Principles to Products: Toward Realizing MOS 2.0

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Context

- AMMOS
  - Advanced Multi-Mission Operations System
  - Product line: Adaptable tools and services for operating NASA's robotic missions
  - Key advantage: Cost and Risk
    - "Why re-invent the wheel?"
- Ops Revitalization Initiative
  - Enhance, extend multi-mission Ops
- MOS 2.0
  - The Next-Generation Mission Operations System

An Architectural Approach

- Principled
- Stakeholder-focused
- Components, connections, constraints
- Separation of concerns
- Identification of fundamental patterns
- Model-Based Methodology
  - Didn’t start with MBSE

Architectural Principles

- Intended to be pervasive invariants
  - Inform design and implementation
  - Not requirements (not strictly verifiable)

– Primacy of Principles	– Technology Independence
– Close The Loop	– Universality of Information Security
– Customer Focus	– Use of Common Services
– Info Accessibility	*– Authoritative Sources of Information*
– Interoperability (open standards)	*– Develop With What You Fly With*
– Learn from Experience	

Stakeholder Engagement

- Directly engaged with domain experts via meetings, 1-1 interactions, talks, etc.
- Major Concerns include:
  - Control and estimate of State
    - Of spacecraft and instruments
  - Lifecycle support by MOS for Mission
    - Availability during FSW development
  - Adaptation (or Development) of the MOS
    - Ease in formulating/implementing (maximizing reuse)

MBSE Methodology

- Rigorous language for system engineering
  - SysML 1.2 and BPMN 2.0
- Explicit
- Standards-based
- Authoritative source
- Leverages architectural patterns
- Substantial gains in managing complexity
- Engineers spend more time engineering

Concerns, Viewpoints, Views

- View
  - Description of a system that addresses a particular point of view or *Viewpoint*
- Viewpoint
  - Template for information needed to construct a *View*
  - Aligned with/responds to *Concerns*
- Stakeholder have *Concerns*
  - Statement expressing interest in a quality or characteristic of the system of interest

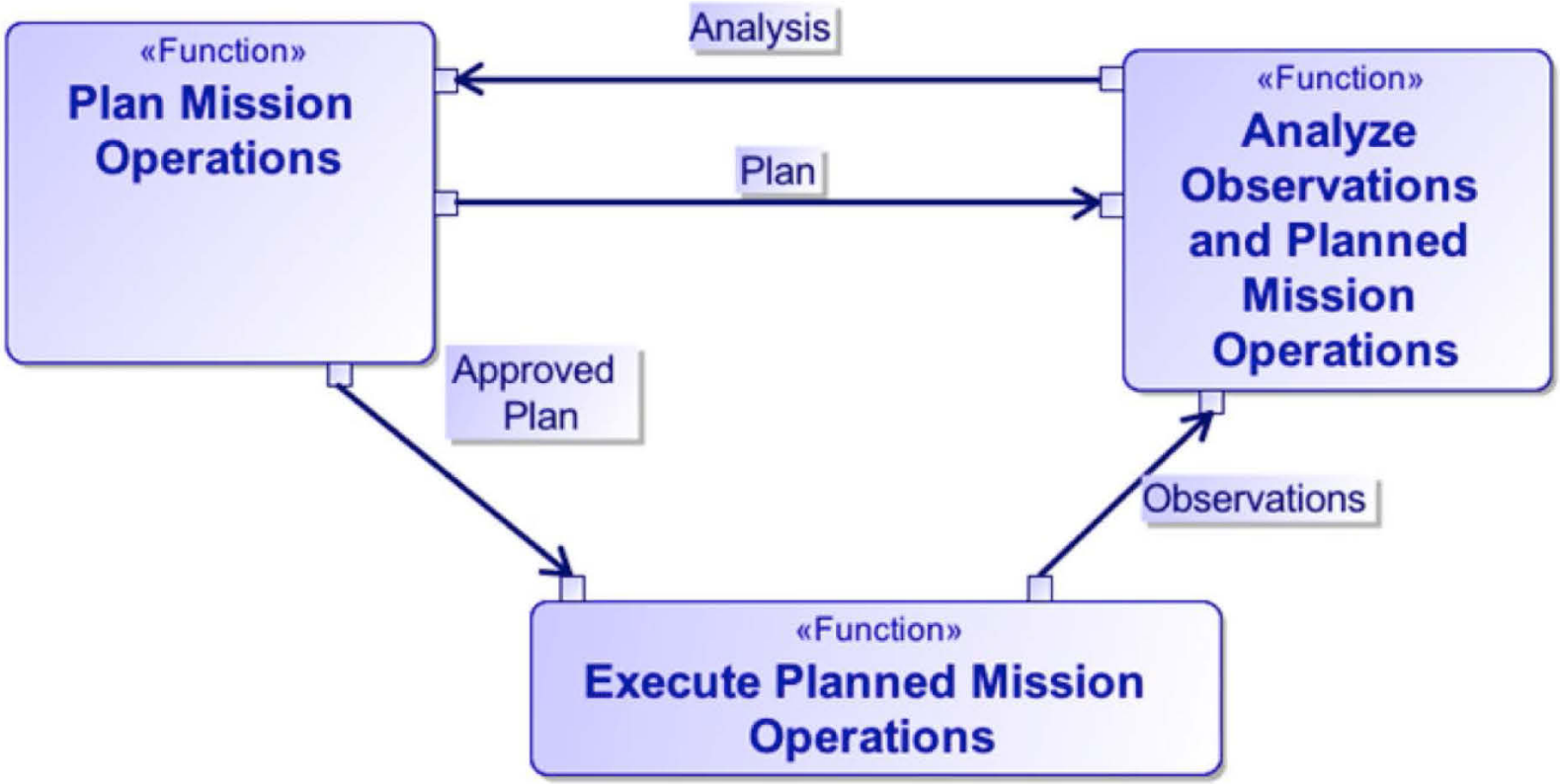
MOS 2.0 Concepts & Patterns

- Timelines
- Control System
- Process
- Services
  - Capabilities offered According to Agreements
- Queueing & Process simulation
- Standardized Design Specs
- **Key Point**
  - Each has a value proposition that supports the overall business case

