A Structured Model-Based Systems Engineering Methodology for Operations System Design

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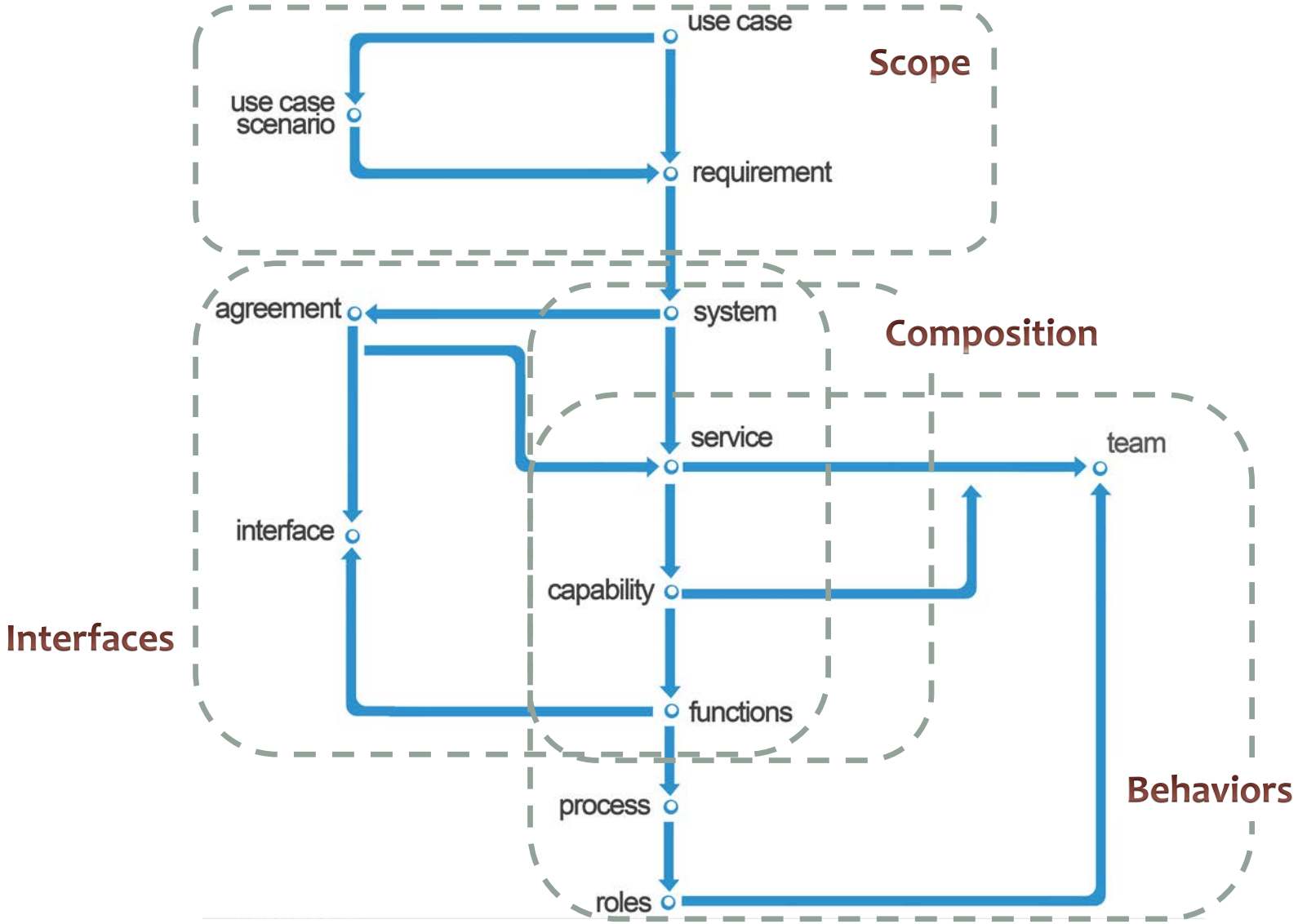
Overview

- Multi-Mission Operations System (MMOS) model
  - And a few words about Architecture
- MMOS model structure and adaptation methodology
- Project Usage
- Conclusions

