Exploration Medical System Technical Development

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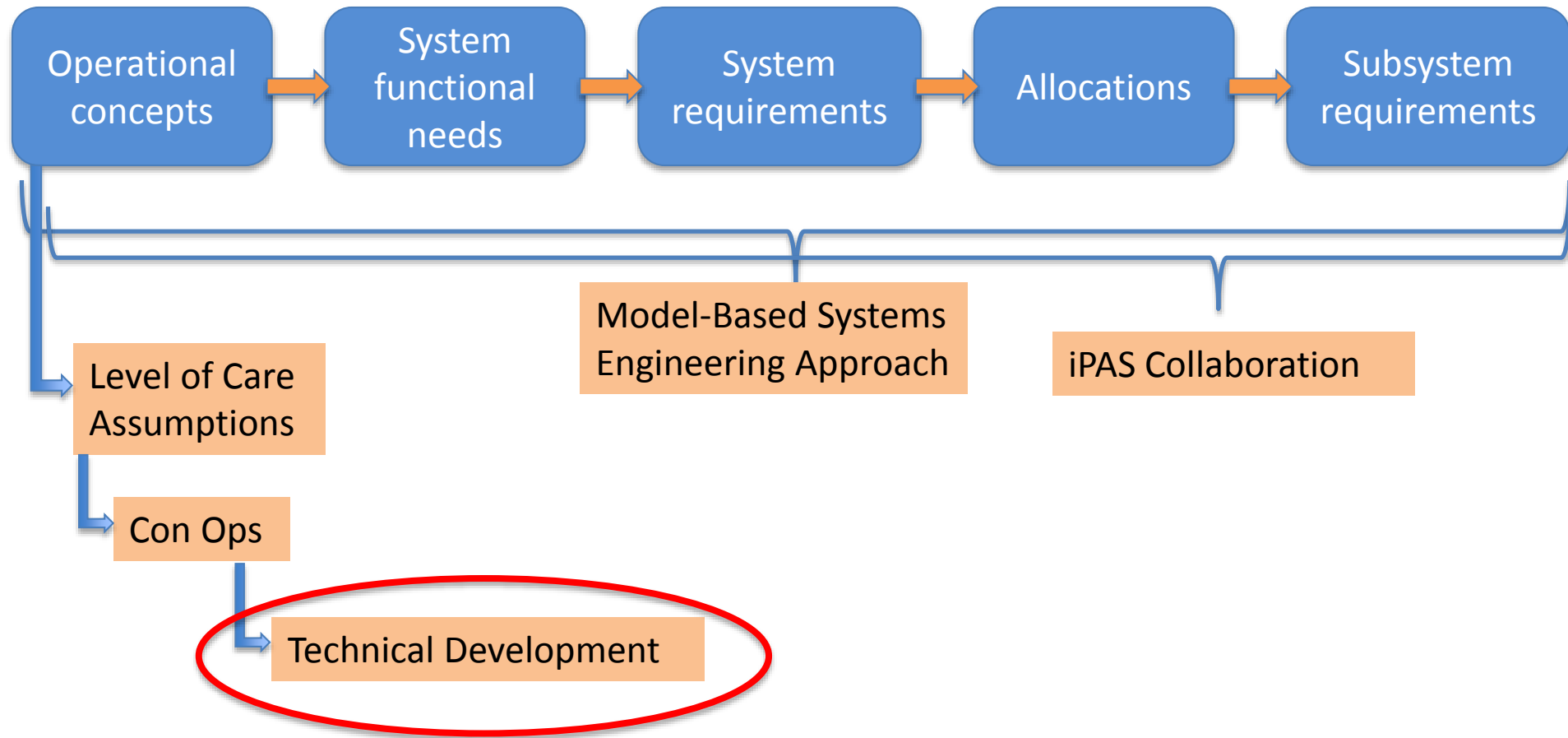[1]NASA Glenn Research Center, Cleveland, OH
[2]NASA Johnson Space Center, Houston, TX
[3]KBRwyle, Houston, TX

