



Medical System Trade Space Evaluation Tool for Exploration Missions

Chris Middour — Ames Research Center

Tony Jannette — Glenn Research Center

Jerry Myers — Glenn Research Center

Melinda Hailey — KBRwyle at Johnson Space Center

Jennifer Mindock — KBRwyle at Johnson Space Center

2018 Human Research Program Investigators' Workshop

- **Introduction**
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- **Acknowledgments**

Introduction



- **Ensuring crew health is of paramount importance as NASA takes the next steps – space exploration beyond low Earth orbit**
 - The Deep Space Gateway (DSG) and Deep Space Transport (DST) vehicle designs need to integrate the medical system alongside traditional subsystems to make best use of limited mass, power, and volume
 - Determining how to accommodate human crews requires using historical experience coupled with risk assessments for the particular missions DSG and DST represent
- **Trade Space Evaluation Tools**
 - ExMC leadership needs to participate in trade studies
 - With medical community (medical conditions, capabilities, risks)
 - FY18 focus is on “Loss of Crew Life” risk metric
 - Support identification of technology gaps
 - With vehicle design community (mass, volume, power)
 - Need timely turnaround to keep up with vehicle design process



Motivation for Developing Medical System Tool



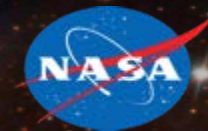
Category	ISS	Gateway – Lunar	Transport – Mars
Response to Acute Symptoms	Stabilize and Evacuate		Stand and Fight
Primary Caregiver	Earth Medical Ops		Physician Astronaut
Level of Care	4: trauma care, diagnostics, private audio/video		5: 4 + basic surgical care
Mission Length	180 days	6 to 42 days	2 to 3 Years
Time to Definitive Care	Less than 24 hours	Days	Months to Years
Crew Communication Delays with Earth	Real-time	Less than 3 seconds	Up to 42 minutes round-trip
Medical Resupply Time	Months	No resupply	No resupply

Exploration Missions Require Paradigm Shift in Medical Care

- Lunar – no resupply
- Mars – crew autonomy from Earth, physician astronaut primary caregiver

