

National Aeronautics and Space Administration



Clinical Decision Support – Overview and Updates

M. Krihak, B. Russell, S. Shetye, K. Martin and T. Shaw

**2021 NASA Human Research Program Investigators' Workshop
February 2021**



Outline



- **Clinical Decision Support (CDS) background**
- **Defining a Clinical Decision Support System (CDSS) for exploration**
- **CDSS Architecture**
- **FY20 products**
- **Look ahead to FY21**



Need for Crew Self-Reliance



- **NASA-STD-3001 presents the need for crew members to operate independently during long duration space exploration missions that require medical Level of Care V**
 - Interpretation of NASA-STD-3001 Levels of Care for Exploration Medical System Development (NASA/TM-2017-219290):
 - Maintains 'autonomous' in the description of capabilities and definitions that pertain to medical Level of Care V.
- **Computational and data resources will play an important role in maintaining crew health, wellness and performance where the crew will need to be more self-reliant.**
 - Communication lags (~20min each way on a Mars mission)
 - Communication blackouts, planned and unplanned



Clinical Decision Support Background



ExMC Element Risk:

Risk of Adverse Health Outcomes & Decrements in Performance due to Inflight Medical Conditions

Clinical Decision Support (CDS) Project Need:

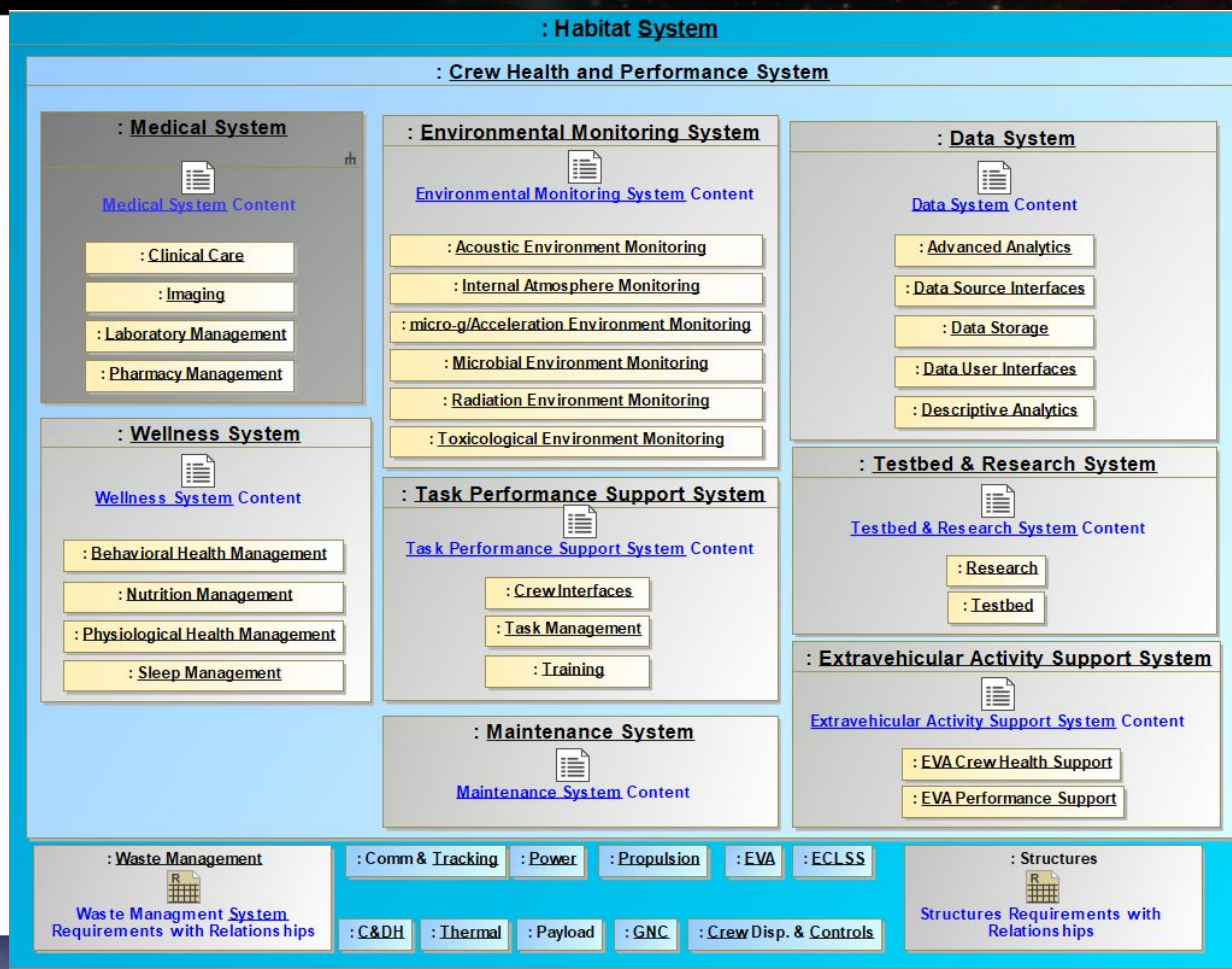
ExMC Gap Medical-701: Enhance medical capabilities within an exploration medical system.

