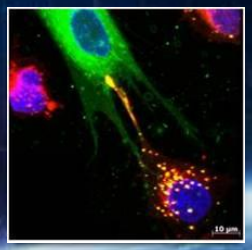
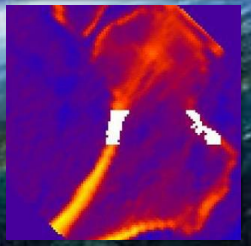
National Aeronautics and Space Administration

Exploration Medical Capability Element Overview IWS 2017








January 2017

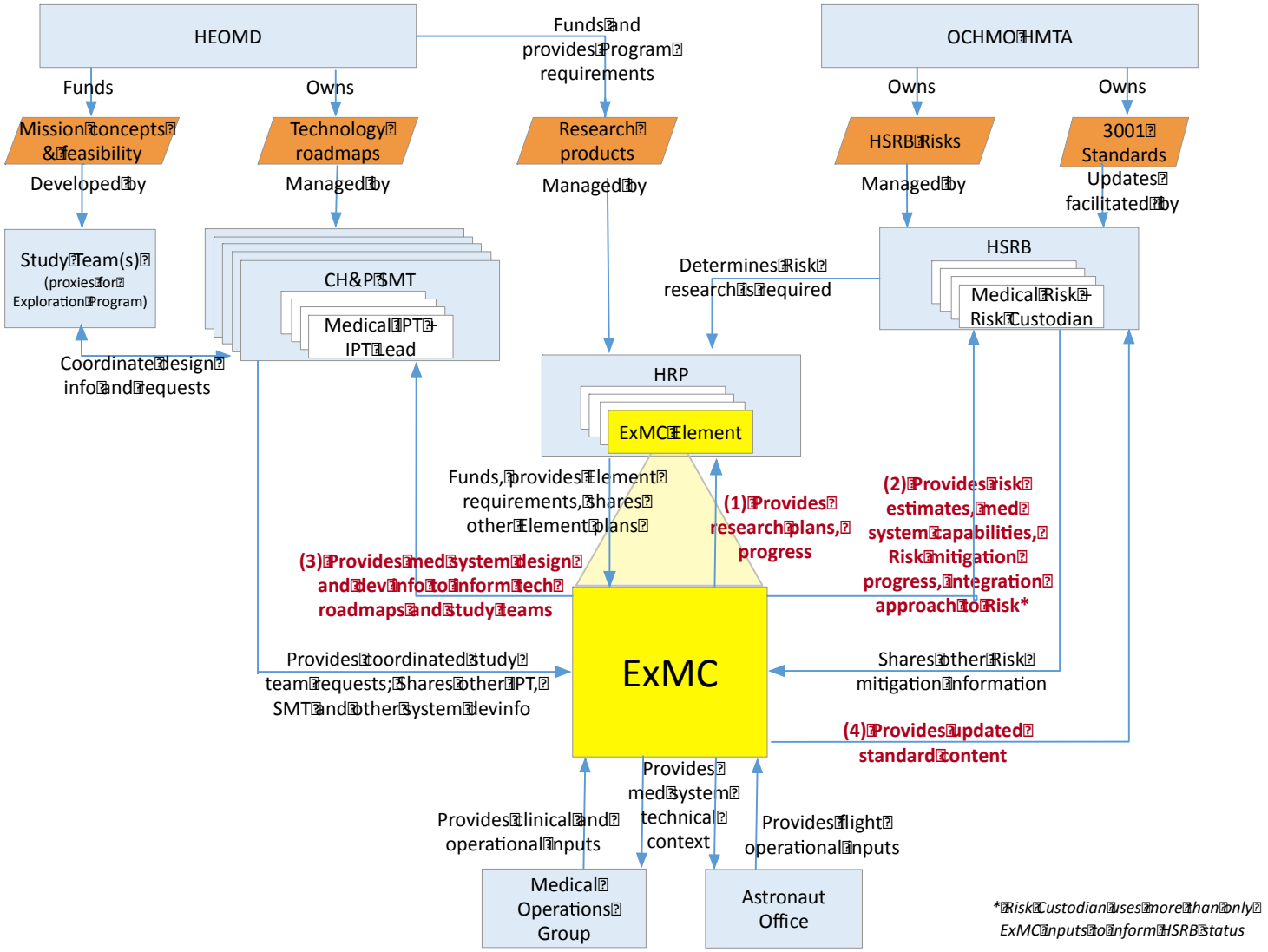
Outline

- ExMC Mission and Goals
- Applied Research Program Operational Target
- Element Conceptual Drivers
- ExMC Risk ownership and POCs
- Current and Future Gaps
- Element Progress in 2016

