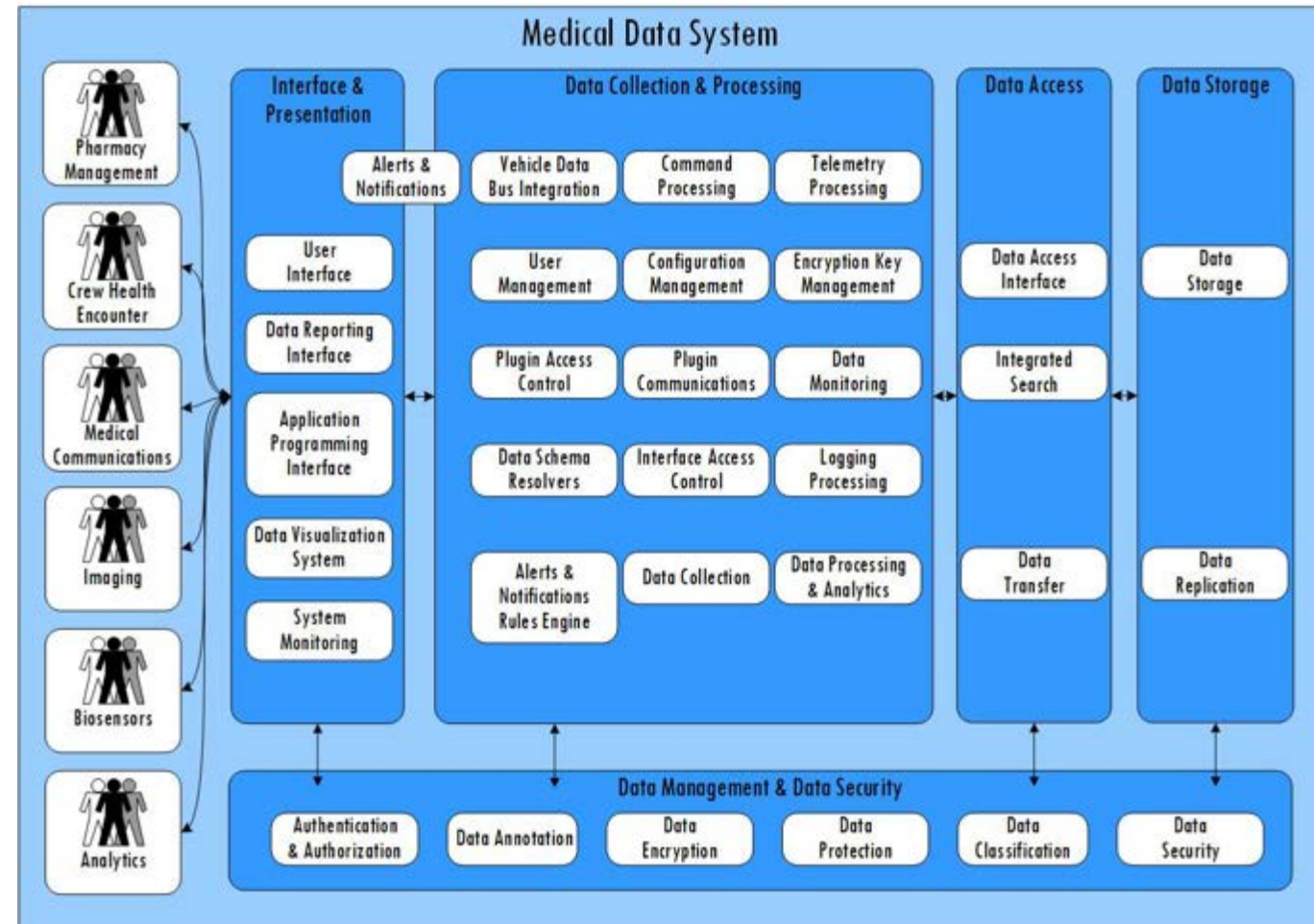
– MDA implementation

- Integrated prototypes
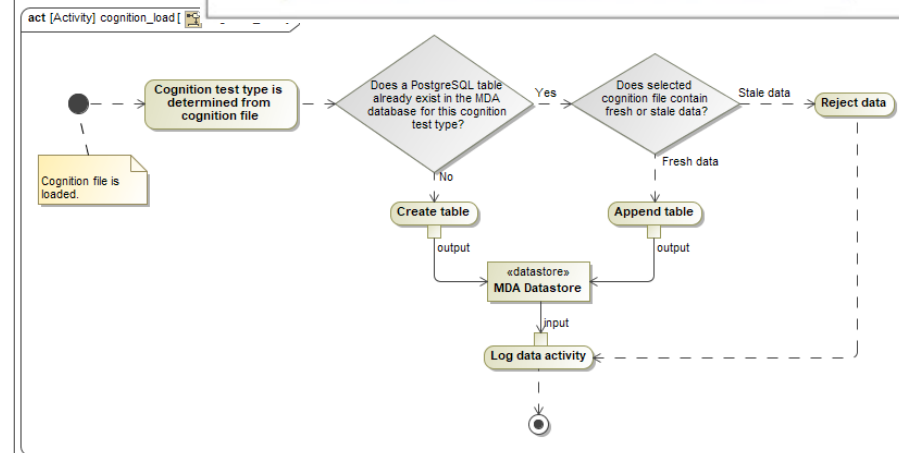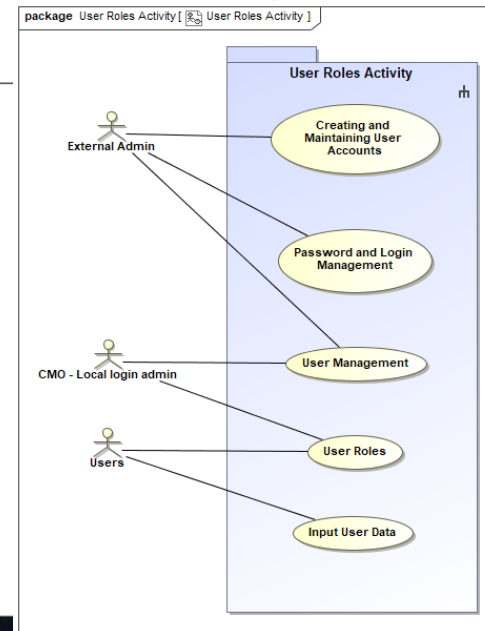