HRP Investigators' Workshop
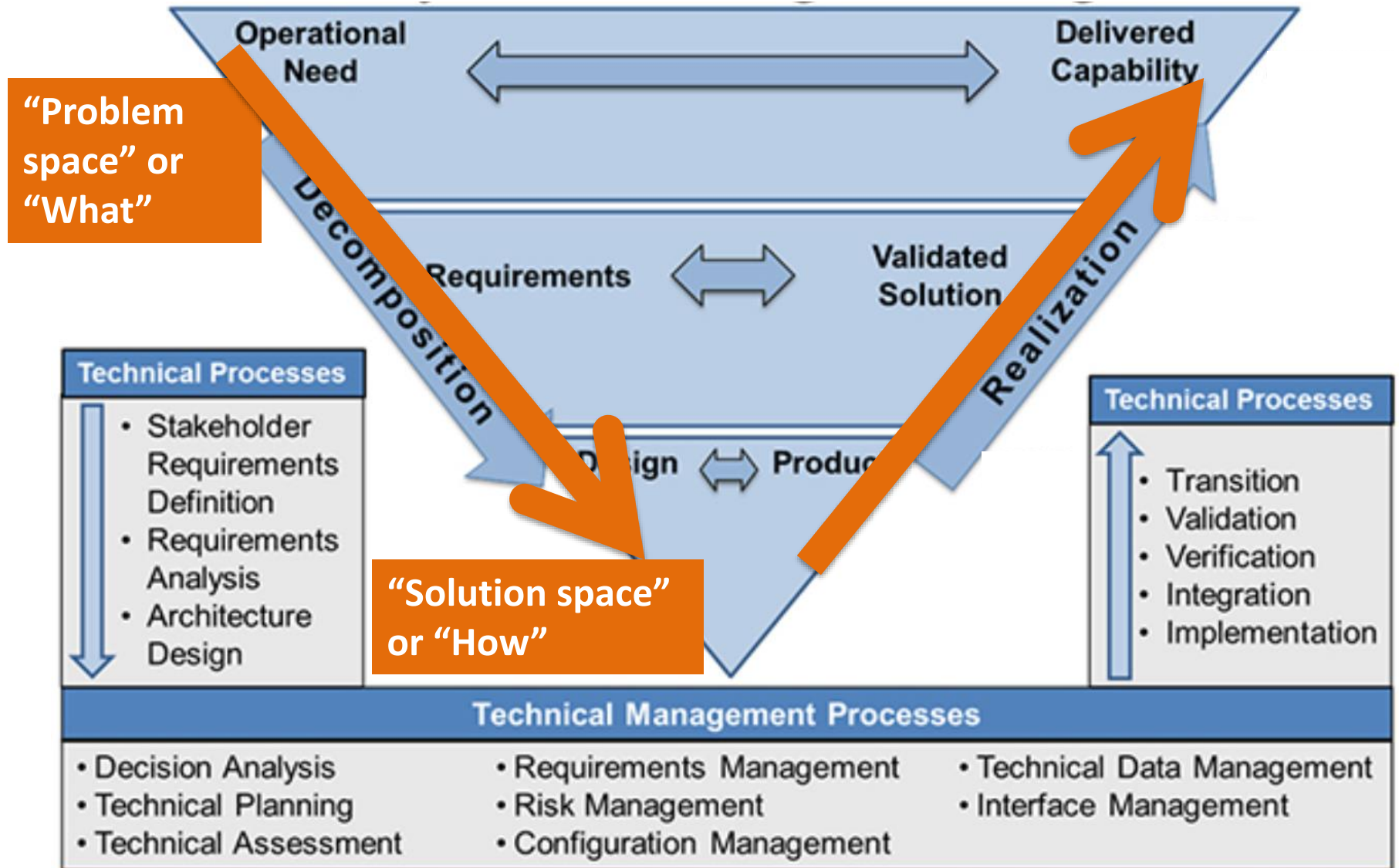