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&
Systems Engineering Research Center (SERC)


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Overview: Addressing Panel Questions

• Modeling
  —Cross-cutting factors to predict cost, schedule and benefits

• Acquire (acquisition)
  —Support collaborative risk-informed decision-making about selecting mix of SoS capabilities to roll out asynchronously

• Verify
  —Use historical quantitative data and subjective qualitative “beliefs” about factors
  —Have used models to predict future costs/schedules - waiting to see results

• Evolve
  —Update conditional probabilities in model based on use
What is the FAA NextGen?

Image credit: NextGen Far-Term (2025), To-Be Enterprise-Level Architecture High-level Operational Concept Graphic (OV-1) Version 1.0, January 29, 2010

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Models Support Decision-Making for Roll Out of SoS Capabilities Aligning with FAA AMS

FAA LIFECYCLE MANAGEMENT PROCESS

Legend
1. Concept & Requirements Definition Readiness Decision
2. Investment Analysis Readiness Decision
3. Initial Investment Decision
4. Final Investment Decision
5. In-Service Decision

FAA Acquisition Management System (AMS) (http://fast.faa.gov/)

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Objective Statement from Kickoff Meeting

- Develop a modeling and analysis framework to enable a process for managing decision-making that occurs when capabilities must be integrated, deployed and acquired asynchronously.

— Predictive Model for Estimating Cost, Schedule, Benefits, with Visualizations to aid in Risk-Informed Decision-making

Modeling Framework for Decision Making at Portfolio & Enterprise Levels

<table>
<thead>
<tr>
<th>Quantitative</th>
<th>Qualitative factors (e.g., airline readiness, airport readiness)</th>
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</thead>
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- Cost, Schedule, & Benefit predictions
- Risk calculations
- Factor impacts on objectives
- Aligns with FAA Acquisition Management System (AMS)

1) Program Releases or 
2) Operational Improvement Candidates or 
3) Risk Scenarios
Stakeholders Talked about Various Challenges for the NextGen System of System (SoS)

- After talking with more than 60 success-critical stakeholders, who were very open about the challenges, we found out that:
  - All component dependencies are not systematically identified
  - All interface dependencies are not formally tracked (e.g., using databases)
  - Tradeoff impacts difficult to assess
  - People can only roughly estimate impact of interdependencies between component functionality
  - Continually challenging those responsible for planning, developing, and deploying capabilities

“Peoples’ internal knowledge is not captured externally or formally”
Example Implementation Portfolio From NextGen Implementation Plan

Portfolio (1 of 10)

www.faa.gov

Operational Timelines:

Increment Concept Available Schedule Change

Situational Awareness and Alerting of Ground Vehicles

Expansion of Surface Surveillance

Improved Runway Safety Situational Awareness for Controllers (2012-2016)

What’s the Probability (Risk) of finishing at this point in time?

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• Three SME inputs illustrate difference in schedule of ~7 months based on different beliefs in factors

<table>
<thead>
<tr>
<th>Operational Improvement Increments</th>
<th>Mean (months)</th>
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<tbody>
<tr>
<td>Situational Awareness and Alerting of Ground Vehicles</td>
<td>27.4</td>
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<tr>
<td></td>
<td>32.0</td>
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<td></td>
<td>34.6</td>
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Four Types of Models Predict Risks Based on Internal Knowledge Not Captured Externally or Formally

1) Improve Collaborative Decision-Making for CRD & IA supporting NSIP Evolution

Model being applied to NSIP 2014

Example:
- Three SME inputs illustrate difference in schedule of ~7 months based on different beliefs in factors for Improved Surface Operations

Maps to a Quantification of Risk

Concept applied to
- ADS-B In
- GBAS and ILS

2) Improve Prediction of Schedule and Cost in Solution Implementations

3) Improve Collaborative Decision-Making About Systemic Risks and Benefits

4) Improve Risk-Informed Decision Making for NextGen Benefits due to Market Stability

Benefits?

Aircraft not equipped

MSP Gate E2

MSP

Minneapolis - Saint Paul International Airport

Map data ©2013 Google
Example Model: Assess Risk of Benefits due to Variability in Market Stability

- Help FAA assess the risk of lost Benefits due to Market Changes:
  - E.g., Delta moves all of their MD80s to Minneapolis – aircrafts don’t have technologies to leverage deployed capability at airport
Summary - Results Support Task Objectives and Research Hypothesis

- Framework models quantitative and qualitative expert judgment about “Peoples’ internal knowledge that is not captured externally or formally”
- Supports collaborative process for risk-informed decision-making
- Helps stakeholders understand cost, schedule, benefits, and risk tradeoffs
- Improves the accuracy of schedule and cost predictions (and reduces the variance)
- Tailored to the decision points of the AMS
- Provides a new approach to Quantify Risk