Model-based approach for trade studies involving COTS integration

Gabriel Lopez

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Agenda

- Topic motivation and focus
- Model description and framework
- Potential applications and examples
- Problems and challenges
- Conclusion

About the Author

- **Education**
  - BSEE– University of Maryland, College Park, MD
  - MSEE – Johns Hopkins University, Baltimore MD
  - MSTM-SE – Johns Hopkins University, Baltimore MD
  - Currently pursuing a Ph.D. in Systems Engineering – George Washington University
- **Work experience**
  - Silicon carbide device research – ARL, Adelphi, MD
  - Various positions and rotations in defense industry
  - Systems Supportability/ Reliability Engineering since 2006
- **Research interests**
  - Systems engineering and systems supportability principles and applications
  - Optimization and streamlining of processes that solve problems
  - Advisors and coauthors: Dr. Shahram Sarkani and Dr. Thomas A. Mazzuchi

This research focuses on system affordability

- **System affordability**
  - A key topic of discussion within Industry and (DoD)

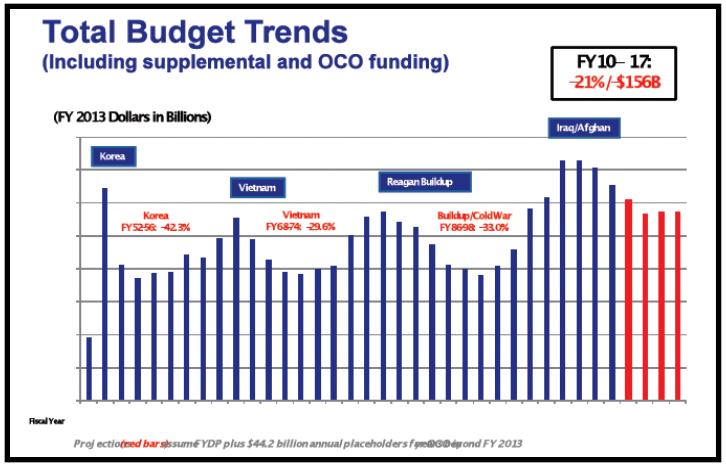
- **Adjustments in system requirements**
  - Increased affordability focus requires adjustment in the way program requirements are defined/viewed by both customers and developers

- **Program acquisition success**
  - Technical performance alone does not guarantee success

- **End result**
  - Customer requirements are moving toward more affordable solutions that minimize operation and sustainment costs

Affordability focus is palpable: Decreasing budgets is a trend

- **DoD budgets are decreasing**
  - Many policy statements about affordability
    - » **More than 50 since 2010**
  - Focus on Innovation and affordability



http://www.defense.gov/news/2013budget.pdf

- **Affordability trends in 2012**
  - RAMS – "Reliability, the key to a better bottom line"
  - NDIA (April 2012) – Ensuring operational logistics effectiveness
  - DTAR – Defense Technology and a Affordability Requirements 2012 conference
  - Development of HB-0009 by Tech America/ANSI partnership

- **INCOSE has an affordability working group charter**

Modular designs and COTS integration are critical for affordable solutions

- **Increased budgets for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT)**
  - More available funds, more innovation, more COTS products to choose from
- **Market saturation**
  - The push for innovative and COTS-based modular solutions can create decision making problems
- **Given a mission profile and operational environment**
  - How do we select the appropriate products in a COTS-saturated market?
  - What COTS attributes and capabilities do we focus on?
  - How do we ensure that the end product passes the “affordability litmus test”?

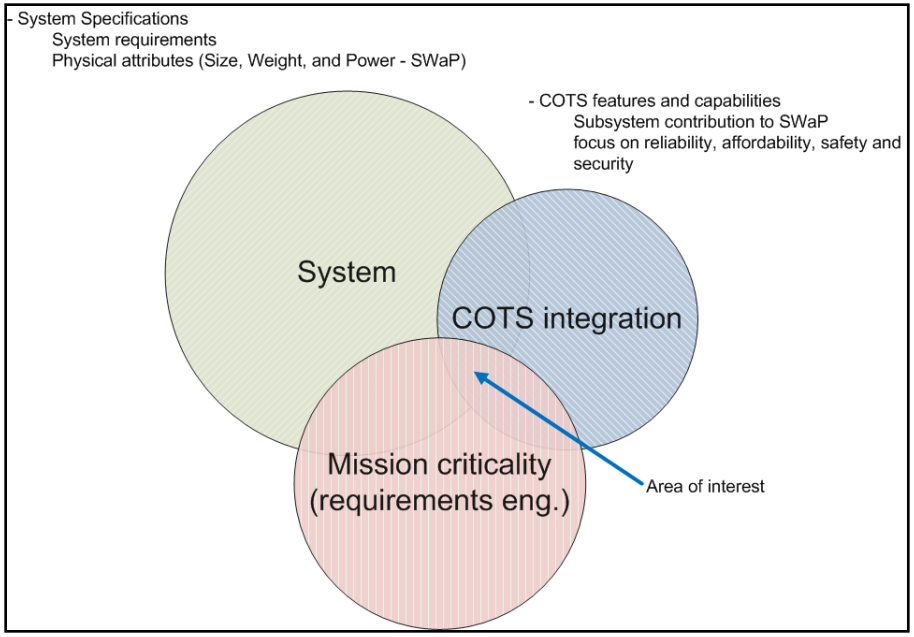
Informed decisions are needed during COTS integration

- **Problem: Uninformed selection of COTS products leads to overdesigned and overpriced systems**
  - Designers and system engineers need more tools that help in the selection process
  - One system design does not fit all (different mission profiles and operation parameters)