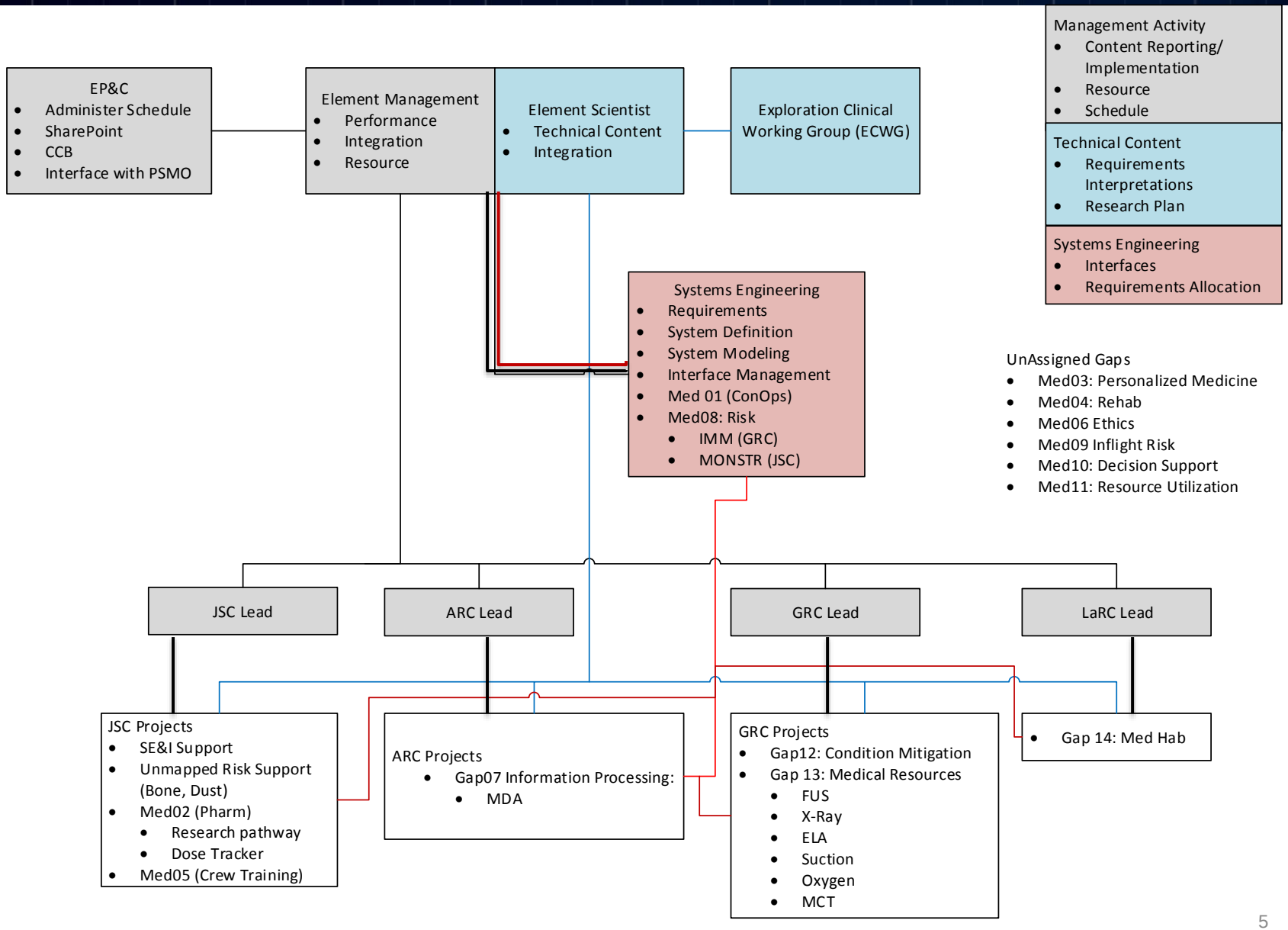
Our Mission

To minimize mission medical risk through medical system design and integration into the overall mission and vehicle design.

