Quantifying Mission Impact for Technology Alternatives

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Research Task and Overview

A persistent challenge for acquisition stakeholders is a method to value technology alternatives against mission impact that meaningfully informs decision-making for the purpose of relating value and cost.

- Expected value of information theory provides a well-established basis for valuing various forms of information within a decision-theoretic framework
- Our approach is to apply this theory as a basis to value technology alternatives for well-specified mission impacts
- Then demonstrate feasibility by analysis comparing two model-informed alternatives of varying fidelity

Goals and Objectives

Our objective for this effort is to demonstrate an effective, i.e. algorithmic, method to value model-informed alternatives for well-specified objectives.

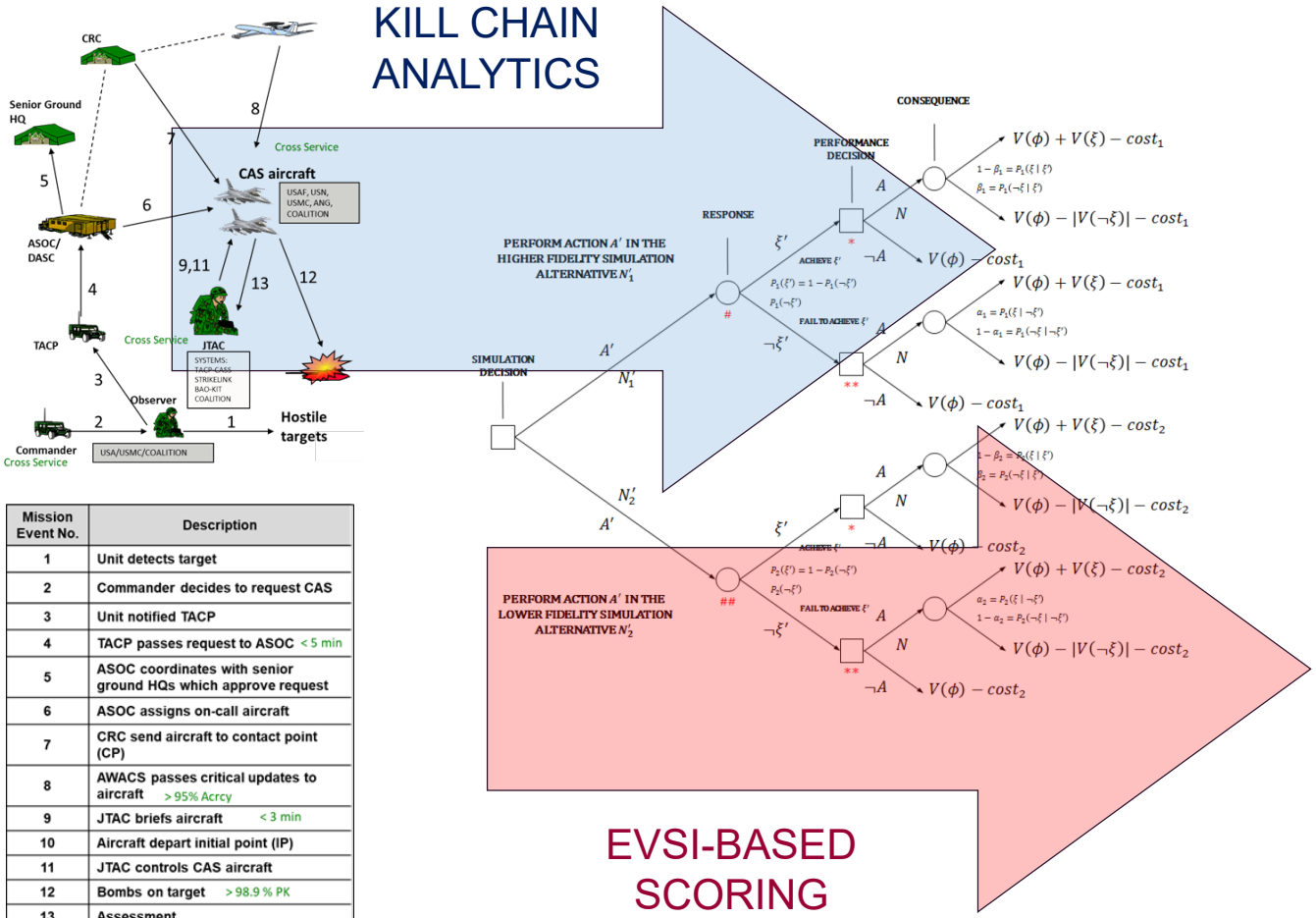
- Provide a rigorous mathematical basis for design of experiments for testing model-based alternatives
- Demonstrate the use of expert opinion as initial evidence via the Bayesian priors
- Formalize growing confidence in model-informed results, even when initial probabilities are difficult to quantify
- Develop techniques to quantify the value of mission effectiveness using familiar financial metrics such as Expected Value of Sample Information and Return on Investment

Methodology

Our methodology is to for this phase is to develop mathematical analyses, walk-through examples, demonstrations, or empirical analyses to demonstrate the feasibility or limitations of the following elements of the technical solution:

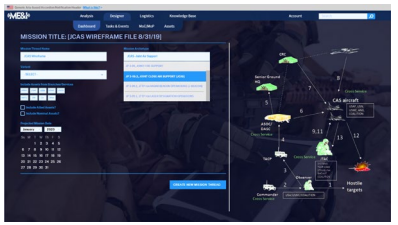
- Value specific performance-based outcomes
- Estimate probabilities using Bayesian analysis
- Initialize using subjective prior probabilities
- Differentiate the value of model-informed alternatives of varying fidelity using expected value or expected utility