CDS Project Goal:

The aim of the CDS project is to develop and provide recommended requirements for an in-vehicle CDS System (CDSS) that acts as an assistant for delivering optimal health and performance and medical care during exploration missions.

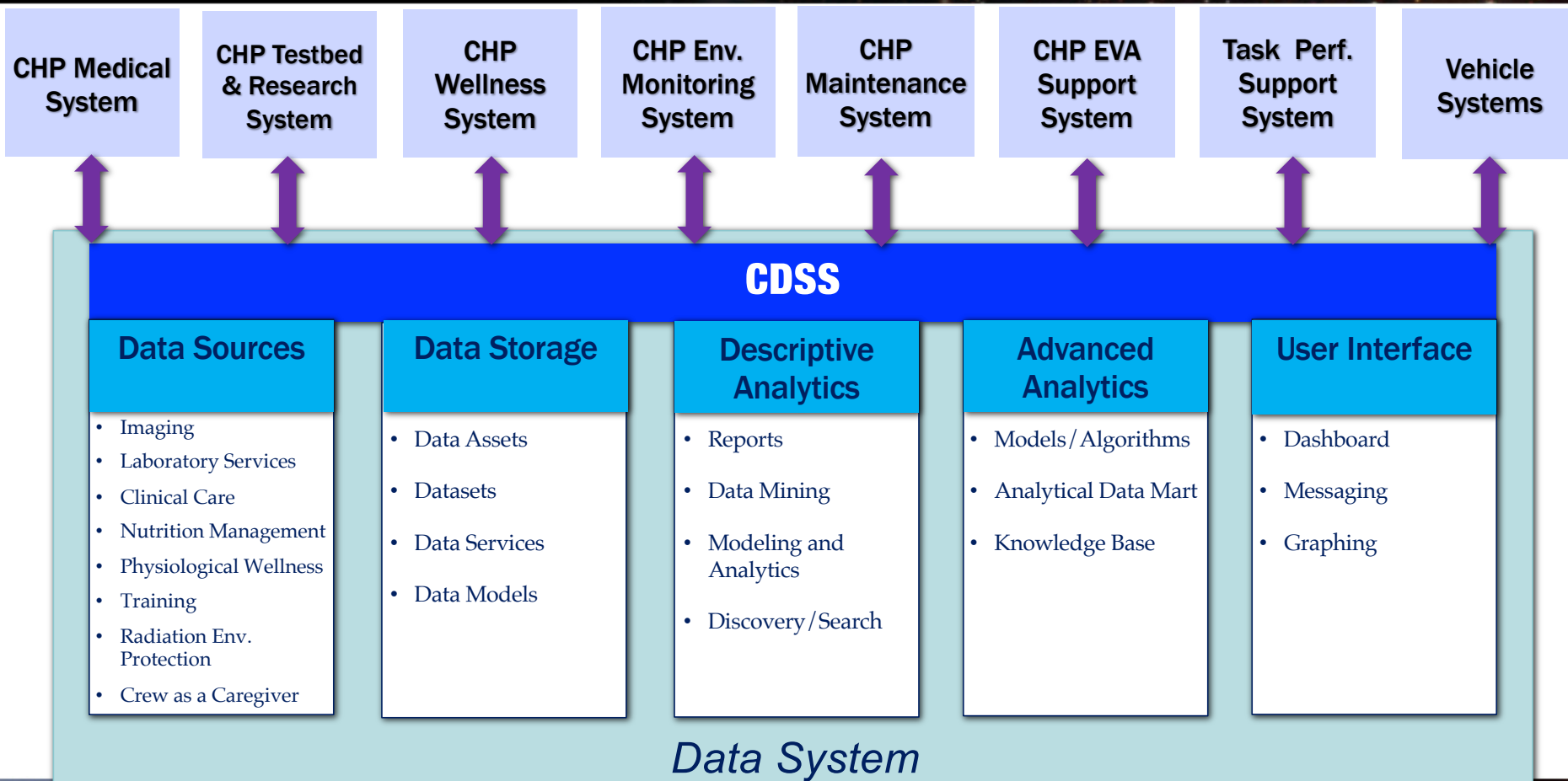


Data System – Central to the Crew Health and Performance (CHP) System





Relationship of CDSS to Other CHP Systems

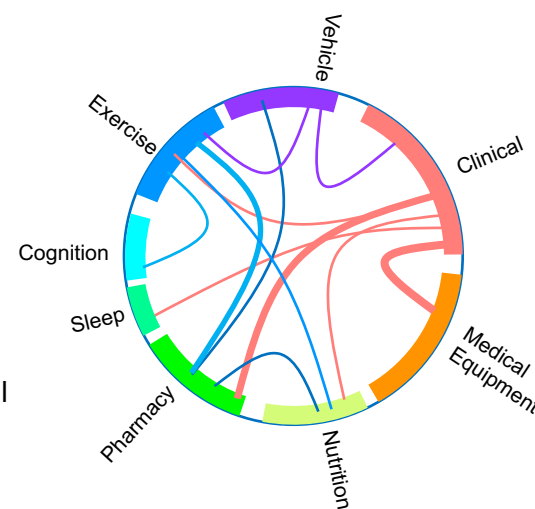




Defining CDSS Functionality

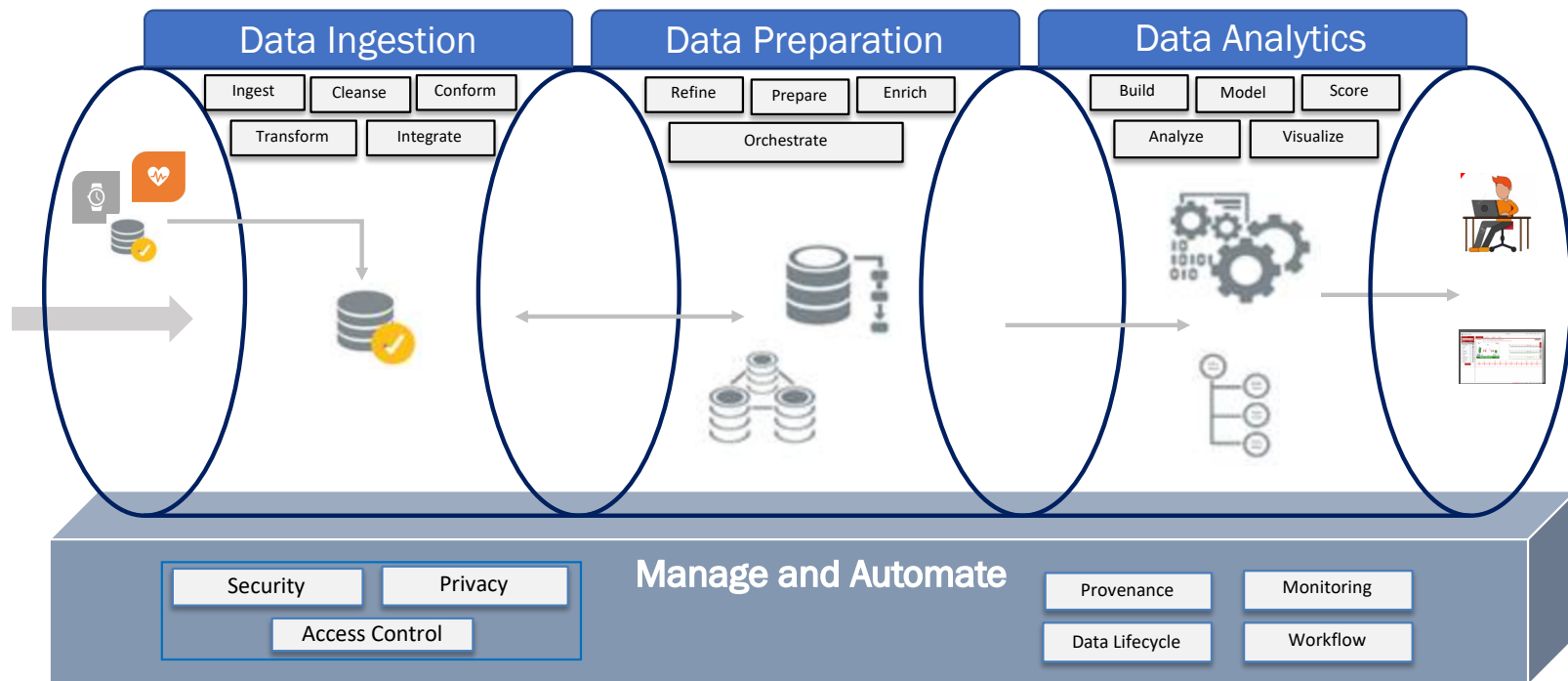


- **Ideal system – ‘Detecting, deciding and doing’**
 - Interacting with crew of different knowledge self-assessment (KSA) in different scenarios which requires different functions.
 - Lots of related work we “could do”; need to decide what we “should do”
- **CDSS as an ‘assistant looking over the caregiver’s shoulder’**
 - Recommends diagnosis, treatment and provides insight on the criticality of the situation
 - Provides actionable insights based on data
 - Augments workload and facilitates workflow
 - Provides timely references and procedures; where to go for more detail
- **CDSS should change the format and flow of the user interface based on situation**
 - Context Aware – User interface (graphics, audio, keyboard, video-gestures, etc.) changes information and guidance content that is shown and requested based on the scenario. (e.g. Heart attack vs general inquiry)
 - Situational awareness or adapting to level of acuity and severity.
- **Additional CDSS capability**
 - Implication for mission – resources left, consumables, equipment, people to assist with procedure, skill levels
 - Pharmaceutical and medical inventory management
 - Reminders integrated into existing scheduling tool
 - Integrated and prioritized Alerts