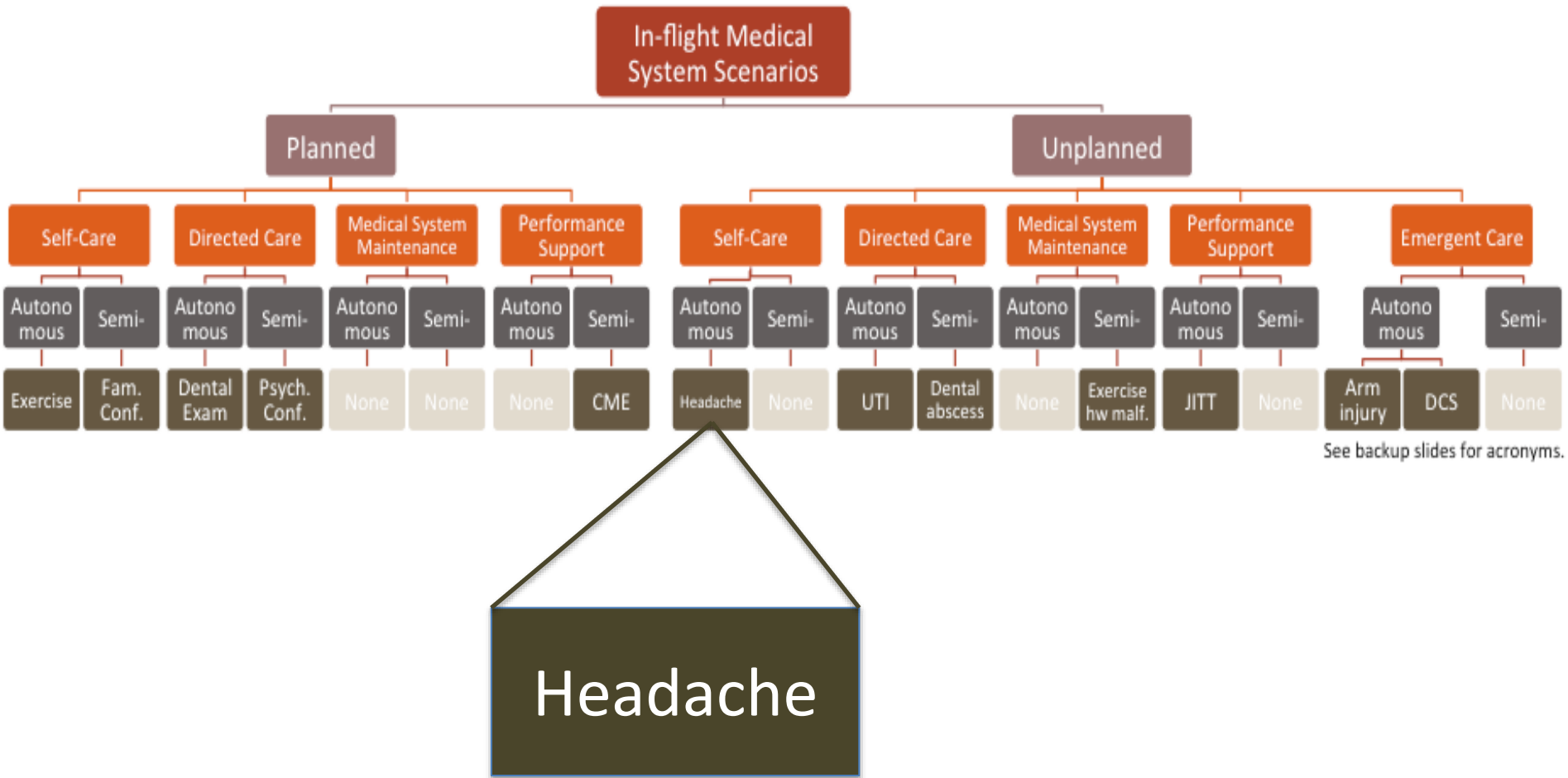
1/23/2017