Fundamentals

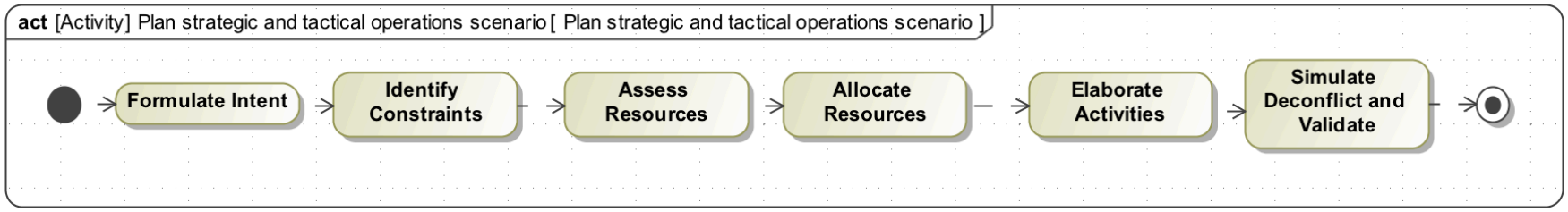
- MMOS is
  - Reusable
  - Adaptable (to Mission needs)
  - Design Model for a Mission Ops System
  - Captured using MBSE
  - Based on a principled Architecture
    - “Close the loop”
    - Use Authoritative Sources for Information