Organizational Environment



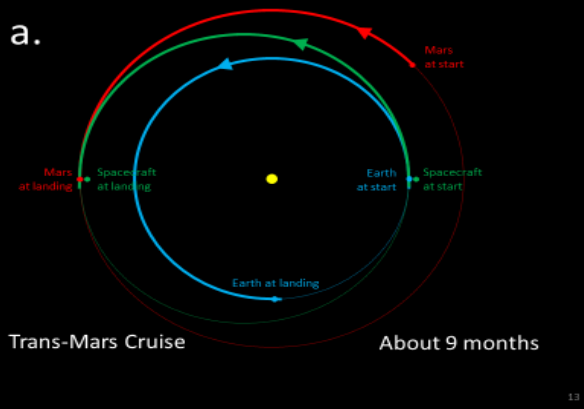
ExMC Management Information Flow

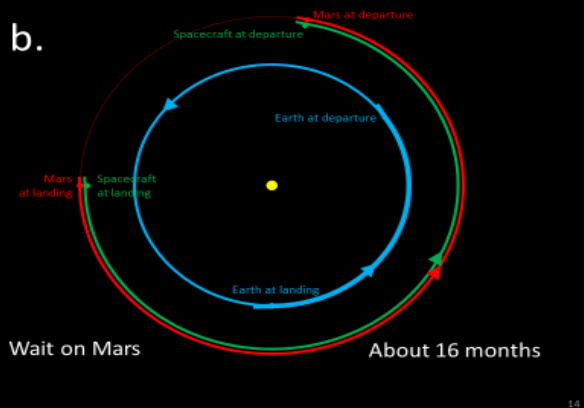


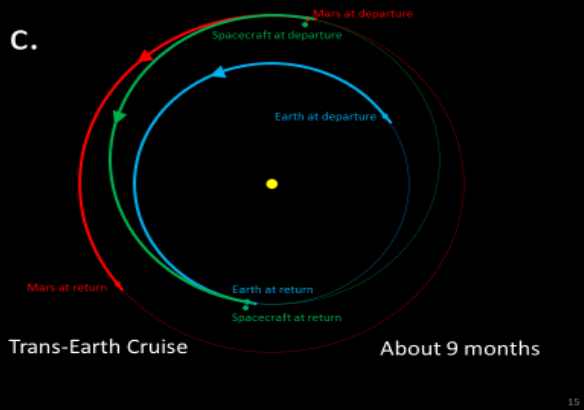
Mars Design Context

- **Current architectures for exploration call for long duration missions of 1-3 years**
- **Mars will not have a capability for medical evacuation.**
- **Mars missions cannot expect resupply although some prepositioning of resources may be available.**
- **There will be periods of limited communications and extended transit times.**
  - Comm rates: kilobits per second, like dial-up internet.
  - The one-way flight time for radio signals can be more than 20 minutes.
  - Comm will not be continuous.
- **Mars Mission will require multiple launches**
  - Launch one or more durable unpiloted ships with non-perishable supplies and equipment to Mars 78 or 52 or 26 months before the crew departs.
  - Construct the crew transit ship in high Earth or Moon orbit with several SLS payloads launched
  - Crew launch.

With low margins available on these missions, we can expect increasing scrutiny and competition for resources across mission systems.