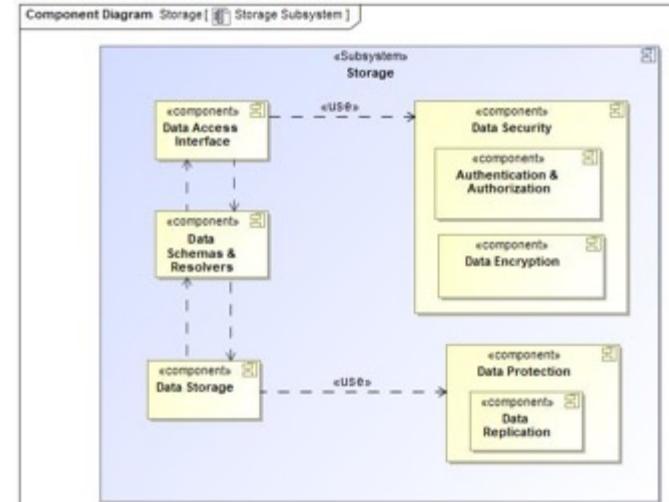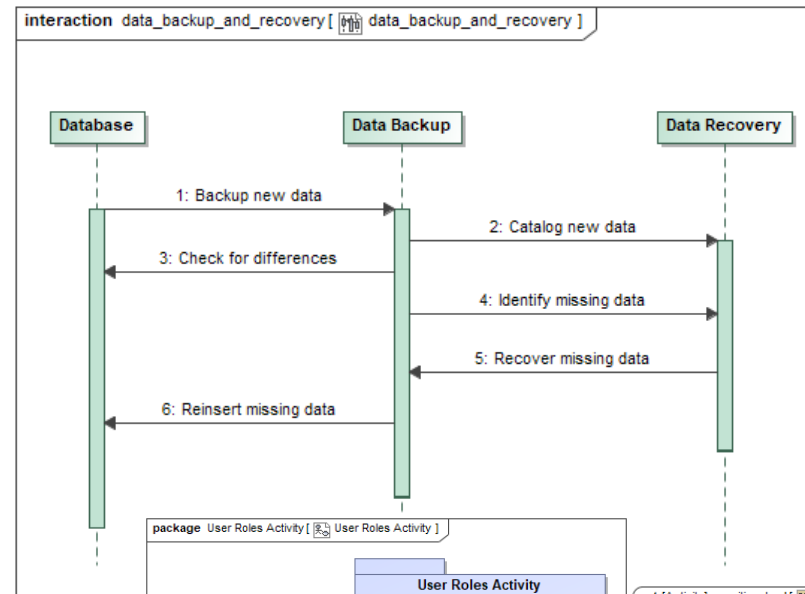
Architecture Highlights

- Expect future software and hardware technology and standards to be different.

