Biosensor Integration Development ExMC/Canadian Space Agency Collaboration

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ExMC/CSA Biosensor Collaboration

- Background
  - Exploration Medical Capability (ExMC) Medical Data Architecture (MDA) Project objectives
  - Canadian Space Agency (CSA) collaboration objectives
- MDA System – CSA Astroskin Integration
  - Astroskin overview
  - Astroskin configuration
  - Integration approach
- Summary & FY17 Next Steps

Exploration Medical Capability (ExMC) Risk & Gaps

ExMC Element Risk:

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

MDA Needs

ExMC Gap Med07: We do not have the capability to comprehensively process medical-relevant information to support medical operations during exploration missions.

ExMC Gap Med13: We do not have the capability to implement medical resources that enhance operational innovation for medical needs.

MDA Goal

The MDA will develop capabilities that support autonomous data collection, and necessary functionality and challenges in executing a self-contained medical system that approaches crew health care delivery without assistance from ground support.
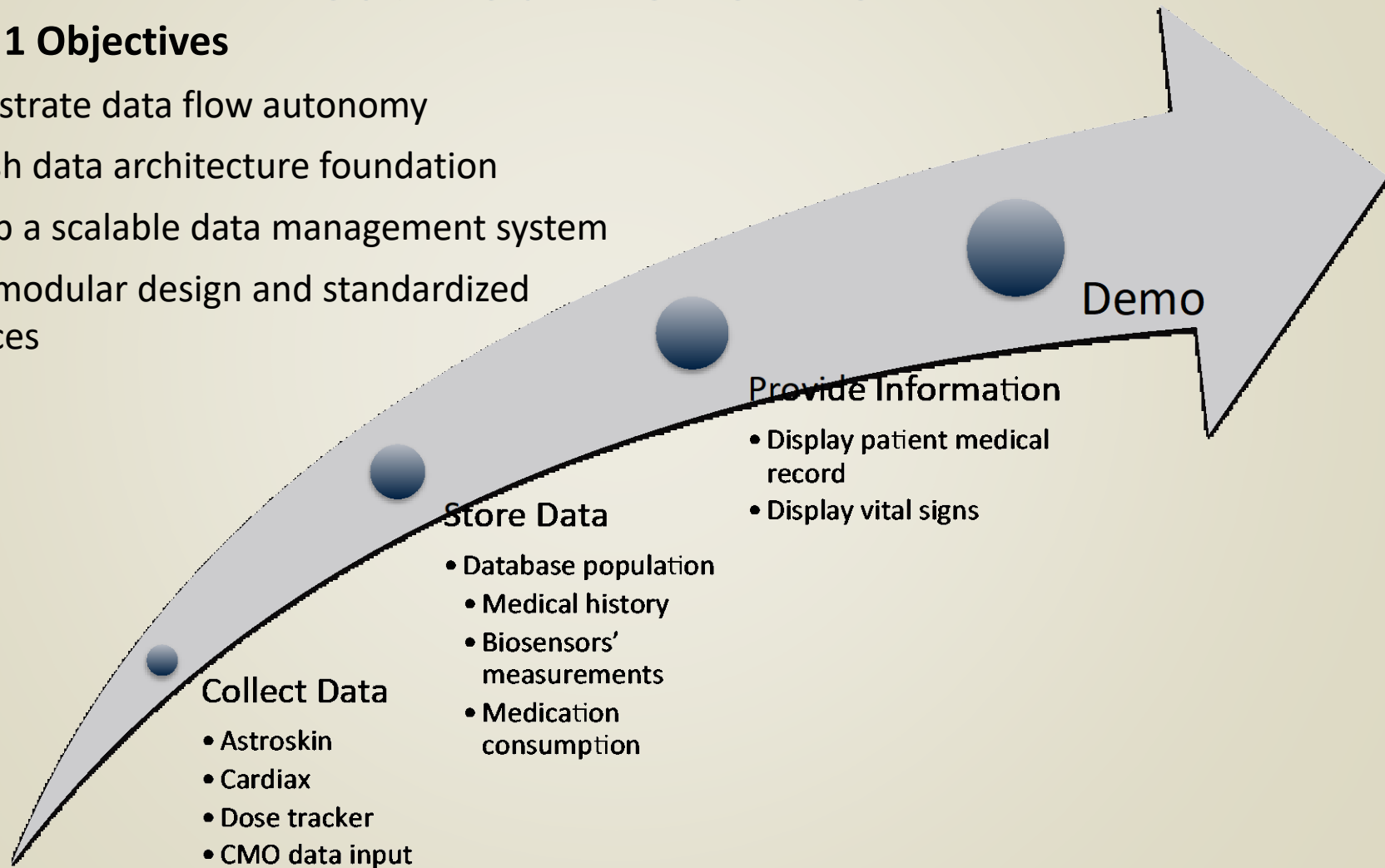
MDA Project Objectives