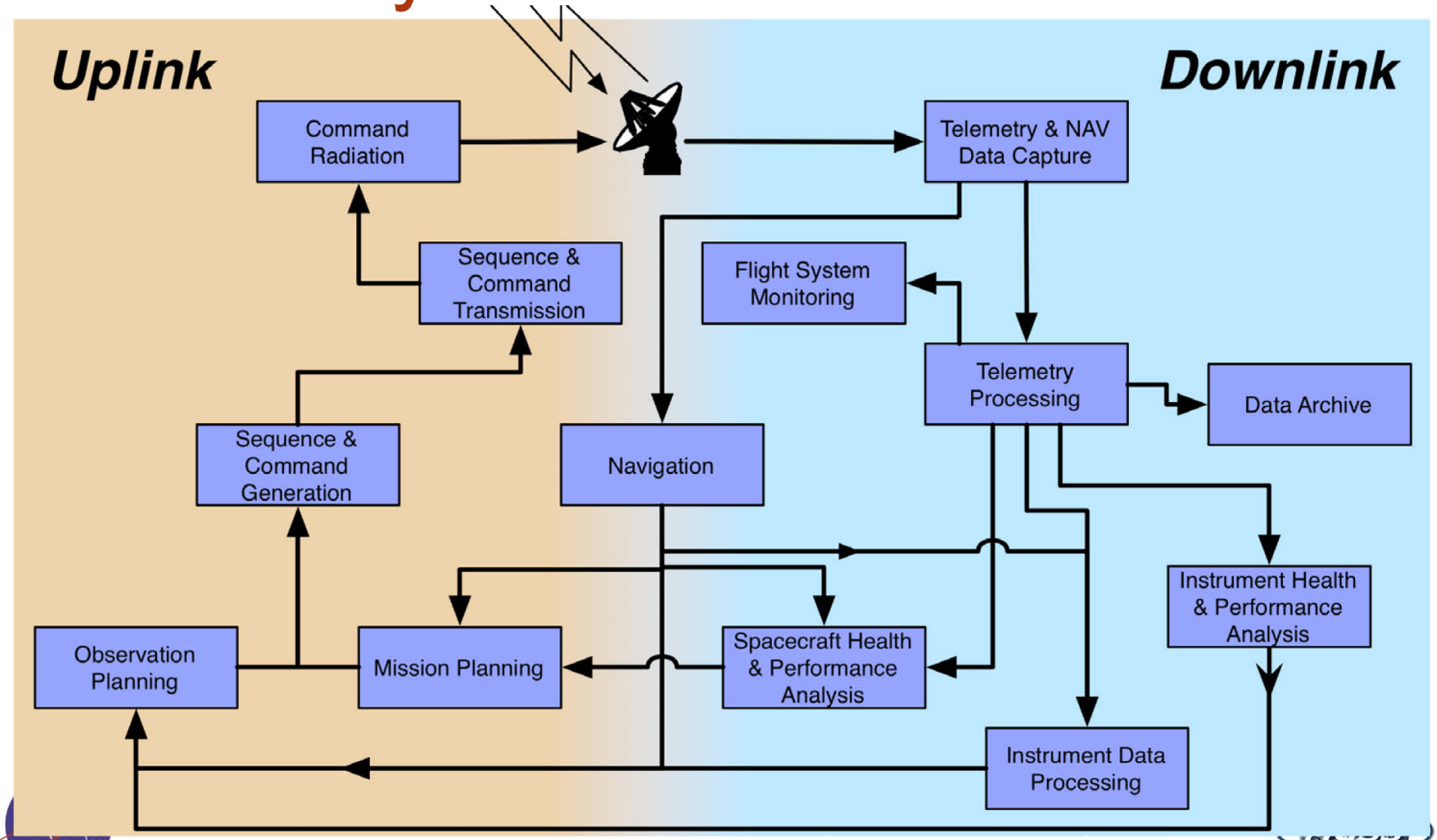
Timelines

- Fundamental to mission planning
- More powerful when applied to all aspects of MOS
- For more, see:
  - Reinholtz, Thurs., 1100-1130 (CSIS)
  - Chien *et al.,* Thurs., 1130-1200 (ME)
  - Seung & Bindschadler, Fri., 0930-1000 (ME)