Systems Engineering Session Talks

The needs identified by this work will drive future ExMC research

Review -Systems Engineering "V"

"Problem space" or "What"

"Solution space" or "How"

Review-Con Ops Scenario Tree
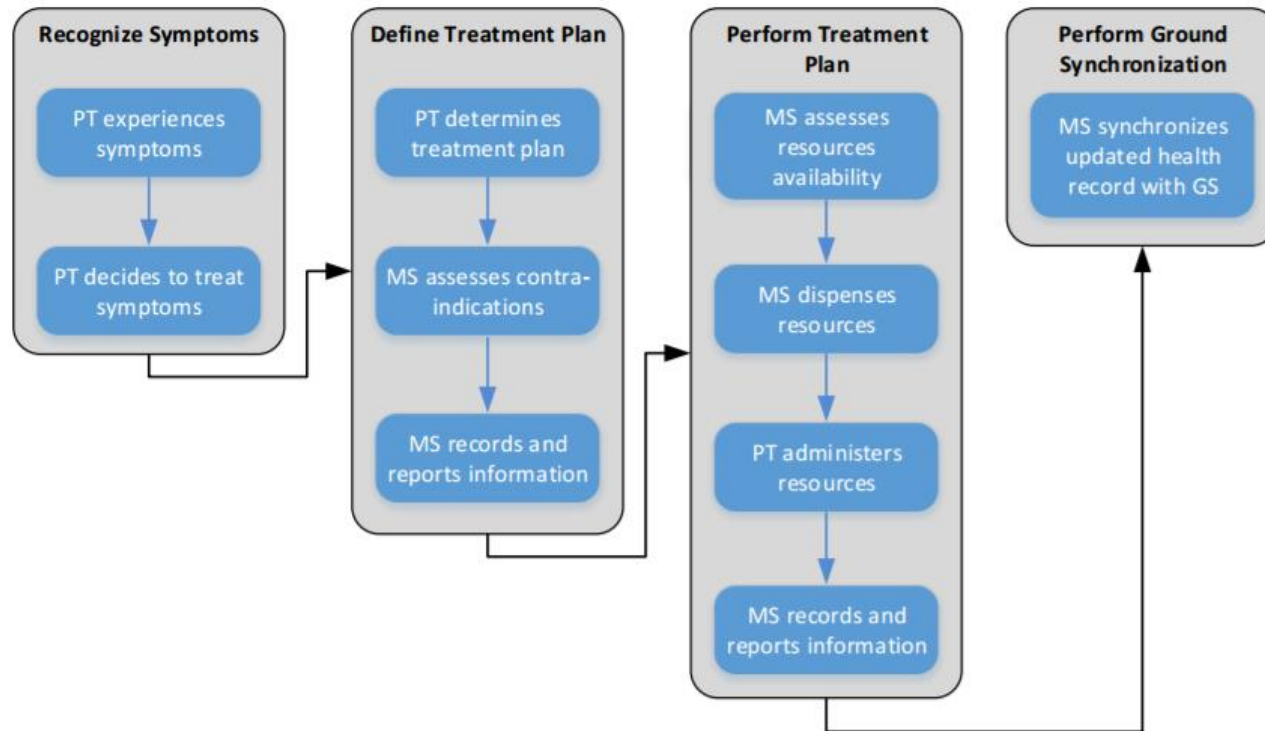
Con Ops Headache Scenario Example

Scenario: 03. Transit – IVA – Unplanned – Self-Care – Autonomous from Ground
Context: Headache

Assumption:
1) The "resource" in this scenario is a medication

Key: **MS** = Medical System   **PT** = Patient
               GS = Ground System

Recognize Symptoms
- PT experiences symptoms
- PT decides to treat symptoms

Define Treatment Plan
- PT determines treatment plan
- MS assesses contra-indications
- MS records and reports information

Perform Treatment Plan
- MS assesses resources availability
- MS dispenses resources
- PT administers resources
- MS records and reports information

Perform Ground Synchronization
- MS synchronizes updated health record with GS

Identify Needed Functions
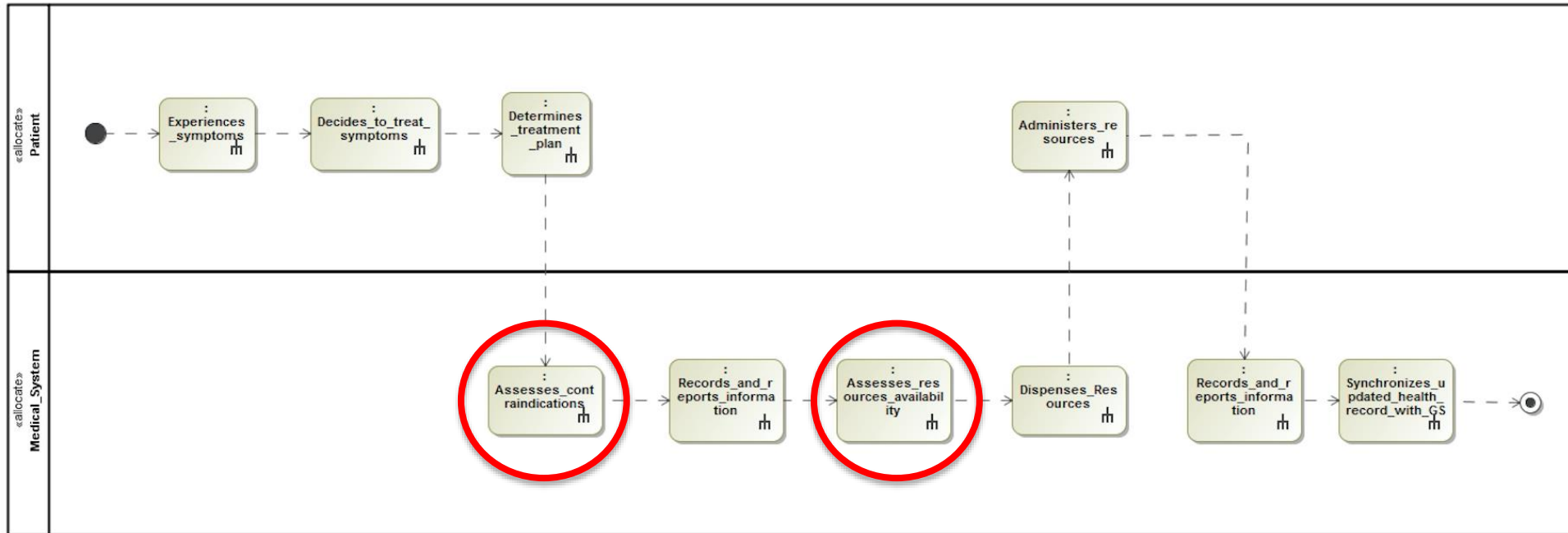
Identify Interactions