- The primary objectives of the MDA project are to establish a robust data architecture that:
  - Provides a unified ability to capture, collect, store, access, integrate, and analyze a spectrum of health-related data to create actionable insight and medical process support leading to an Exploration Medical System (EMS)
  - Provides the capability to manage and process medically relevant data from a variety of sources both medical and non-medical

  ➡ *Establishes interfaces for the integration of hardware and software components*
  - Enables data retrieval as meaningful information that can inform diagnosis, treatment and health management

  ➡ *Automates data transfers*
  - Expands the medical system to enable sophisticated data analytics and clinical decision support capability

Test Bed 1 Overview

Test Bed 1 Objectives

- Demonstrate data flow autonomy

- Establish data architecture foundation

- Develop a scalable data management system

- Utilize modular design and standardized interfaces

Demo

Provide Information
- Display patient medical record
- Display vital signs

Store Data
- Database population
- Medical history
- Biosensors' measurements
- Medication consumption

Collect Data
- Astroskin
- Cardiax
- Dose tracker
- CMO data input

ExMC/CSA Collaboration Objectives

- Establish a mutually beneficial working relationship

- Clinical decision support

  ⇒ *Establish interfaces for the integration of CSA analytical tools as identified by the MDA system*

- Advance MDA development

  ⇒ *Integration of the CSA biosensor tool – Astroskin*

  - Provides data source for MDA development and helps define integration interfaces for the integration of hardware and software components

- Advance biosensor development

  ⇒ *Automates data transfers to facilitate streamed data acquisition*

  ⇒ *Expand Astroskin capabilities and evaluate performance*

  - Validate functionality in an operational environment

  - Validate operational feasibility for crew health monitoring & crew fitness evaluations

Description

- Wearable garment-based continuous physiological monitoring system, reusable (washable)
- Secure wireless communication
- Physiological events detection & alerts (planned for future version)
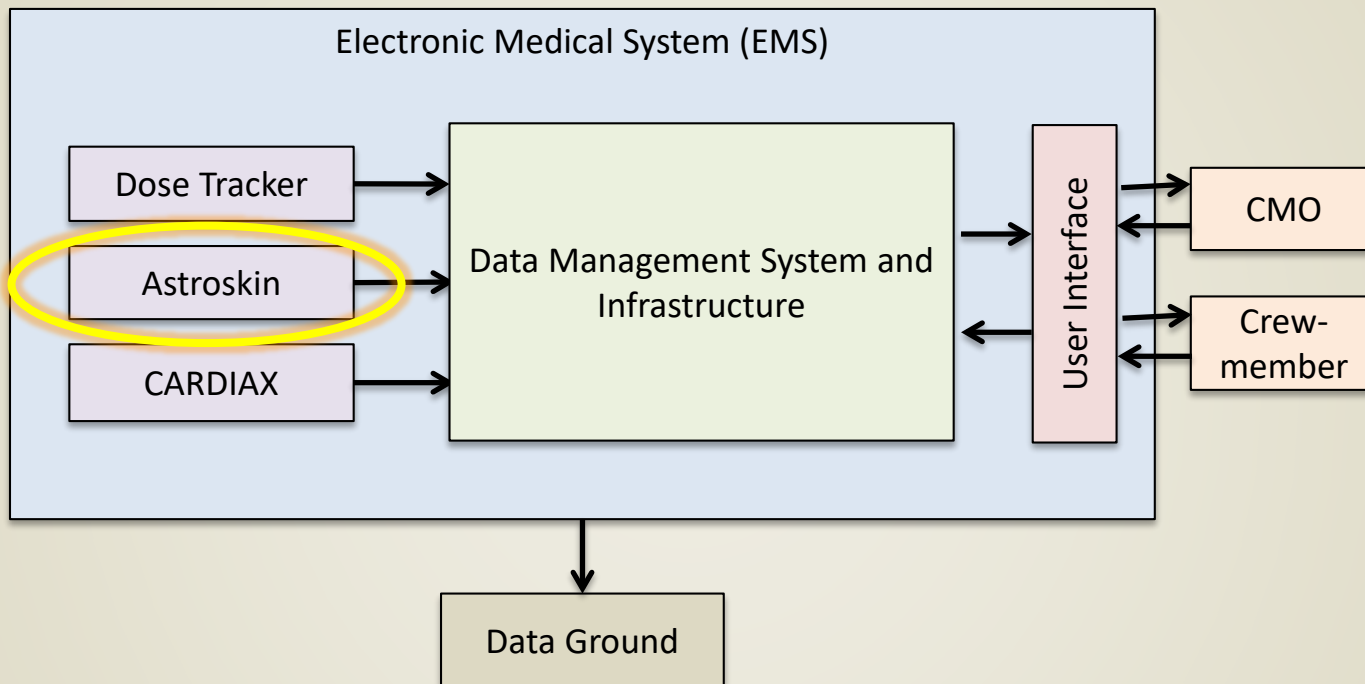- Decision support capabilities (planned for future version)