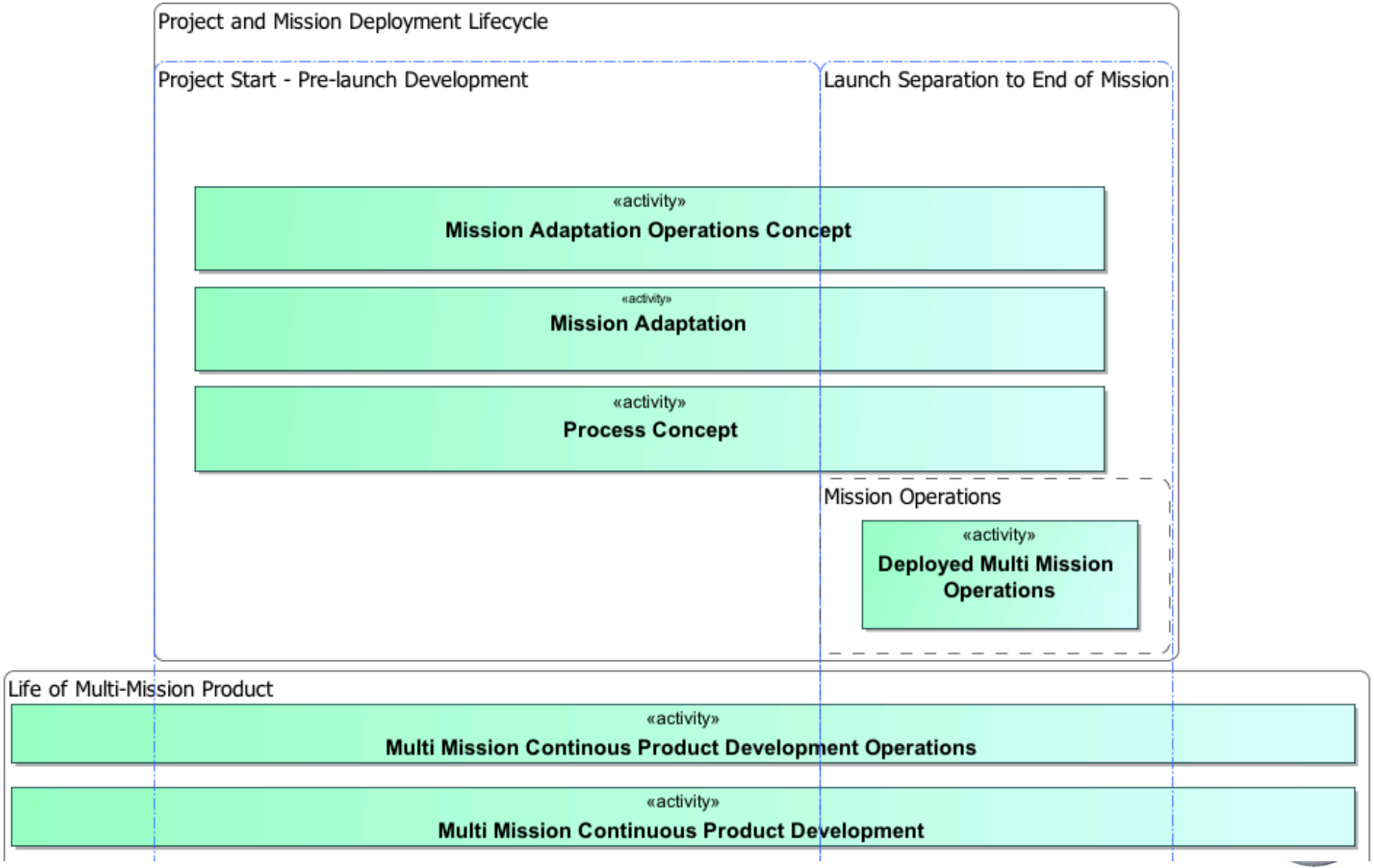
Control System: To-Be



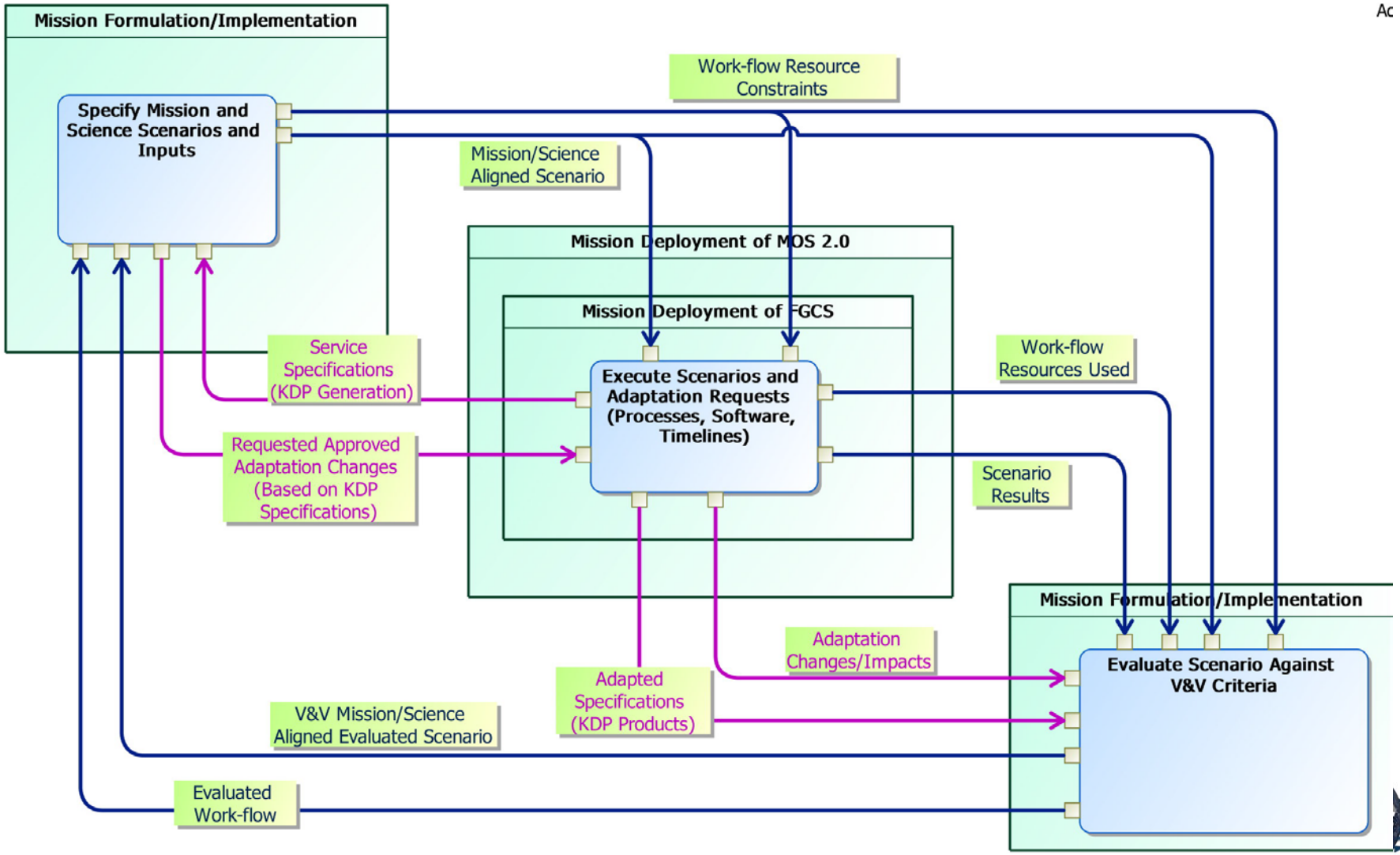
Control System: As-Is



AMMOS Lifecycles