sd [Interaction] 03_Transit IVA Unplanned Self Care Autonomous from Ground [03_Transit IVA Unplanned Self Care Autonomous from Ground]

Assumptions
1) The resource in this scenario is a medication

«block»
pt : Patient

«block»
ms : Medical_System

«block»
vh : Flight_Vehicle_System

«block»
gs : Ground_System

«comment»
Pt experiences symptoms and decides to self treat

1: msPtInputTreatmentPlan
2: msAssessContraindications
3: msRecordReportInfo
4: msAssessResourceAvail
5: ptMsDispenseResource
6: msRecordReportInfo
7: vhMsTxHealthRec
8: gsVhTxHealthRec
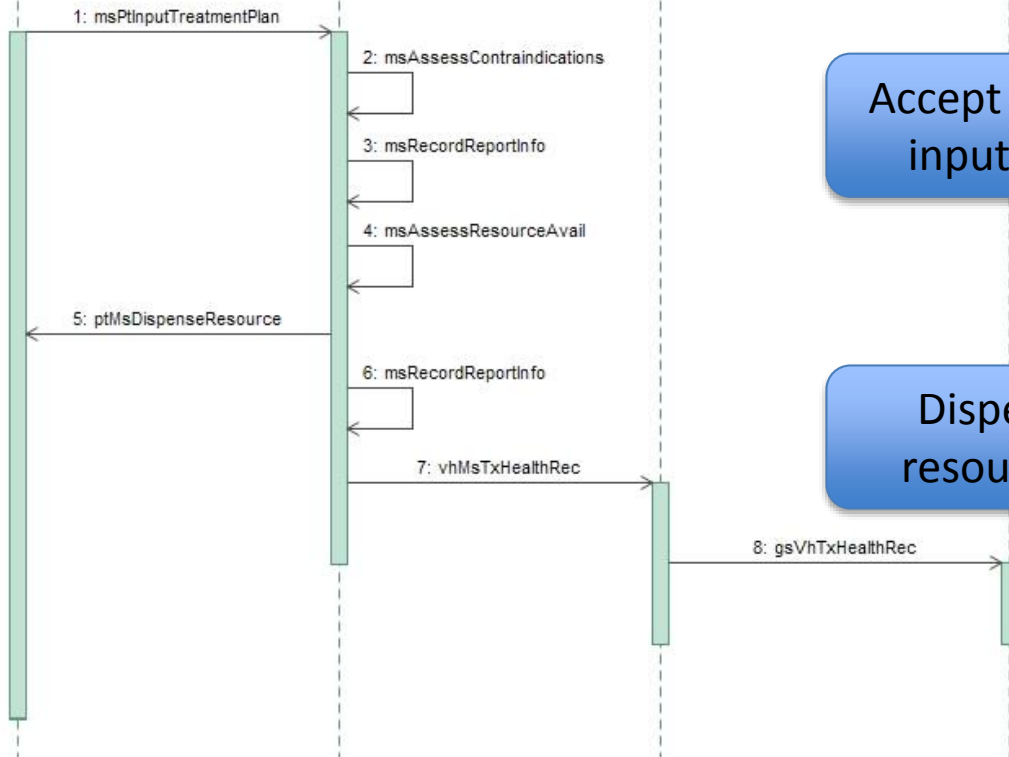
Accept treatment plan input from patient

Dispense medical resource to patient

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Build Functional Decomposition