Adaptation Methodology



Step 1: Scope the MOS

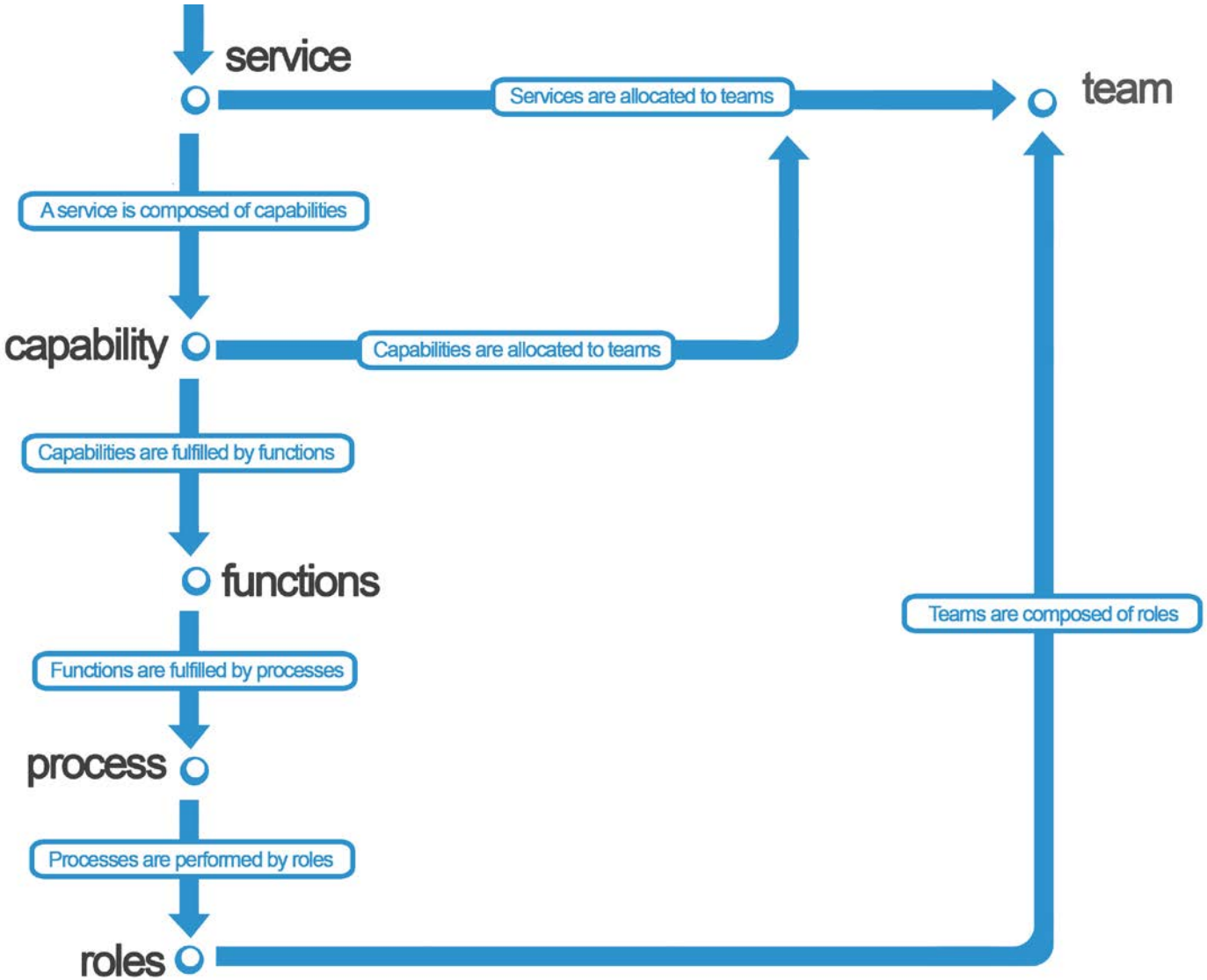
Use Case Scenario



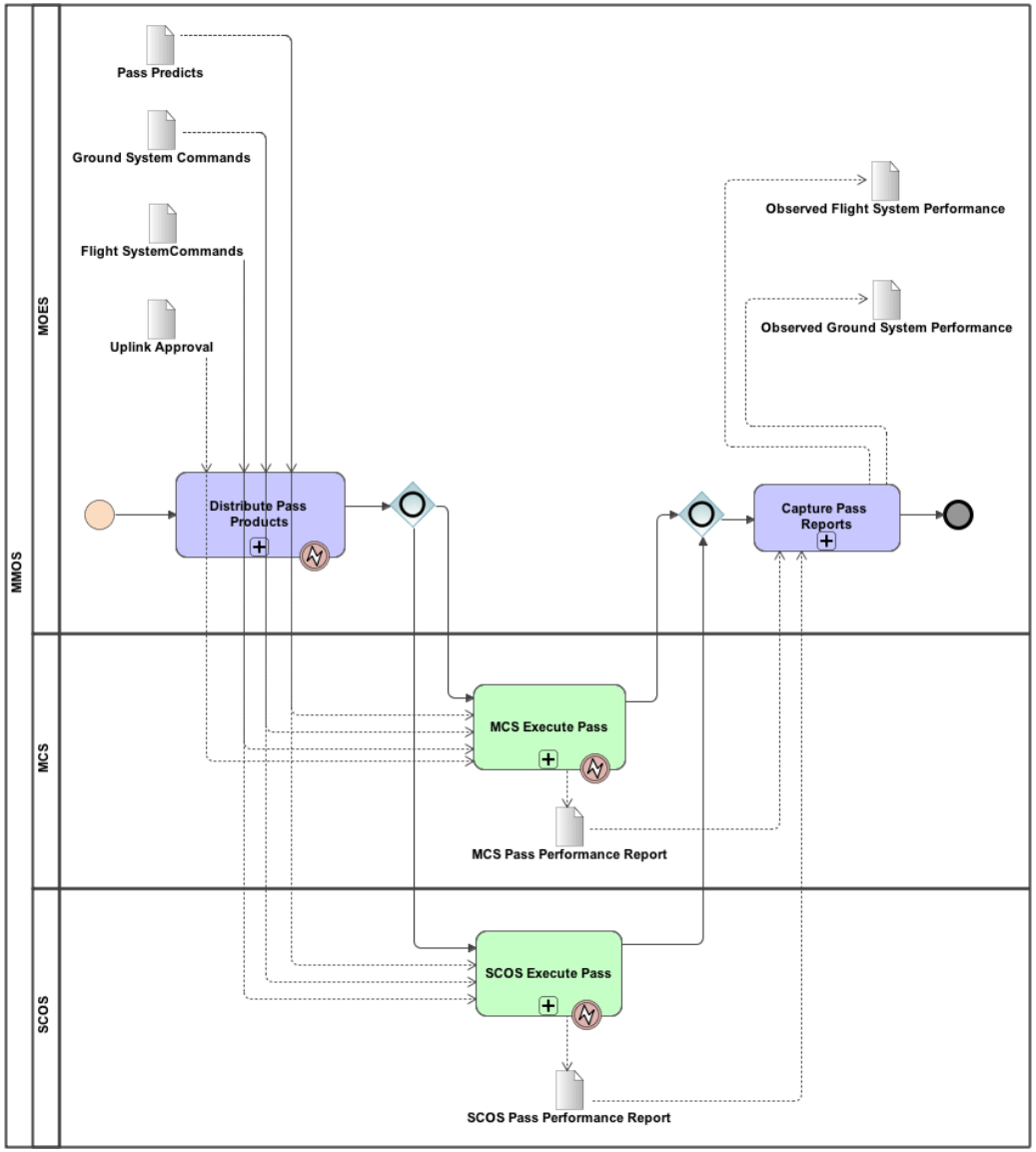
Step 2: Compose the MOS

Step 3: Design Interfaces

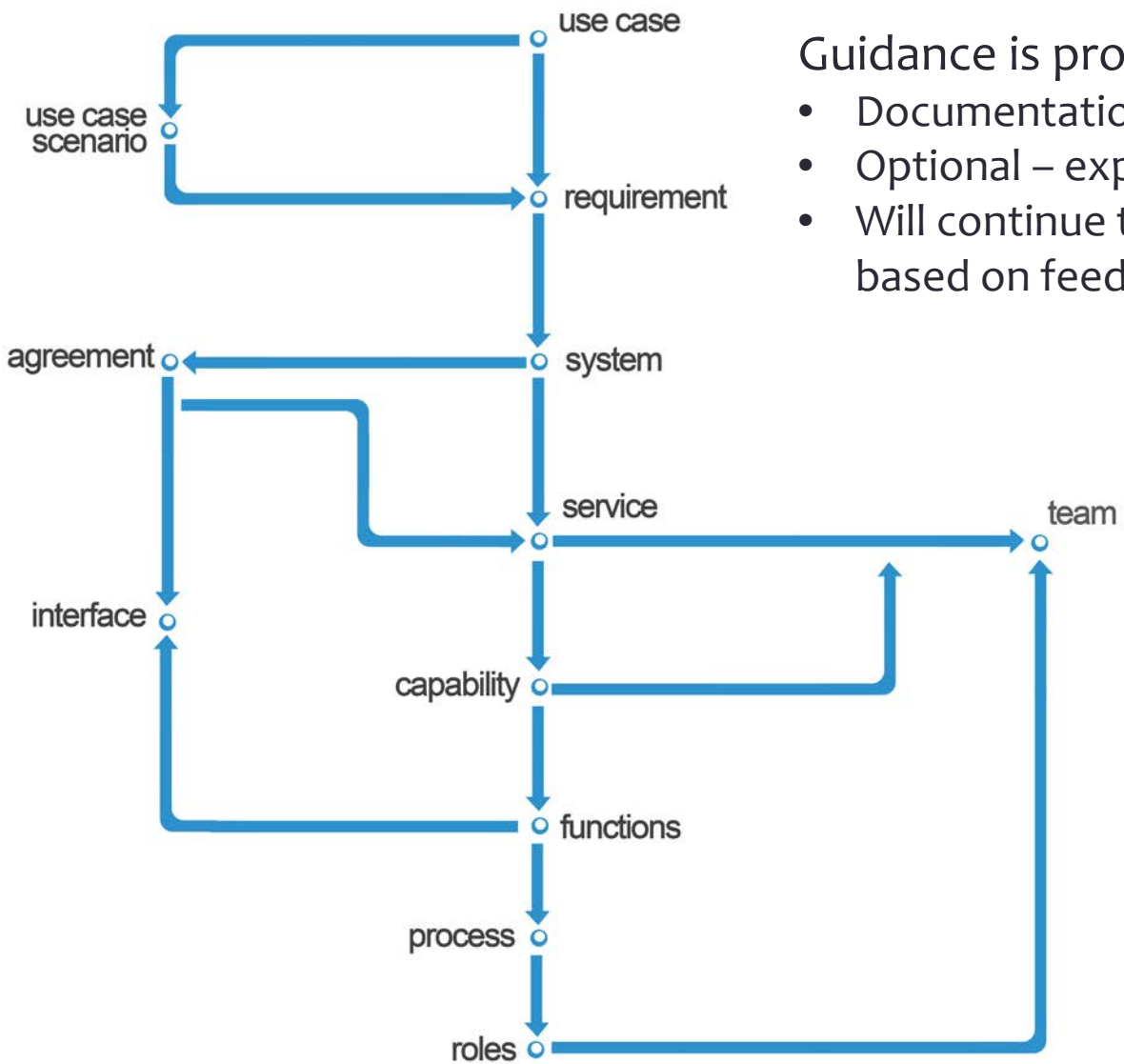
Step 4: Specify MOS Behaviors



Process Specification



Adaptation Guidance



Guidance is provided with MMOS

- Documentation is part of the model
- Optional – expert users aren't affected
- Will continue to be refined and updated based on feedback

Project Usage: Proposed and Planned Missions

- ARRM
  - Robotic retrieval and return of a boulder from an asteroid's surface to lunar orbit
  - Precursor to human spaceflight mission
- Europa
  - Repeated Europa flybys, investigation of Europa surface and interior
  - Associated lander
- Asteria
  - Cubesat, arc-second LOS pointing demo
- Lunar Resource Prospector Mission
  - Tech demo, harvesting volatiles near lunar South Pole

Challenges

- Learning curve
- Resistance to change
- Evolving software platform and tools
- Change control, standardization, and model integration
- Feedback and reintegration of Project results into MMOS model

Benefits (so far)

- Ability to very quickly specify an initial set of functional requirements
  - Europa Project reported better than 10x less work effort than for previous missions
- Scalability
  - Cubesats (< 1 workyear design effort) to flagship-class (tens of workyears)
- Improved degree of reuse, enabling lower cost and lower risk

Conclusions

- Initial experience with use of MBSE shows considerable promise
  - Greater reuse and some increased efficiencies even in early mission development
  - Applicable to very wide variety and missions (in both mission type and overall cost/scope)
- Consistent with NASA efforts to find enterprise-scale efficiencies
- Tooling needs more refining
- Requires commitment to methodology