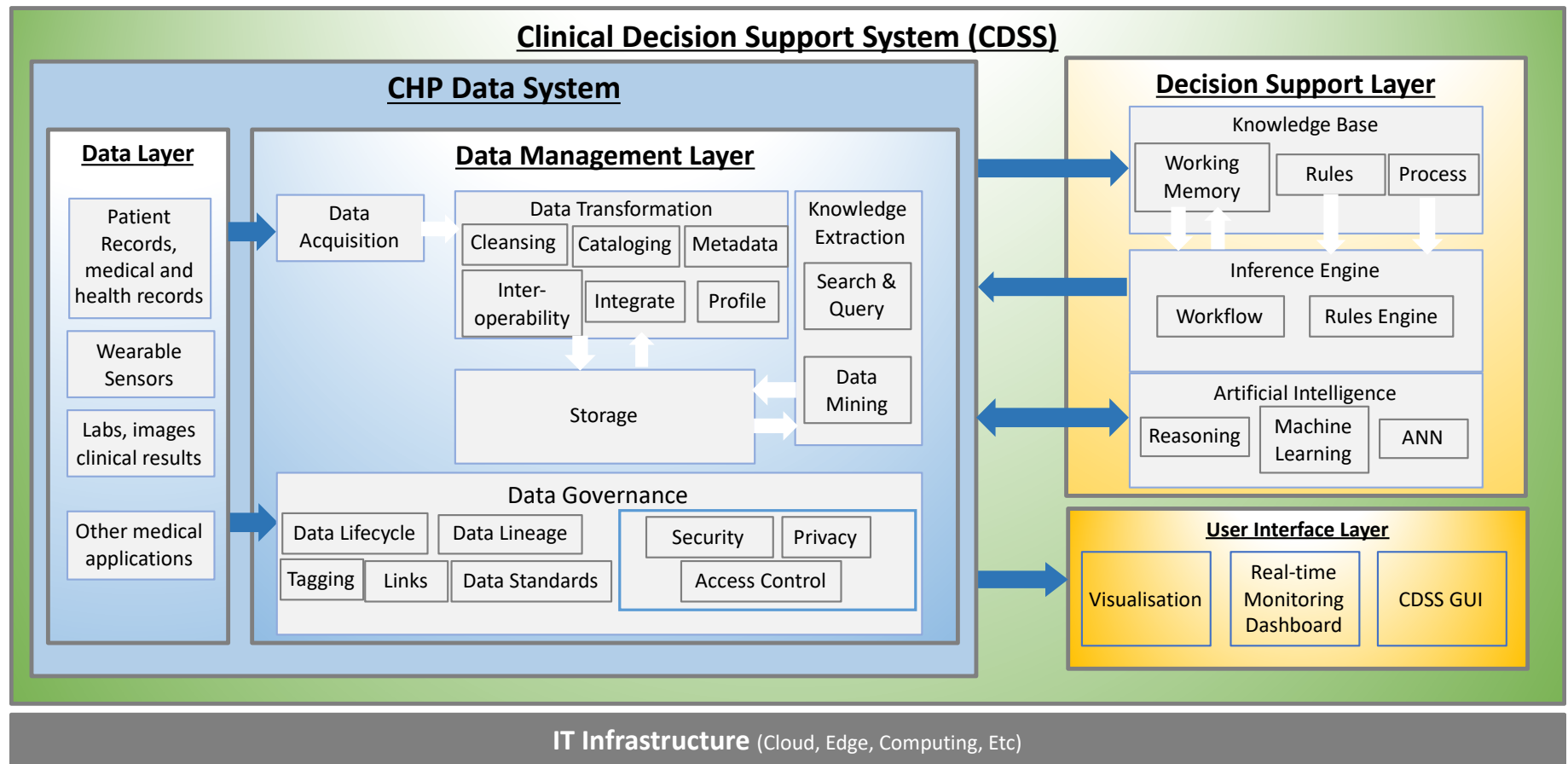


CDSS Data Pipeline





CDSS Logical Architecture



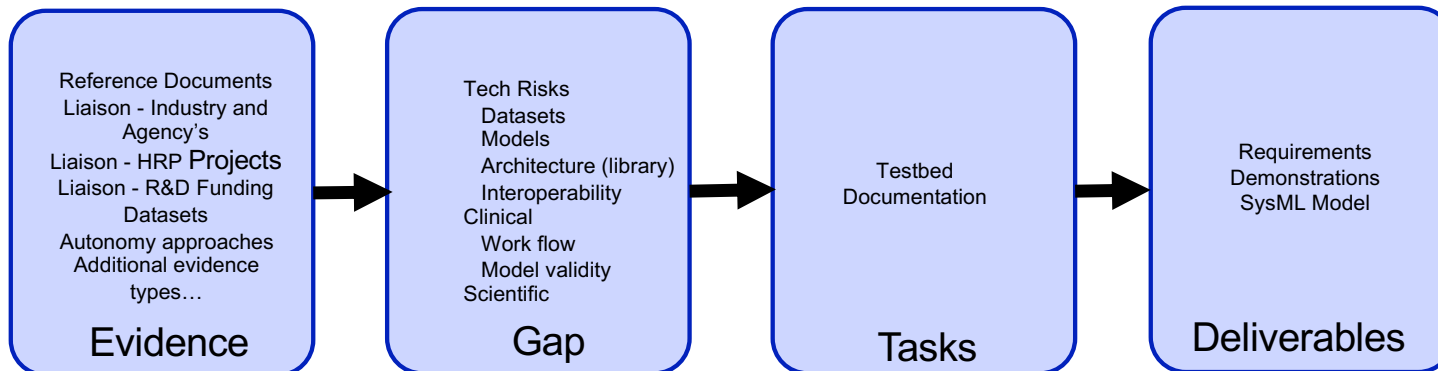


CDS Project Process



Start with Evidence

- Risk based gaps
- Tasks to close gaps
- Deliver requirements



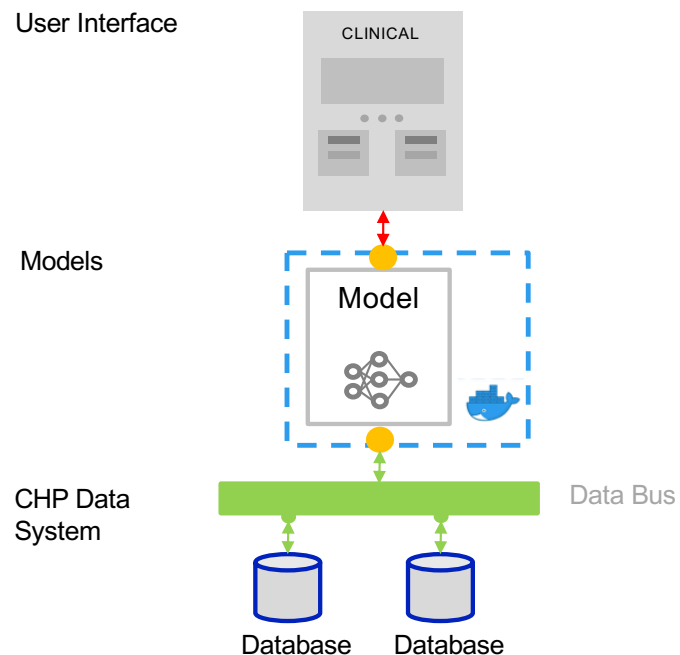
Process to be implemented starting FY21



New Model Development and Integration



Simplified CDSS Architectural View



- CDSS comprised of three layers
 - i. data and knowledge storage
 - ii. models and algorithms interpreting the data
 - iii. user interface interacting with the crew
- Simplified model communicates where functionality resides and how sub-systems from different collaborators can be developed and interact with the overall system.
 - Standard interfaces are defined to the CDS user interface and data system data pipeline.
 - Function calls to CDSS and CHP data system are via an imported library.
 - Example code and standard libraries supplied to the modelling group.
 - Model is validated for performance (accuracy, power, non ideal data reactions).
 - Model is integrated into CDSS, data requirements and other consumables are updated.
 - Clinical validation takes place