- Begin defining problem space

«block»
Provide medical system implementation functions

«block»
Understand crew health and system status

«block»
Guide decisions on crew health actions

«block»
Support crew health action execution

«block»
Sense crew health and system status
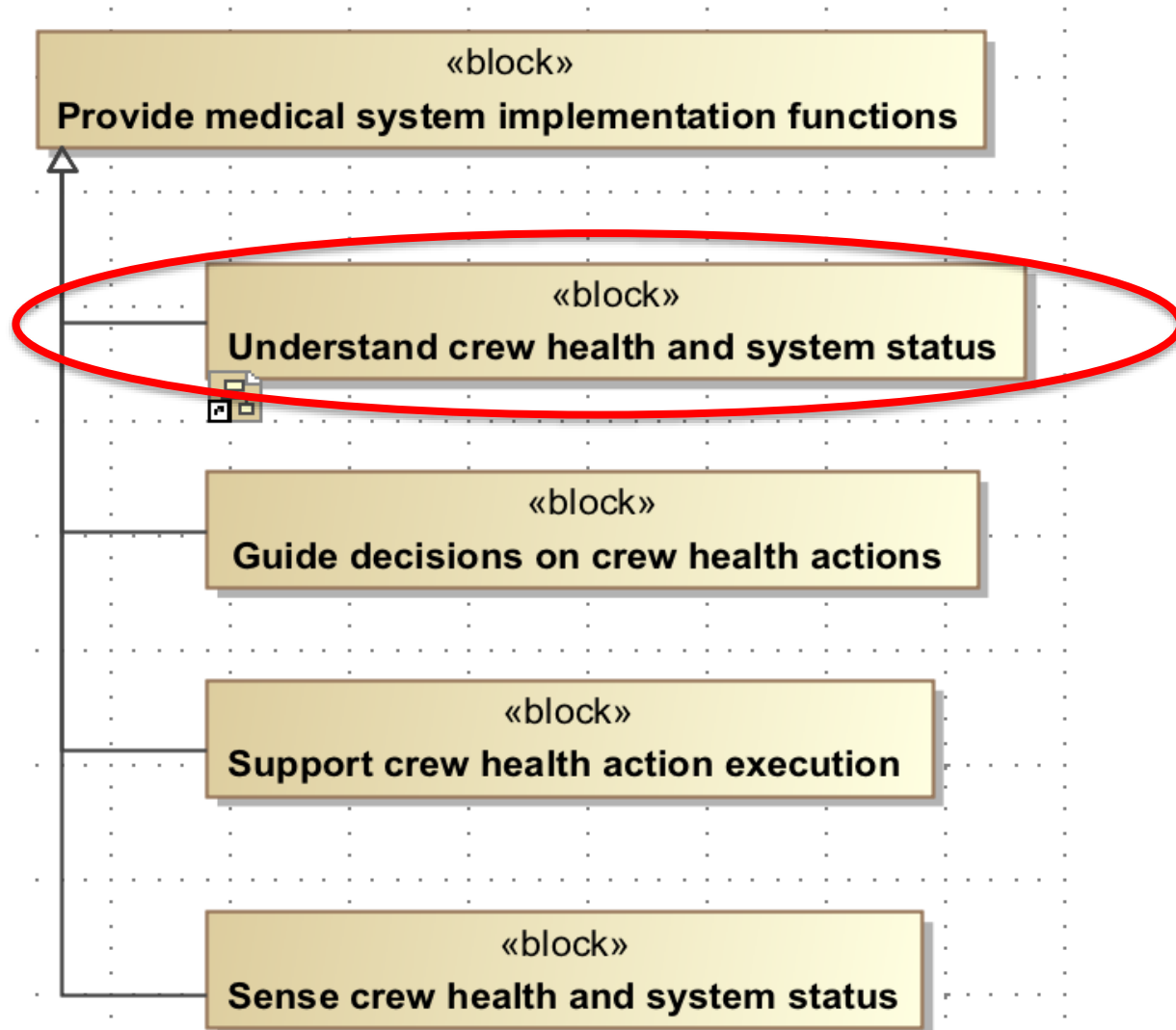
Build Functional Decomposition Cont.
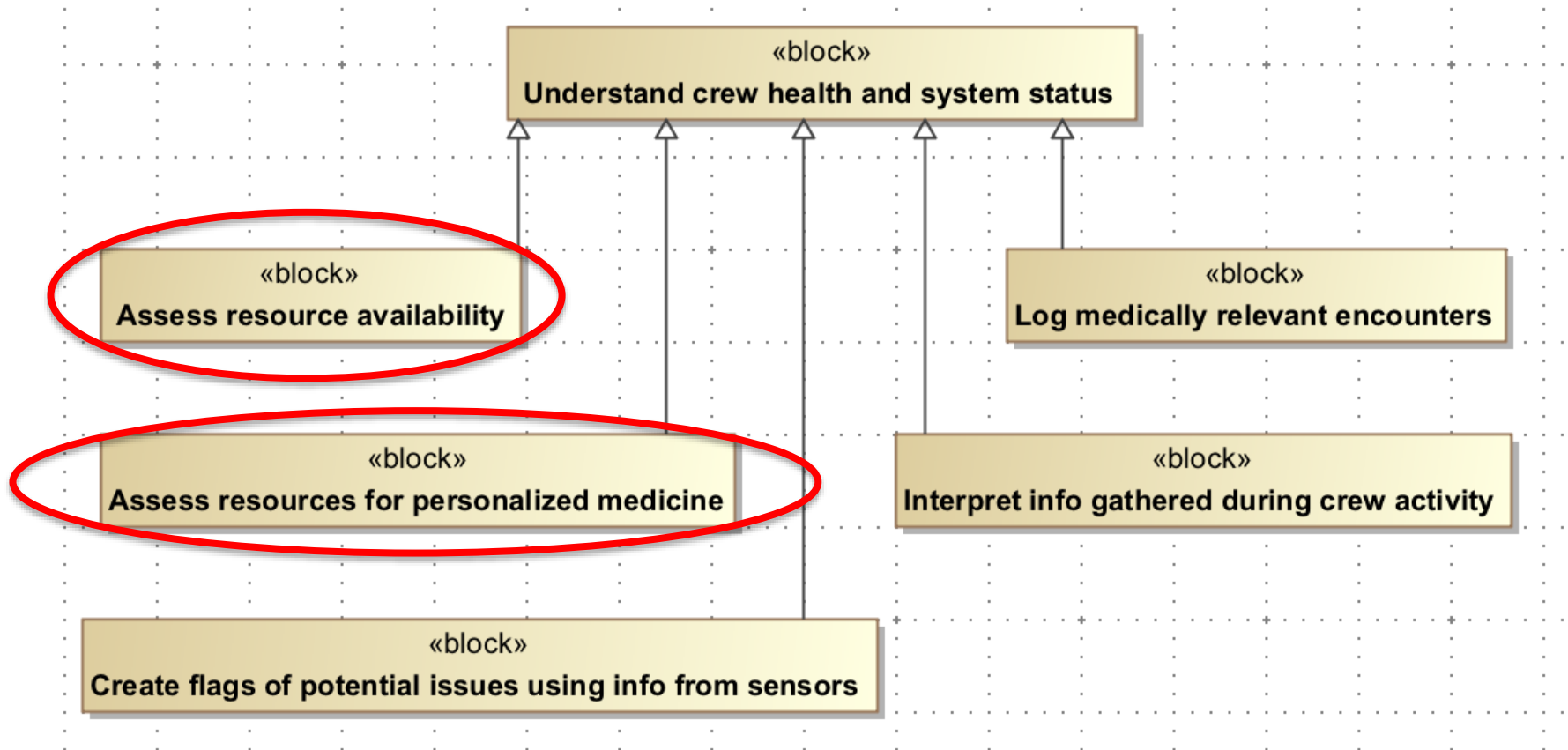
Draft System Architecture Decomposition