Sensors (embedded)

- 3-axis accelerometer (activity levels)
- Electrocardiogram (ECG) (3-lead)
  - QRS detection, heart rate, heart rate variability
- Respiration (respiration rate, respiration volume, minute ventilation)
- Oxygen saturation (SpO_2)
- Systolic Blood pressure (calculated)
- Skin temperature

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Astroskin Configuration

- Current Configuration
  - Data storage contained in a module connected to the worn garment.
  - Data is later transferred from the module to a laptop for offline processing, analyses, and viewing.
    - This approach used in the FY16 Human Exploration Research Analog (HERA) study.
    - Limits the ability to monitor biosensor data quickly and provide near real-time feedback to the subjects.

- Proposed Configuration
  - ➡ Collaborate with the Canadian Space Agency (CSA) to develop the appropriate interfaces to capture data in the MDA system.
    - CSA will provide a software application to serialize data and forward to MDA system.
    - NASA Ames Research Center will develop a 'receiver' to decode the data.
  - ➡ Approach facilitates automated data collection from the Astroskin.

MDA Test Bed 1 Functional Block Diagram

Electronic Medical System (EMS)

Dose Tracker → Data Management System and Infrastructure
Astroskin →
CARDIAX →

Data Management System and Infrastructure → User Interface

User Interface ↔ CMO
User Interface ↔ Crew-member

Data Management System and Infrastructure → Data Ground

- Modular design
  - Layers allow for organization of code and components
- Subsystems separated by interfaces
  - Drop-in replacements of systems in later versions (upgrades, etc)
- Biosensor device adapters are modular
 - Allows device modules to come and go as directed by the Element

Astroskin Data Processing Diagram
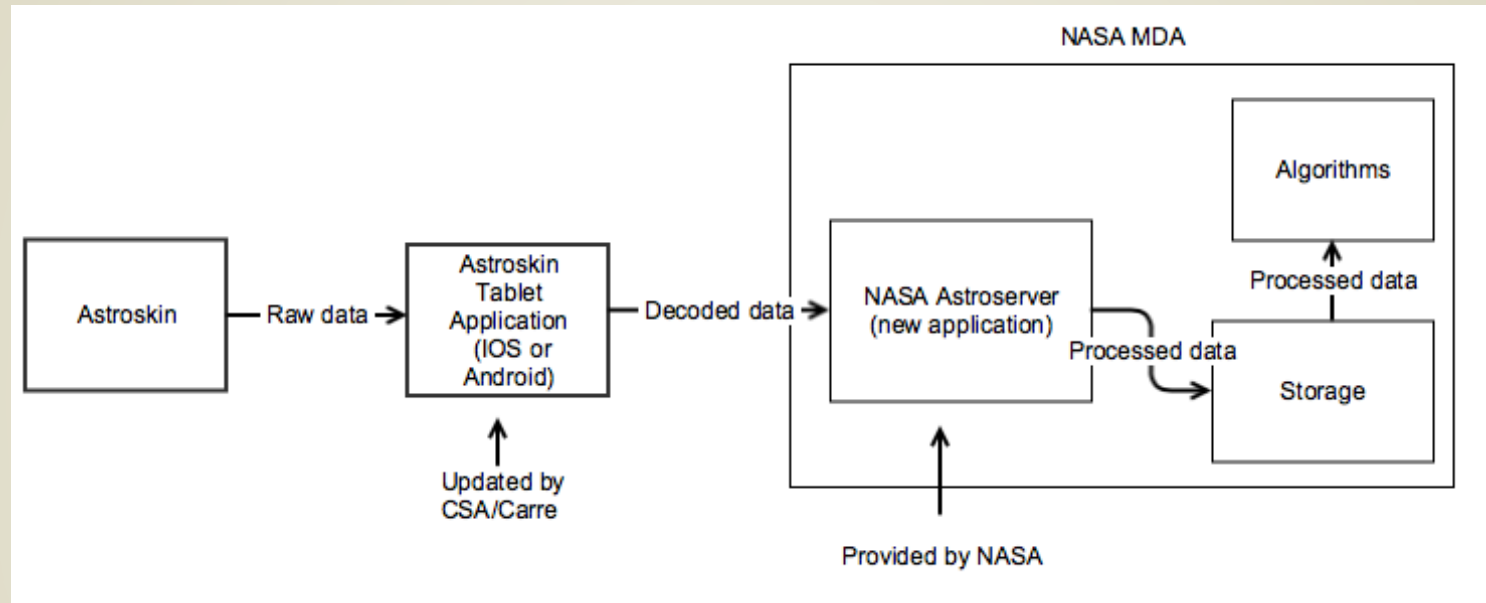
MDA system integration tests with the Astroskin scheduled for FY17