Departure from
prior experience

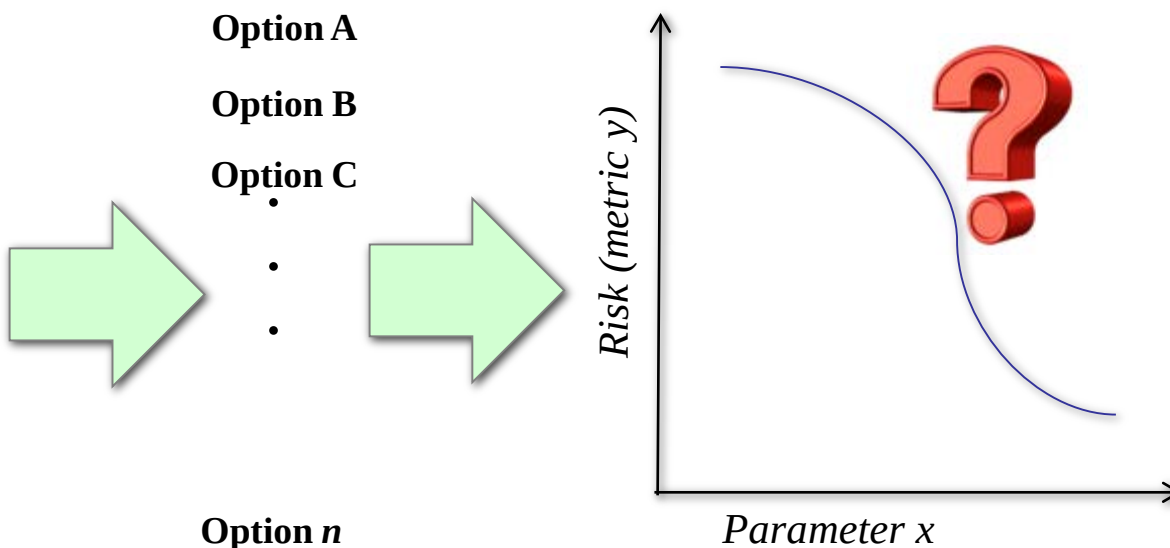
Purpose of Trade Space Evaluation Tool



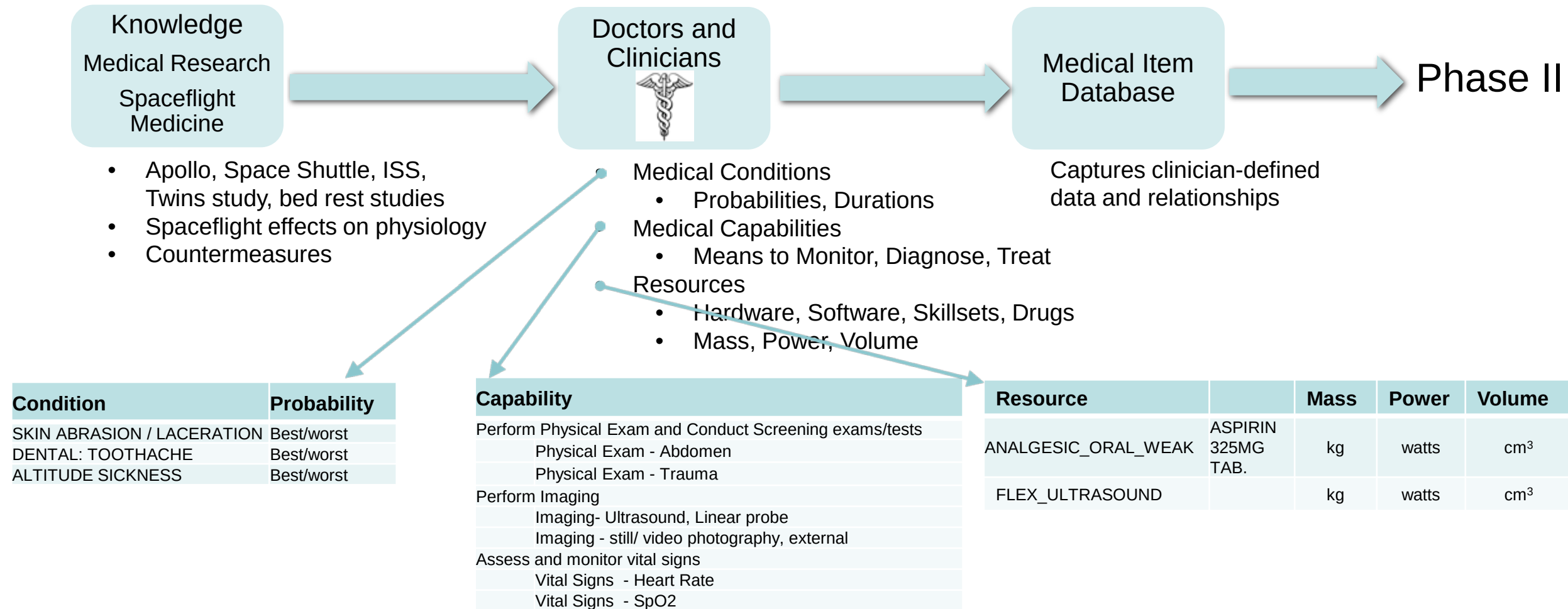
- **ExMC is leveraging prior efforts to produce an Integrated Risk Analysis tool to**
 - Inform the design of Medical Systems for Deep Space Exploration Missions
 - Enable “what if” scenarios to be done quickly in response to varied risk postures, missions, and/or mass, power, and volume constraints
 - “What if medical system mass were cut by 50%? How would risk be affected?”
 - Identify “gaps” in capability that require research or technology development
 - Establish infrastructure to coordinate with other crew health and performance tools
 - Provide a quick turnaround in answering queries (days, not months)
 - Provide consistent results across the set of tools

Trade Option Characterization

Medical conditions addressed
Medical Standards met
Master equipment list
Mission characteristics (trajectory, communications, duration)