Mission Engineering and Integration (MI&E) Analytics Platform Concept

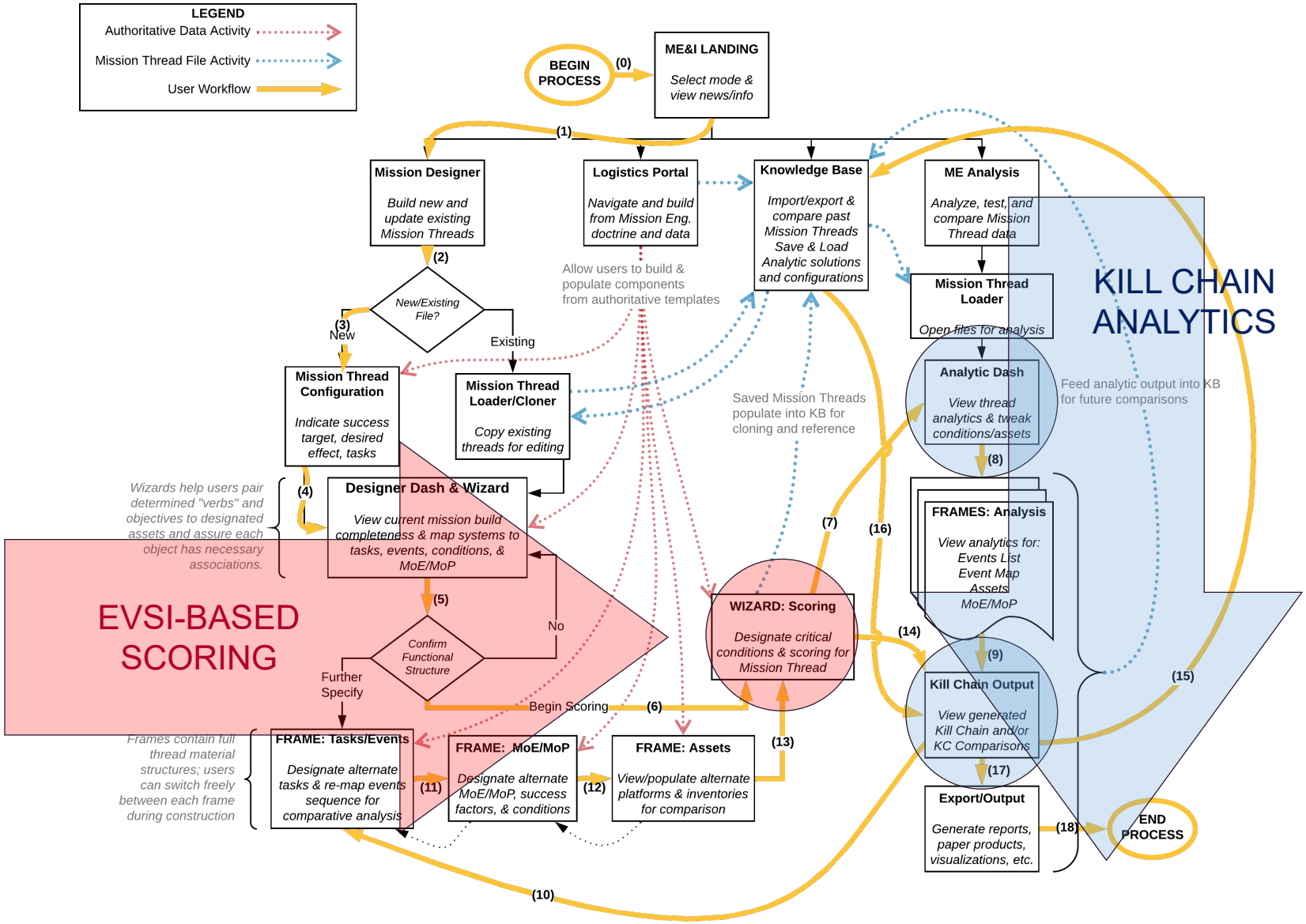


Mission Event No.	Description
1	Unit detects target
2	Commander decides to request CAS
3	Unit notified TACP
4	TACP passes request to ASOC < 5 min
5	ASOC coordinates with senior ground HQs which approve request
6	ASOC assigns on-call aircraft
7	CRC send aircraft to contact point (CP)
8	AWACS passes critical updates to aircraft > 95% Acrcy
9	JTAC briefs aircraft < 3 min
10	Aircraft depart initial point (IP)
11	JTAC controls CAS aircraft
12	Bombs on target > 98.9 % PK
13	Assessment

$$EVSI = V(\xi)\left[(1-\gamma)[P(\xi'|\xi) - P(\xi'|\neg\xi)] - \delta\left(P(\neg\xi'|\xi) + \frac{(1-\gamma)}{\gamma}P(\neg\xi'|\neg\xi)\right)\right]$$



MI&E Analytics Platform User Flow



Future Research

Develop a software component that calculates EVSI-based score for technology alternatives in a Mission Engineering and Integration Framework:

- Specification tools for missions and mission threads
- Adaptive data engineering and scenario generation
- Persistent data collection from simulation analytics
- Integrated scoring component in Mission Engineering and Integration analytics environment

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