- Now begin bridging to "Solution Space"

Example Traceability to Requirements

Operational concepts → System functional needs → System requirements → Allocations → Subsystem requirements
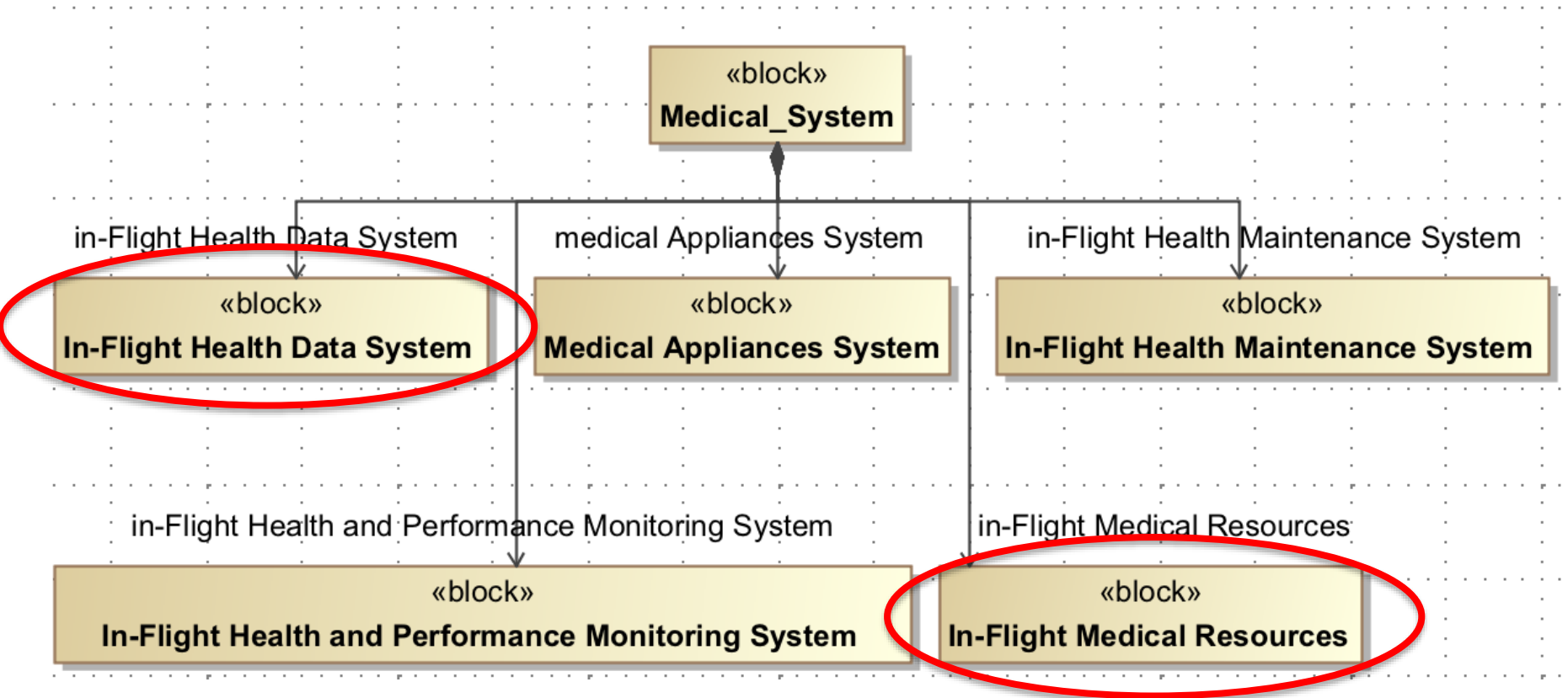
All content is in draft form!

Headache scenario

- Accept treatment plan inputs
  - The **Medical System shall** accept treatment plan inputs from a crewmember.
- Assess resource availability
  - The **Medical System shall** track and assess medical resource availability.
- Assess resources for personalized medicine
  - The **Medical System shall** assess medical resource appropriateness for individual crewmembers.
- Dispense medical resources
  - The **Medical System shall** provide medical resources to a crewmember.

In-flight Health Data System
- The In-flight Health Data System shall...
- The In-flight Health Data System shall...
- The In-flight Health Data System shall...

In-flight Medical Resources
- The In-flight Medical Resources shall...
- The In-flight Medical Resources shall...
- The In-flight Medical Resources shall...

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Systems Engineering Process "V" Example

Traceability supports system negotiation

Informs V&V planning

Operational Need

Delivered Capability

Decomposition

Realization

Requirements

Validated Solution

Design

Product

Technical Processes
- Stakeholder Requirements Definition
- Requirements Analysis
- Architecture Design

Technical Processes
- Transition
- Validation
- Verification
- Integration
- Implementation

Technical Management Processes
- Decision Analysis
- Technical Planning
- Technical Assessment
- Requirements Management
- Risk Management
- Configuration Management
- Technical Data Management
- Interface Management

Summary

- "What" not "How" initially
  - ConOps → Functions → Requirements

- Structured approach
  - Envisioning and guiding the development of an exploration medical system is a big job
  - This approach gives an organized path

- Traceability
  - When negotiations are necessary regarding capabilities to include (hardware and/or software), we are able to trace to impacted requirements and system functions
  - Identify orphans – then why do we have this capability?
  - Identify parents with no implementation – function and capability are lacking → **RESEARCH NEED**

Conclusion

- Next steps
  - Top Down – continue:
    - Activities and interactions
    - Functional decomposition
    - System architecture
    - Traceability
  - Bottom Up – begin reconciling existing subsystem level content
  - Draft system functional requirements 2017

- Cross-disciplinary, cross-Center team has made huge strides in only a few months

Thank you