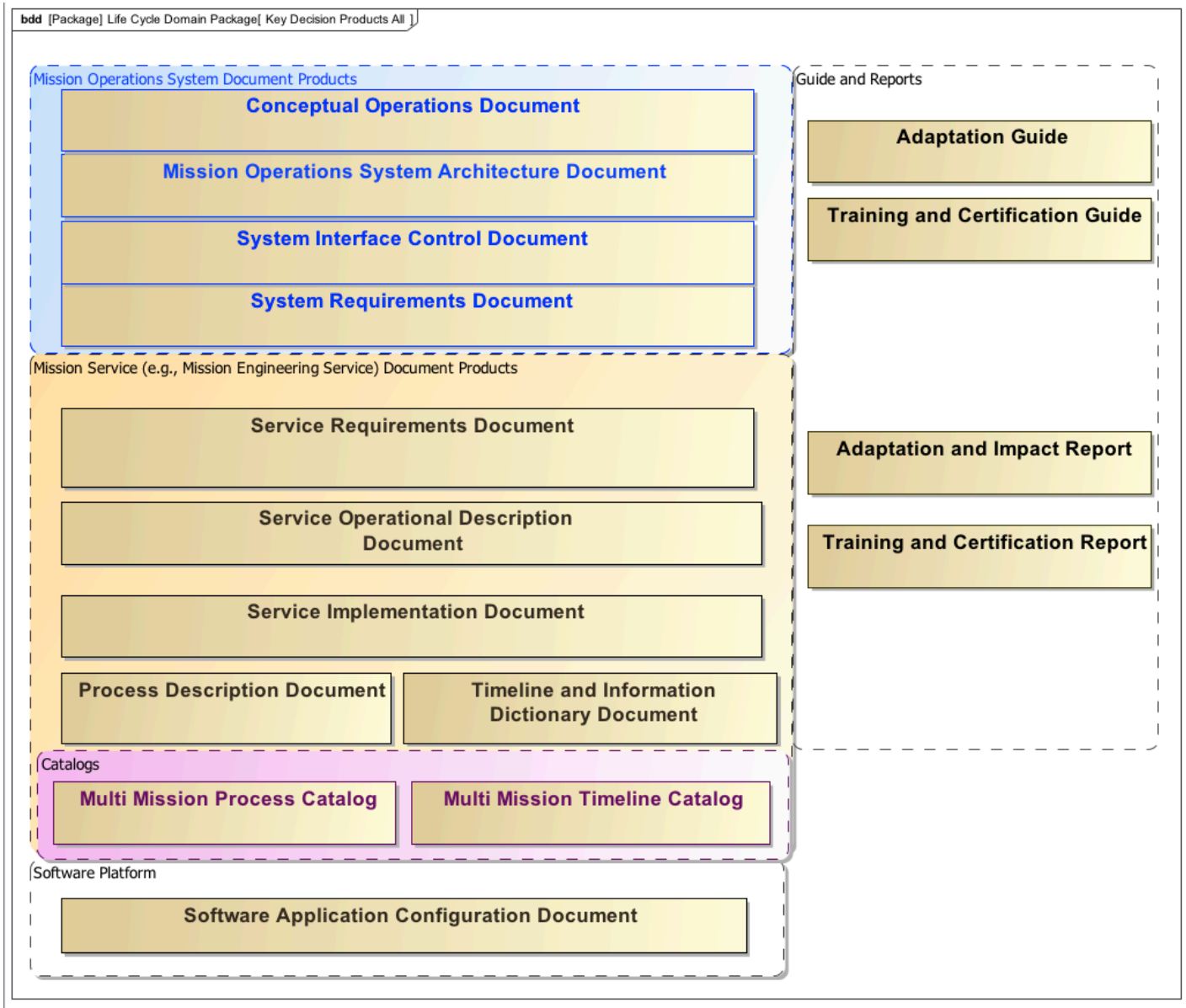


Adaptation Concept

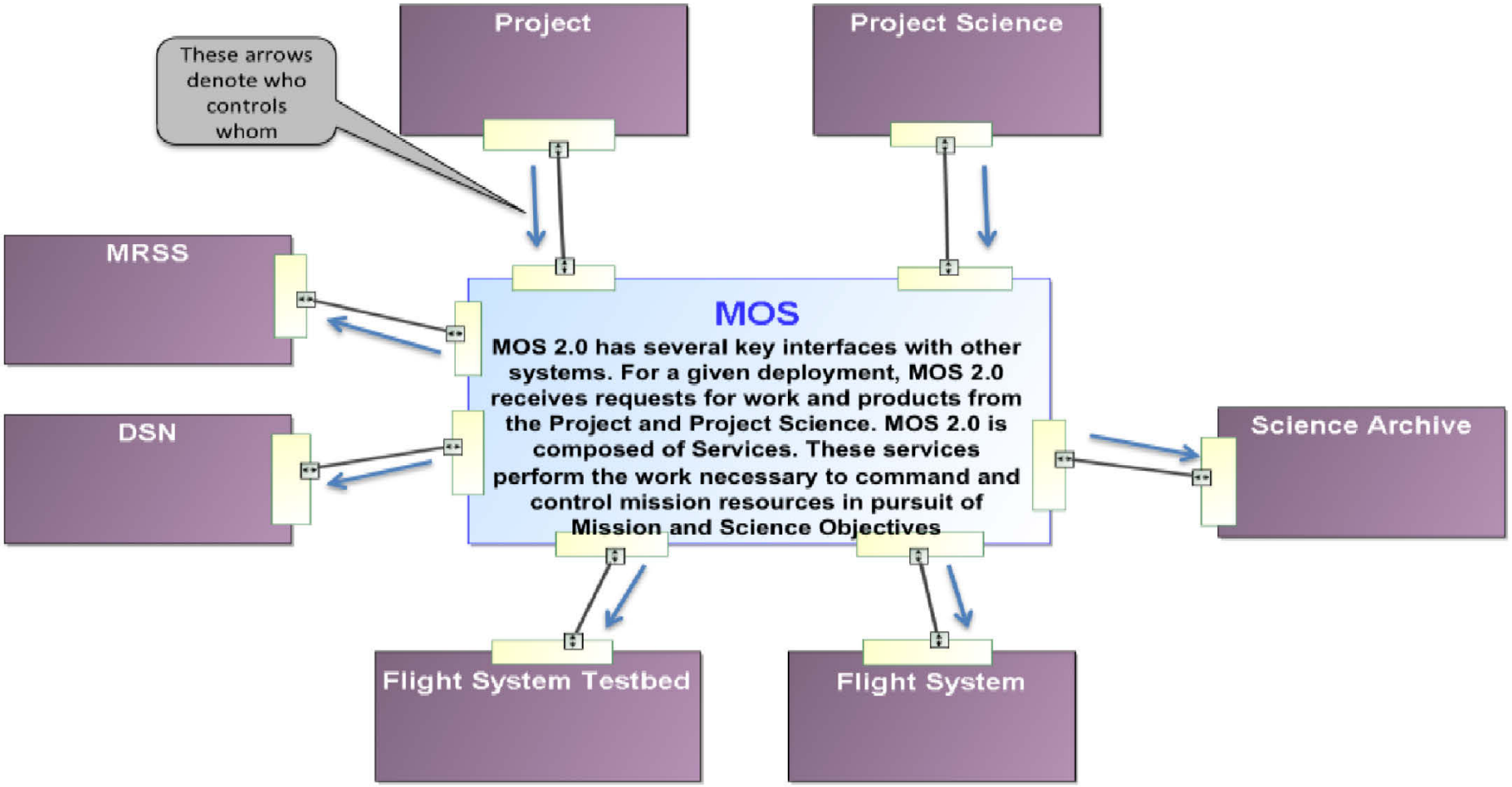


Ops Revitalization Results

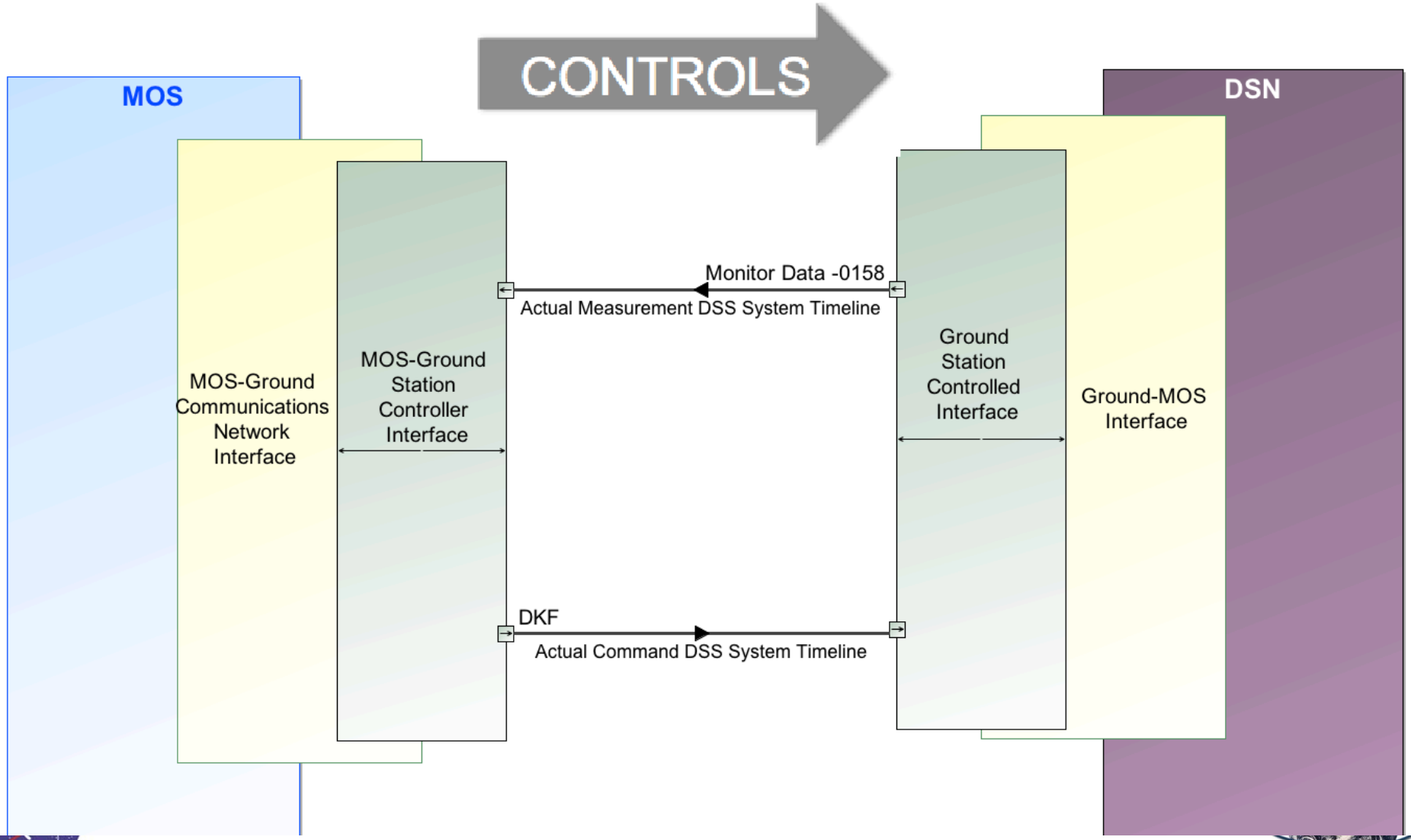