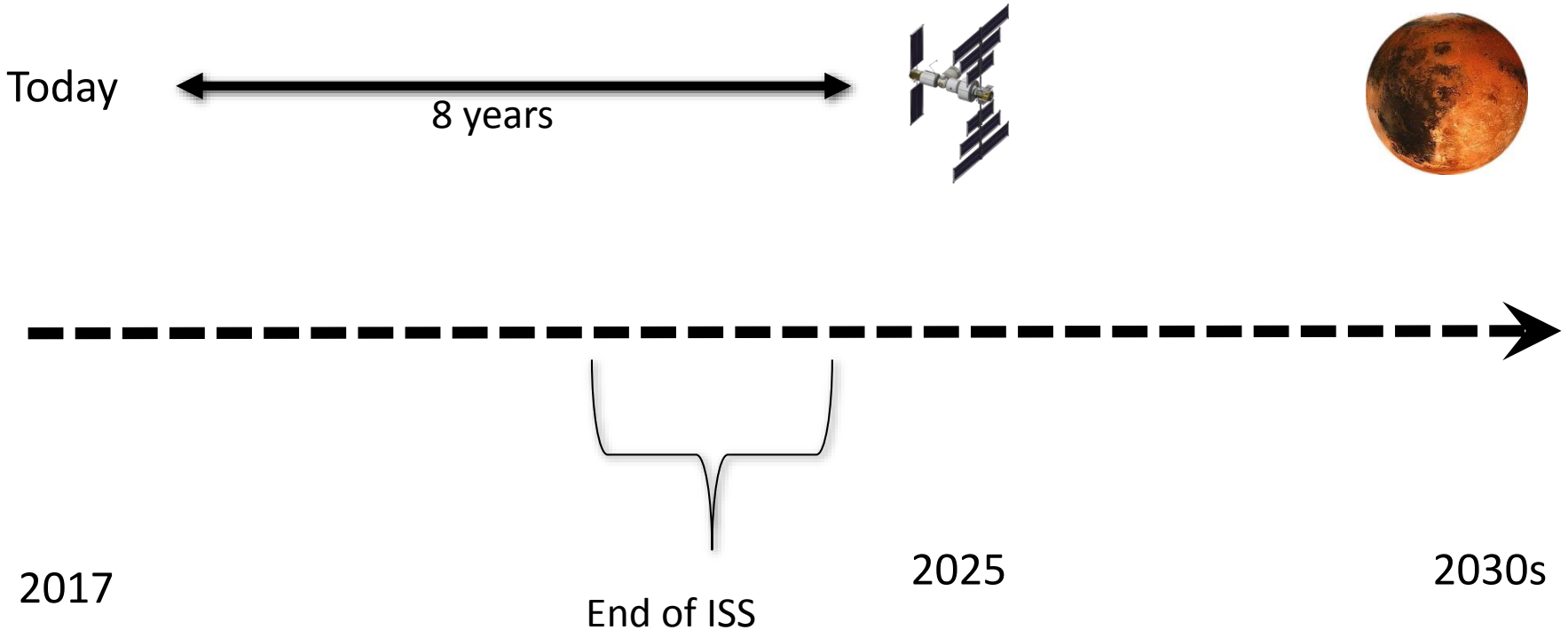


Element Closure?

- **The goal of the element is to supply sufficient information and validation of a vehicle medical capability that the future program of record will be able to build and integrate the medical system with minimal design issues confident in the risk reduction to the crew**

Timeline and Target – Why now?

- Must have a target to design towards
- Must have a way to make hard decisions
- This is not “sometime” in the distant future



ExMC Risk Ownership

- **Medical Risk – Erik Antonsen**
- **Pharmaceutical Stability Risk – Vernie Daniels**
- **Renal Stone Risk – Bob Pietrzyk**
- **Acute Bone Fracture Risk – Jean Sibonga**
- **Celestial Dust Exposure Risk – Torin McCoy**

Medical Care Capabilities

- **Medical care includes:**
  - Prevention/Screening
  - Diagnostic capability
  - Treatment capability
  - Rehabilitation capability
  - Prognosis

How are these implemented in a mission we've never done before?

Element Conceptual Drivers

- **How do we envision doing medicine?**
  - Levels of Care
  - Planned medical operations
  - Unplanned medical operations
  - Performance
  - Research

ConOps

- **How do we value and prioritize medical capability?**
  - What is likely to happen and how often?
  - What would a physician want to have with them if it happened?
  - A repeatable way of prioritizing medical capability to invest research $$ in.

Quantifying Risk

- **How do we enable system operations that support crew medical autonomy?**
  - Information handling from lots of sources
  - Command and control of devices (ultrasound, lab analysis, etc.)
  - Proving System-Vehicle and Ground-Vehicle Interfacing

System

Medical Risk

Current Gaps

Med01	**We do not have a concept of operations for medical care during exploration missions.**
Med02	**We do not have the capability to provide a safe and effective pharmacy for exploration missions.**
Med03	**We do not know how we are going to apply personalized medicine to reduce health risk for a selected crew.**
Med04	**We do not have a defined rehabilitation capability for injured or de-conditioned crew members during exploration missions.**
Med05	**We do not know how to train crew for medical decision making or to perform diagnostic and therapeutic medical procedures to enable extended mission or autonomous operations.**
Med06	**We do not know how to define medical planning or operational needs for ethical issues that may arise during exploration missions.**
Med07	**We do not have the capability to comprehensively process medically-relevant information to support medical operations during exploration missions.**
Med08	**We do not have quantified knowledge bases and modeling to estimate medical risk incurred on exploration missions.**
Med09	**We do not have the capability to predict estimated medical risk posture during exploration missions based on current crew health and resources.**
Med10	**We do not have the capability to provide computed medical decision support during exploration missions.**
Med11	**We do not have the capability to minimize medical system resource utilization during exploration missions.**
Med12	**We do not have the capability to mitigate select medical conditions**
Med13	**We do not have the capability to implement medical resources that enhance operational innovation for medical needs**

New Gaps

Med14: Capability to assess how well medical equipment, supplies, and workspace are incorporated into habitat and mission architectures and constraints.

- **Developed with HFBP**
- **In Element Review**
- **Will go to SMP**

In the last year:

- IMM External Review Completed
- MDA passed gate reviews and early system demonstrations
- Flew MDA (again! After it was blown up once)
- Got the FUS out to users -> multiple projects!
- Renal PRR Red -> Yellow with US stuff
- ConOps -> LOC and Mars Transit
- SEI began decomposing ConOps
- Pharm research plan
- Dose Tracker collecting data on 6 subjects
- MONSTR Version 1
- Planning a new gap – MED14

Goals For 2017

Areas of Emphasis for 2017 (and Beyond)

- Completion of initial ConOps
- Requirements definition
- Identification/development of systems engineering tools
- Identification of lucrative medical technologies
- Initial testing of MDA
- Initial Development of Test Plans including Analogs