- Modular design provides extensibility

  - Data sources (e.g. medical devices) in future missions will be different from those implemented today

  - Additional data sources/internal components may be added or exchanged without affecting other system components

 - Plugin design accesses the underlying data model and MDA system services through exposed Application Programming Interfaces (APIs)


Medical Data System

MDA System Engineering Products

– MDA deliverables included MDA architecture framework document and requirements document.

– MDA system Magic Draw SysML model

Requirements

Core flight software (cFS) application objectives

- Telemetry MDA Vehicle System status/medical data to Ground System

- Receive and display vehicle sub-system data (e.g. ECLSS simulator data)

- Simulate ground telemetry commands to MDA system

- Stretch Goal: Integrating MDA CFS App on vehicle (Gateway-in-a-box) with MDA Ground through CFS

  - Gateway-in-a-box is a digital simulation of the integrated Gateway vehicle
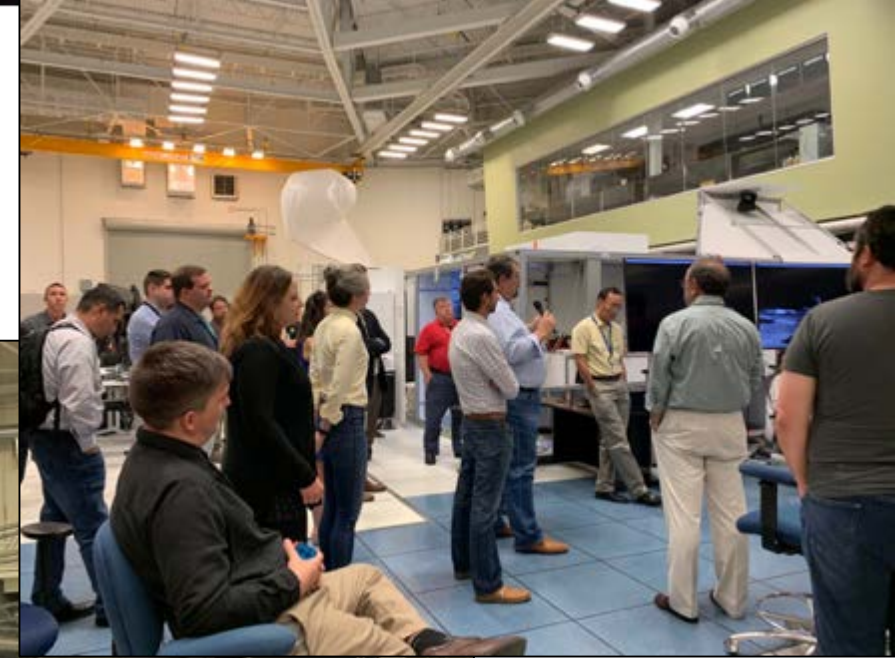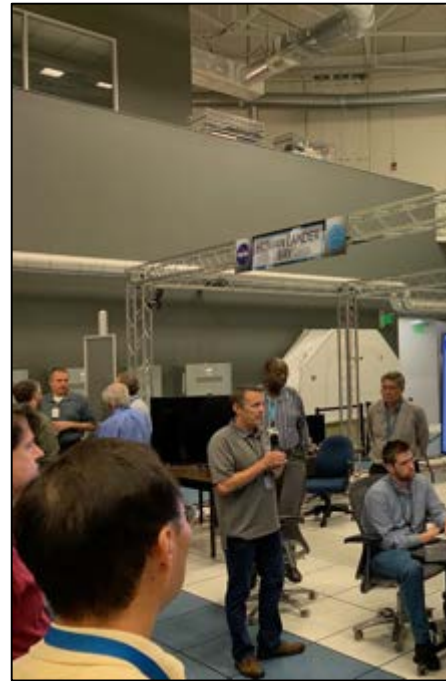
MDA cFS app demonstration in the Integrated, Power, Avionics and Software test facility at NASA JSC
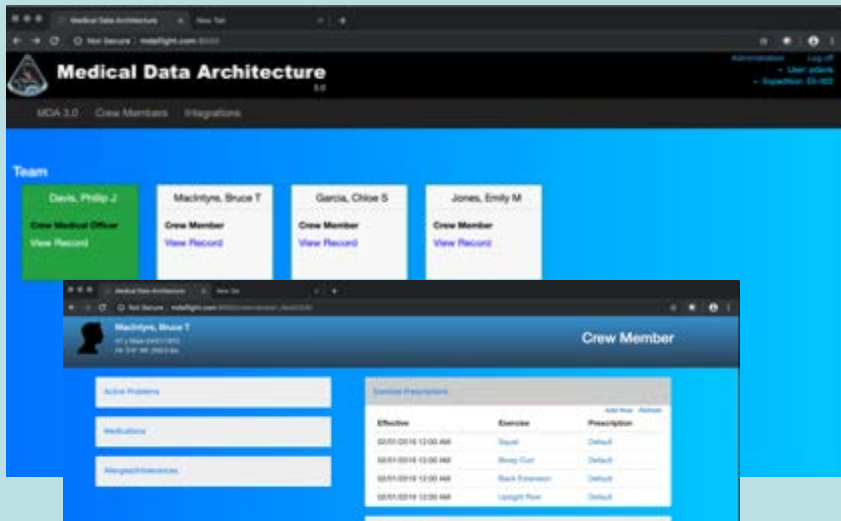
MDA system integrated with analog vehicle core flight software (cFS)
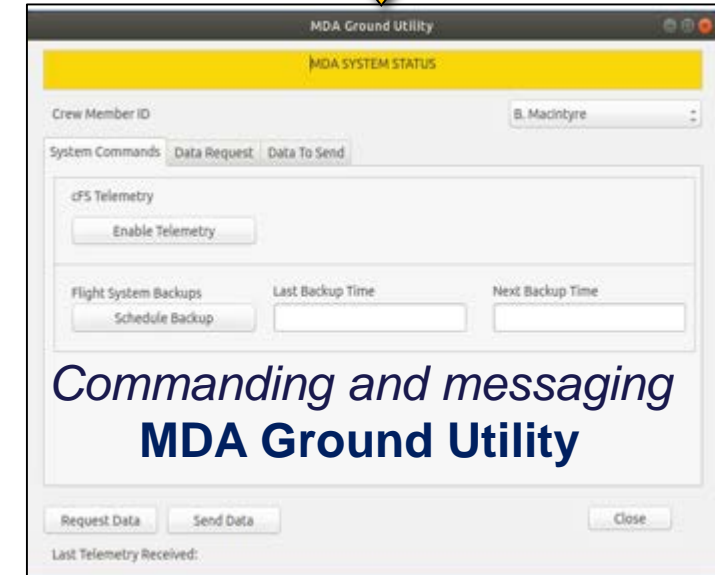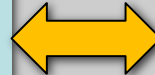
Analog Vehicle System