Documentation & Reports



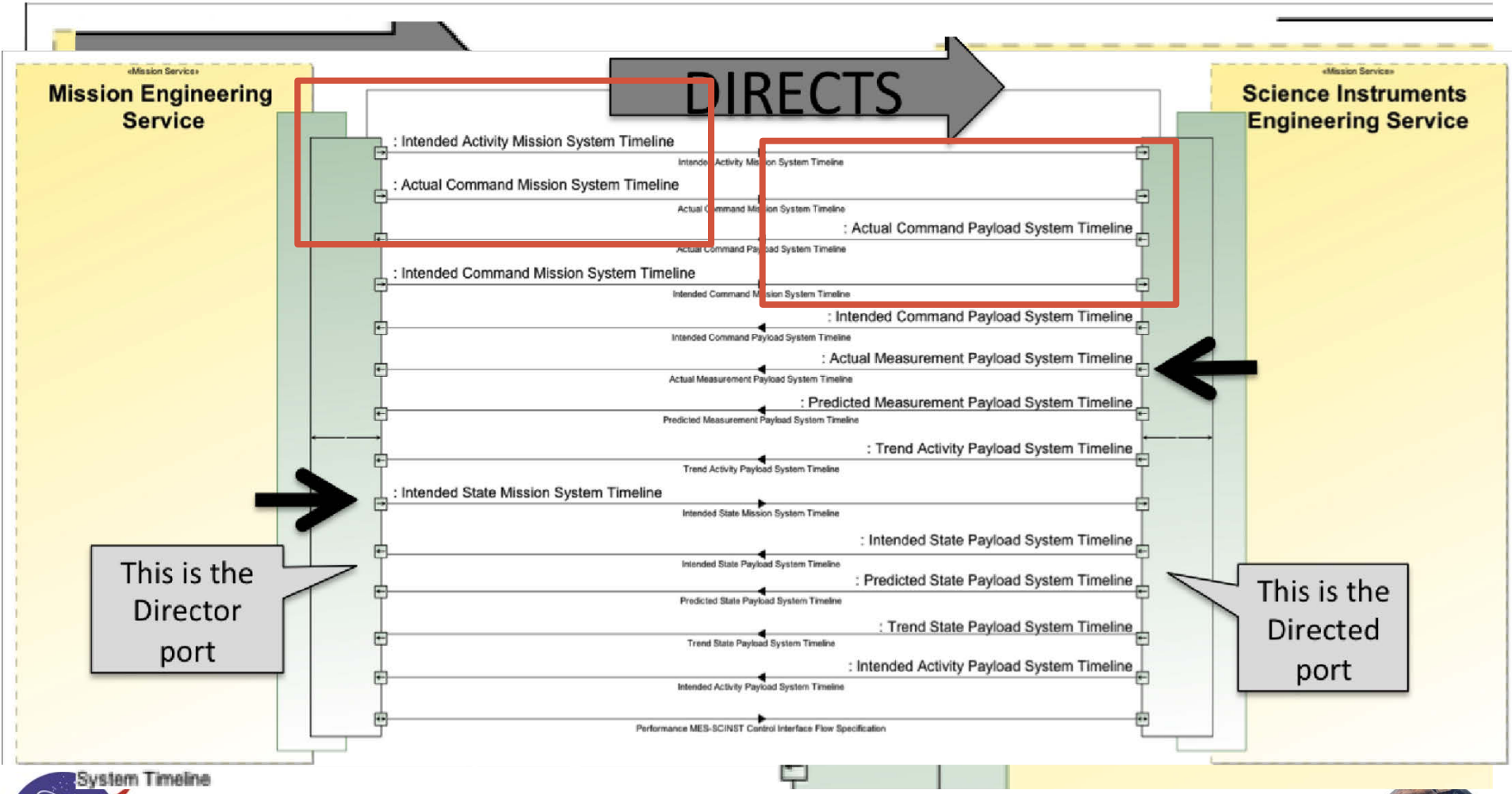
Control Interactions



Controlling Interface

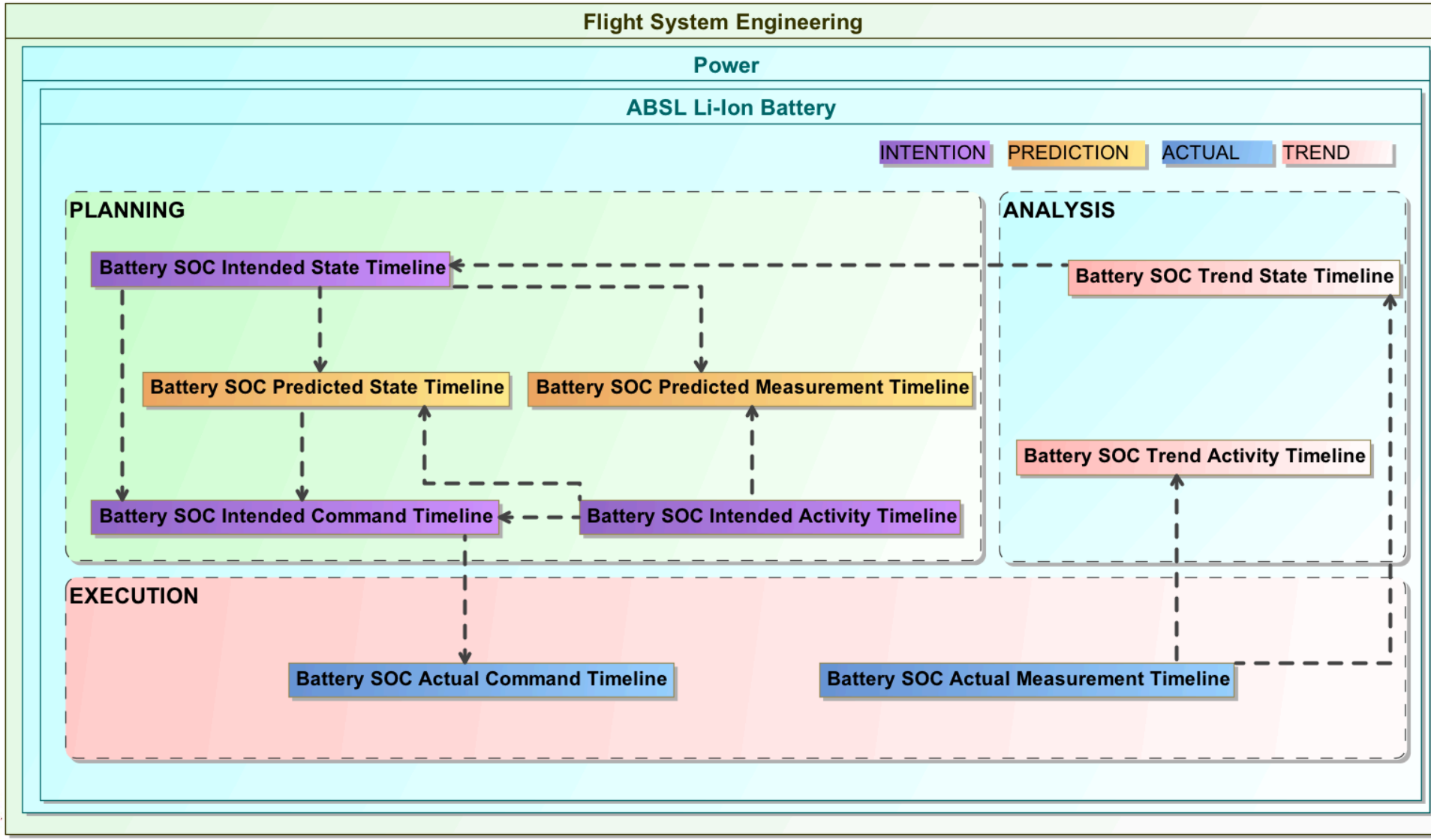


Directing Interface