 - Mission planning tools updated to include the model as an option.



CDS Project Documentation



Document Title	Document Number	Purpose
Exploration Medical Capability Clinical Decision Support System Architecture Recommendation	HRP-48032	CDSS vision of functionality
Exploration Medical Capability Clinical Decision Support Market Survey 2020	ARC SCF 7848	Knowledge capture of CDSS relevant technologies
Exploration Medical Capability Clinical Decision Support Roadmap	ARC SCF 7867	Vision and timeline of technology development
Exploration Medical Capability Clinical Decision Support Technology Development Plan	ARC SCF 7868	Process for developing prototypes and requirements
Exploration Medical Capability Clinical Decision Support Concept of Operations	HRP-48033	Basis for developing requirements and providing use cases for implementation
Clinical Decision Support Use Cases for MDA Test Bed 4	ARC SCF 7834	Data and functionality specifications to be implemented in early CDSS prototypes



Summary



HRP-48032

FY20 CDS-Related Products

- Produced ExMC controlled documents:
 - Recommendation for CHP Habitat Data System Level 5 Functional Requirements for Gateway Missions (Medical Level of Care IV and V)
 - ExMC Clinical Decision Support System Architecture Recommendation
 - ExMC Clinical Decision Support Concept of Operations
 - CHP Data System Model (MDA)
- Produced project level documents:
 - ExMC Clinical Decision Support Market Survey 2020
 - ExMC Clinical Decision Support Roadmap
 - ExMC Clinical Decision Support Technology Development Plan
 - Clinical Decision Support Use Cases for MDA Test Bed 4

Exploration Medical Capability Clinical Decision Support System Architecture Recommendation

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

September 2020
Baseline



National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas



FY21 CDS Project Objectives



Documentation

- CDSS Concept of Operations finalized through ExMC control board review
- Updated Data System requirements, medical Level of Care IV and V
- Develop draft requirements for initial CDSS concepts based on Level of Care V
- Generate project documentation including Program Management Plan, Software Management Plan

Implementation

- Execute the CDS Project Process
- Develop uses cases for CDSS implementation in FY21
- Quarterly prototype and demonstrations
- CHP Data System SysML Model that includes CDSS functionality