MDA System

Simulated environmental data

20.33 °C

Gateway-in-a-Box
(MDA cFS App inside!)

MDA Ground Utility

MDA SYSTEM STATUS

Crew Member ID   B. Macintyre

System Commands | Data Request | Data To Send

cFS Telemetry

Enable Telemetry

Flight System Backups   Last Backup Time   Next Backup Time
Schedule Backup

Commanding and messaging
MDA Ground Utility

Request Data   Send Data   Close

Last Telemetry Received:

MDA Test Bed 3

– Developed Level 5 Crew Health and Performance Habitat Data System requirements:

- NASA STD-3001 medical Level of Care IV

- Prototype integrations built on previous test bed capabilities and included collaborators external to ExMC

- Systems Engineering products – Use cases, SysML diagrams

– Produced ExMC controlled documents:

- Recommendation for a Medical Data Architecture for Gateway Missions (Medical Level of Care IV)

- Recommendation for Draft CHP Habitat Data System Level 5 Functional Requirements for Gateway Missions (Medical Level of Care IV)

– Demonstrated MDA prototype operability in the analog Gateway vehicle environment

HRP-48019

Human Research Program
Recommendations for a Medical Data Architecture for
Gateway Missions (Medical Level of Care IV)

Medical Data System Architecture Framework

Verify this is the correct version before use
https://hrp.sp.jsc.nasa.gov/HRP%20Pages/HRP%20Document%20Management%20System.aspx

December 2019
Baseline

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center

FY20 MDA Objectives

MDA Test Bed 4 Objectives

- Implement prototype
  - Medical data system platform established
  - FY20 integrations that support a clinical decision support system that provides crew self-reliance
- Develop Level 5 Crew Health and Performance Habitat Data System requirements based on:
  - NASA STD-3001 medical Level of Care V
  - Systems Engineering products
  - Revise architecture framework document