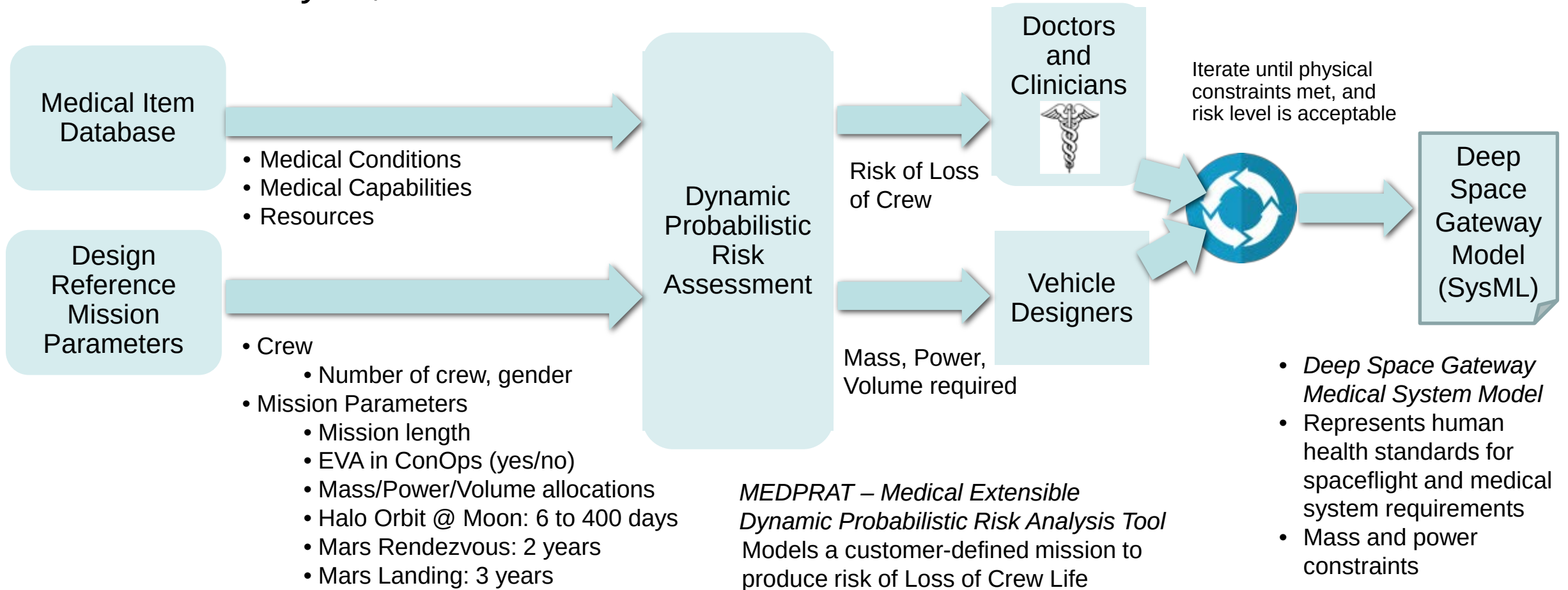
Phase I: Assemble Data



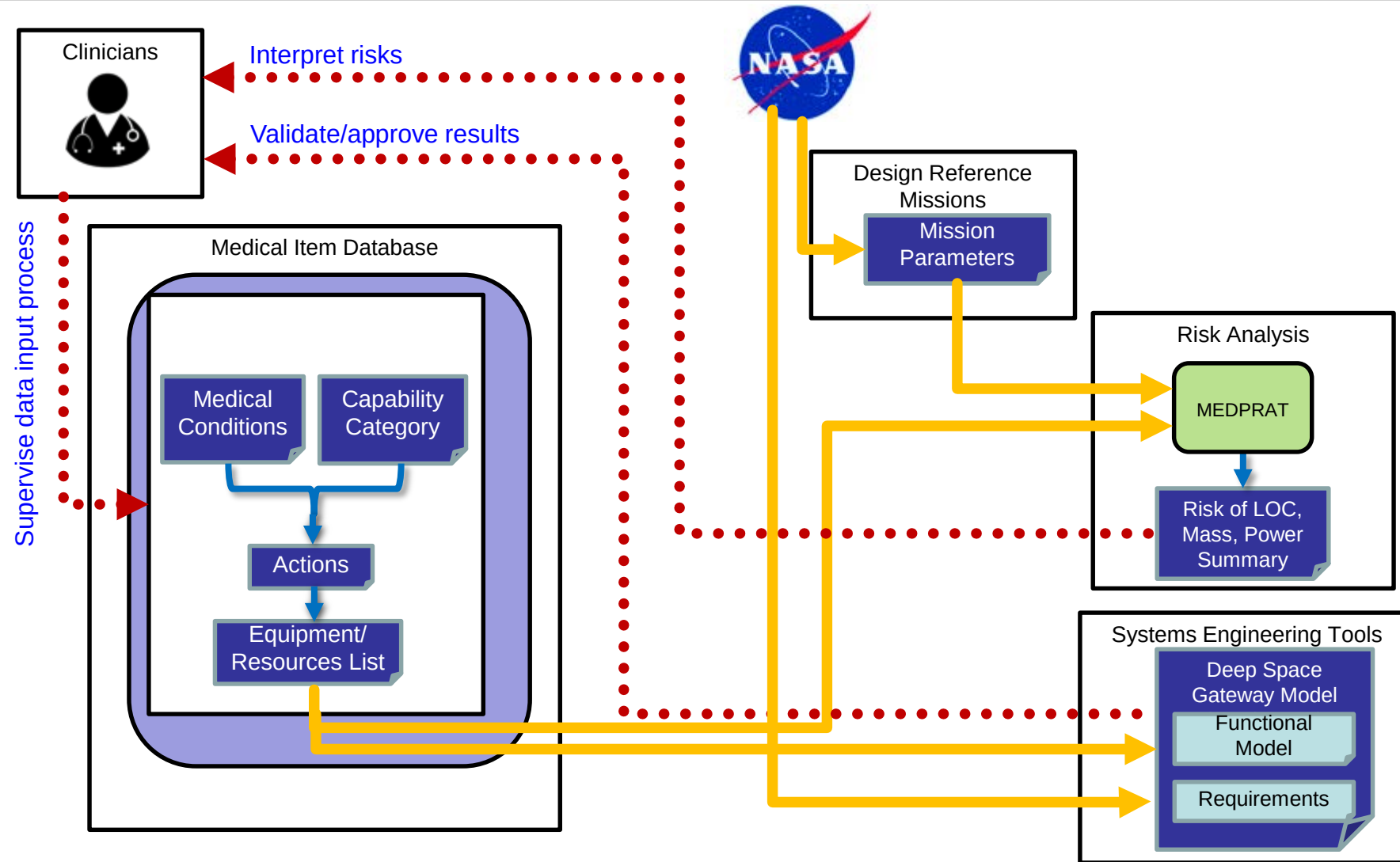
Conceptual Model: Phase II



Phase II: Analysis, Trade Studies



Logical Model: Integrated Tool



Schedule



2017	2018									
Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct

Define Goals
and Objectives

Identify gaps
between goals
and existing
component
capabilities

Baseline
Design

Baseline
Components

Integrate, Test,
Validate

Demo Dry Run

Demo for
Stakeholders

Enable medical system to inform vehicle design up front

Enable trades between risk, mass, power, and volume

Integrate medical system model in vehicle model

Model captures medical requirements and architecture to integrate into vehicle model

Identify medical technology and method gaps

Identify areas of medical technology that need further research and development

Demonstration of capabilities in FY2018

Integrate support tool

Ensure tool is evolvable to integrate with future tools

SOLV, workstation evaluation, decision support

Identify gaps in medical capabilities

Identify medical health monitoring, diagnosis, and/or treatments without spaceflight heritage

Optimize software

Auto-select resources to mitigate risk based on pre-set parameters

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