System Timeline

Control System using Timelines

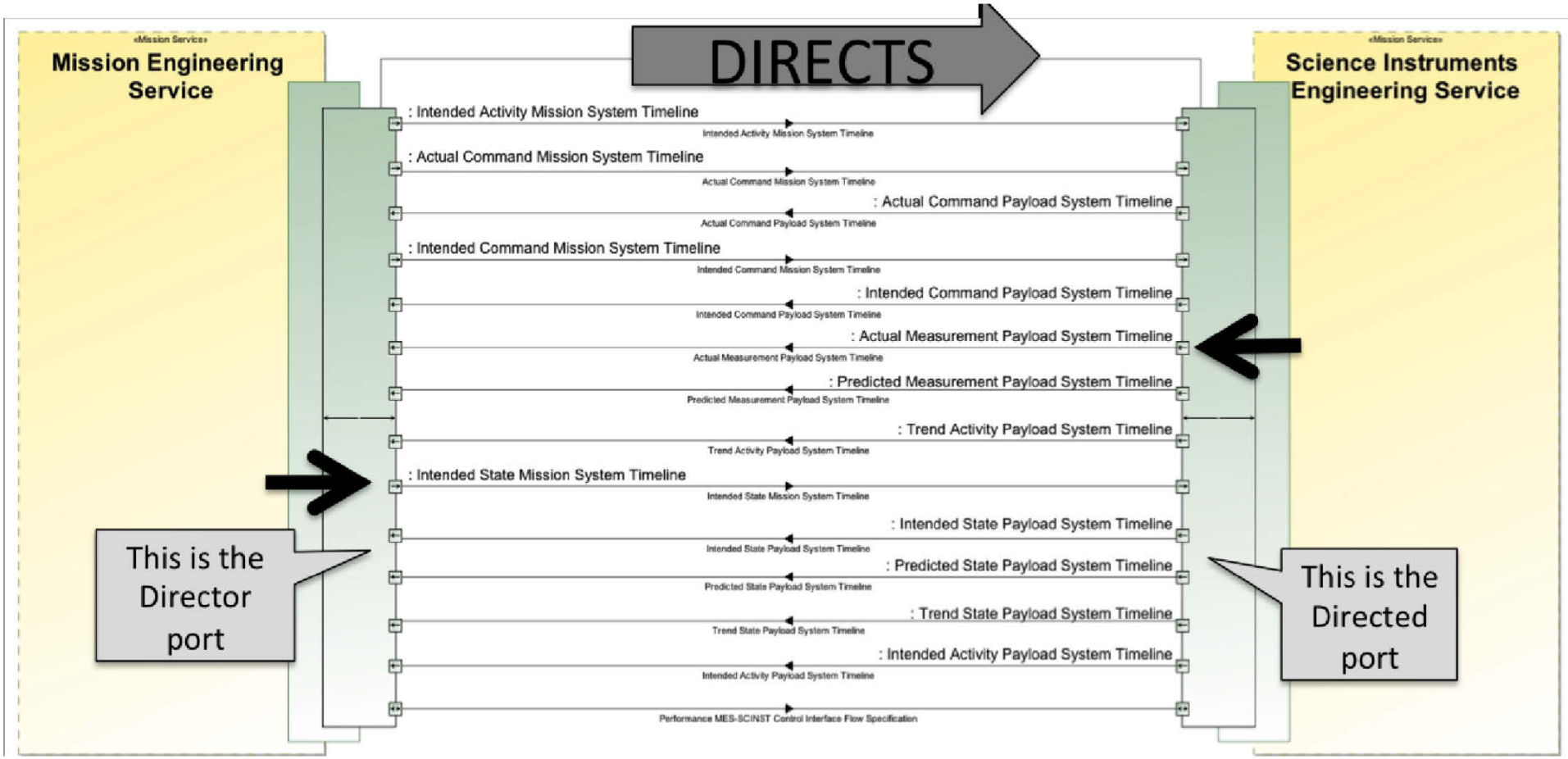
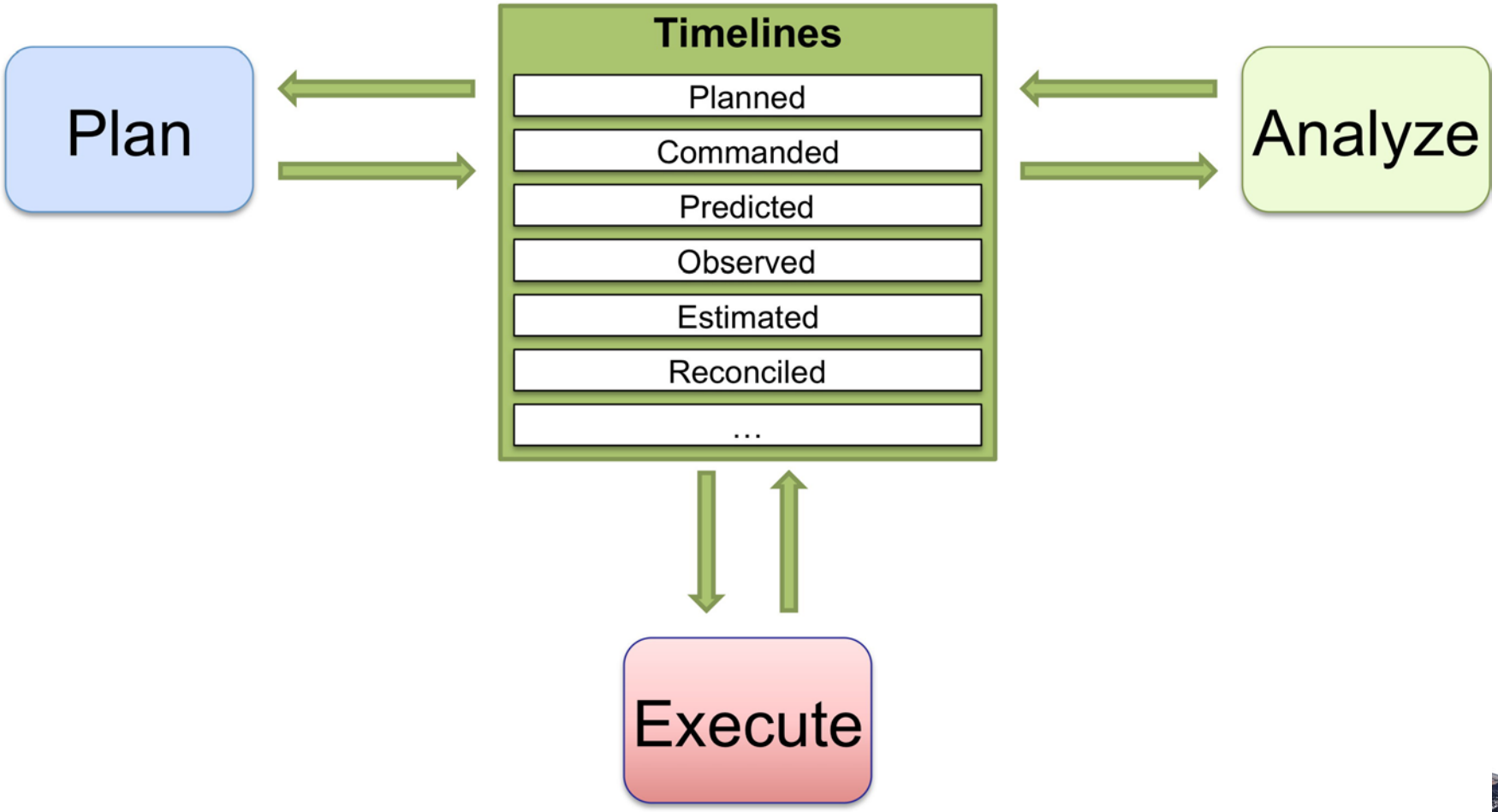


Conclusions

- Architecture and MBSE enable a new kind of Mission Operations System
- A Control System
  - Composed of Services
    - Common components and interaction patterns
  - Using Timelines
    - *Lingua franca* for the MOS
  - With Authoritative Sources for Information
    - Within the MOS
    - About the MOS

Backup

Directing Interface



Timeline-Based Control