- o Purpose of the ExMC/CSA study is to:
  - ▪ evaluate Astroskin performance and data receiver system with human participants during physical activities relevant to exploration missions (e.g. exercise)
  - ▪ validate functionality in an operational environment
  - ▪ validate operational feasibility for crew health monitoring and fitness evaluations

Astroskin Process Diagram
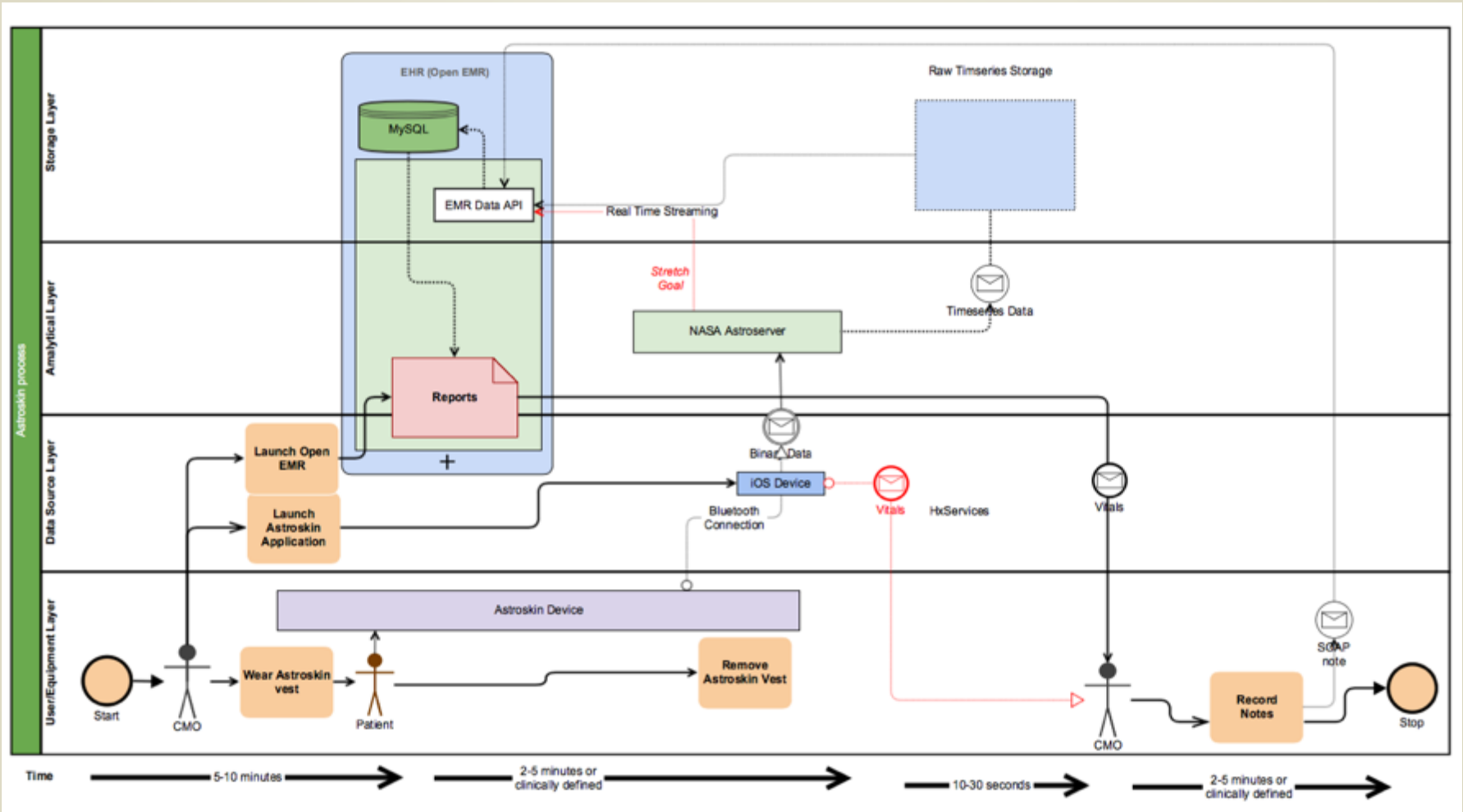
Laboratory Testing Photos

Summary & FY17 Next Steps

- Astroskin Integration
  - CSA developed software app to stream data
  - ExMC developed server to accept and read data from iPad software app
  - Demonstrated feasibility of streaming data
- FY17 Objectives
  - Perform data streaming protocol tests with Astroskin
  - Submit a Step 2 Omnibus proposal for next generation CSA biosensor integration
  - Identify common areas of interest for clinical decision support, and development future collaborative investigations