- **Solution Approach**
  - Incorporate mission criticality analysis and requirements engineering in the COTS selection process
  - Create a model that helps designers and systems engineers make informed decisions during COTS integration for new designs and/or for updates to existing designs

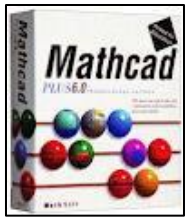
Informed decisions during COTS integration lead to affordable solutions

- System specs and SWaP
- Mission criticality analysis
- Requirements Engineering
- Decision making trade studies
- Potential solutions
  - Best technical and affordable solutions



The main goal is to utilize system engineering methodologies and concepts to develop a tool that helps in the decision making process

One can create a model-based approach for trade studies involving COTS integration



- **MATLAB® /MathCAD®/ VBA®**
- **System's Inputs**
  - Systems requirements
  - Fault tree analysis
  - System failure data
  - Money available for design/improvements
- **COTS inputs**
  - Physical properties: weight and size/volume
  - Features and attributes: reliability, cost, security, and safety
- **Conduct Mission Critically Analysis (MCA)**
  - Provides the weighted parameters for the sensitivity analysis
- **Success definition**
  - Trade offs between potential COTS products and highlight cost-effective designs

The goal of MCA is to obtain a set of weighted parameters to be used in the sensitivity analysis

- **Assessment of current COTS selection process**
  - Defense acquisition guidebook: Systems engineering and COTS (section 4.4.2)
  - Use existing research and best system engineering practices
- **Full assessment of mission profile**
- **Data collection methodology**
  - Consult a group of experts via surveys
  - Gather the data, analyze the data, recommend weighted parameters
- **Weight parameters will be a function of mission profile, relevant COTS characteristics, and cost**

One can obtain useful data for the sensitivity analysis by surveying field experts

- **Generate survey questions**
  - Tap into CoP initiatives and leverage relevant research
  - Fine tune the survey by conducting a set of iterations with a focus group
  - Finalize survey questions (web- based or traditional survey methods)

- **Survey a group of experts**
  - Systems engineers, system designers, safety engineers, reliability engineers, maintainability engineers, security and anti-tampering experts, and so on

- **Conduct regression analysis and assess statistical significance**

MCA begins by categorizing mission profiles based on three general mission environments

- **Protected Environment**
  - Maintainable /controlled environment, temperature range from 0°C to +70°C
  - Application life span up to 5 years

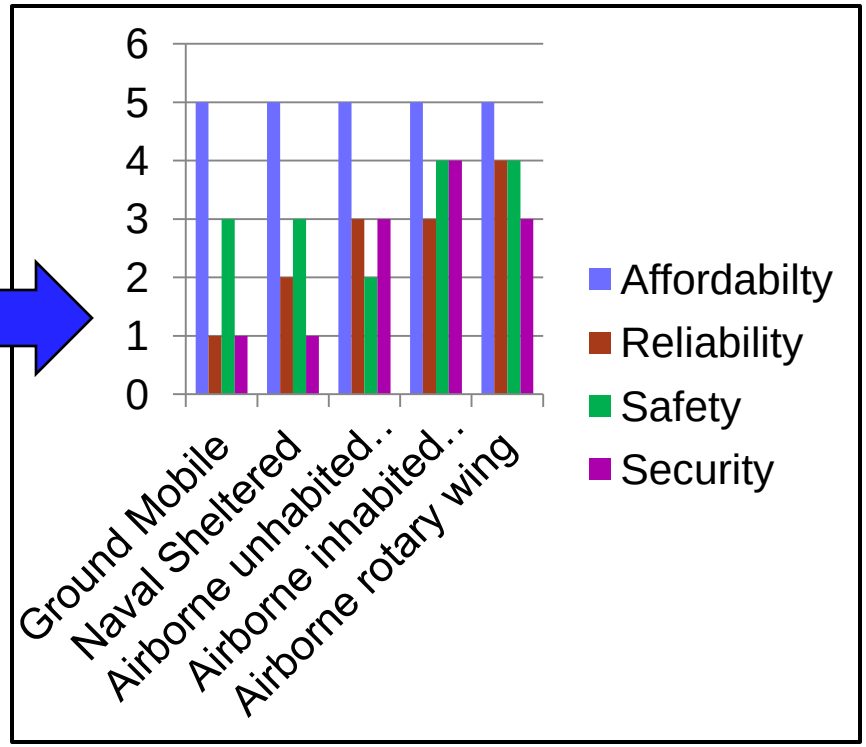
- **Normal environment**
  - Inhabited applications/usually maintainable/uncontrolled but not extreme
  - Minimal to medium controlled shock/vibration. Temperature from -40° to +85°C
  - Life span from 5 to 10 years

- **Severe Environment**
  - Uninhabited applications, varying temperatures and extremes
  - Temperature ranges from -55°C to +125°C
  - Medium to high shock, pressure, vibration, life span of 10 to 20 years

http://src.alionscience.com/pdf/Reliability_Prediction_Env_Conversion.pdf

Weighted parameters are generated by mapping mission profiles to specific environments

GB	Ground, Benign
GF	Ground, Fixed
GM	Ground, Mobile
NS	Naval Sheltered
NU	Naval Unsheltered
AIC	Airborne, Inhabited Cargo
AIF	Airborne, Inhabited Fighter
AUC	Airborne, Uninhabited Cargo
AUF	Airborne, Uninhabited Fighter
ARW	Airborne, Rotary Winged
SF	Space, Flight Earth Orbital



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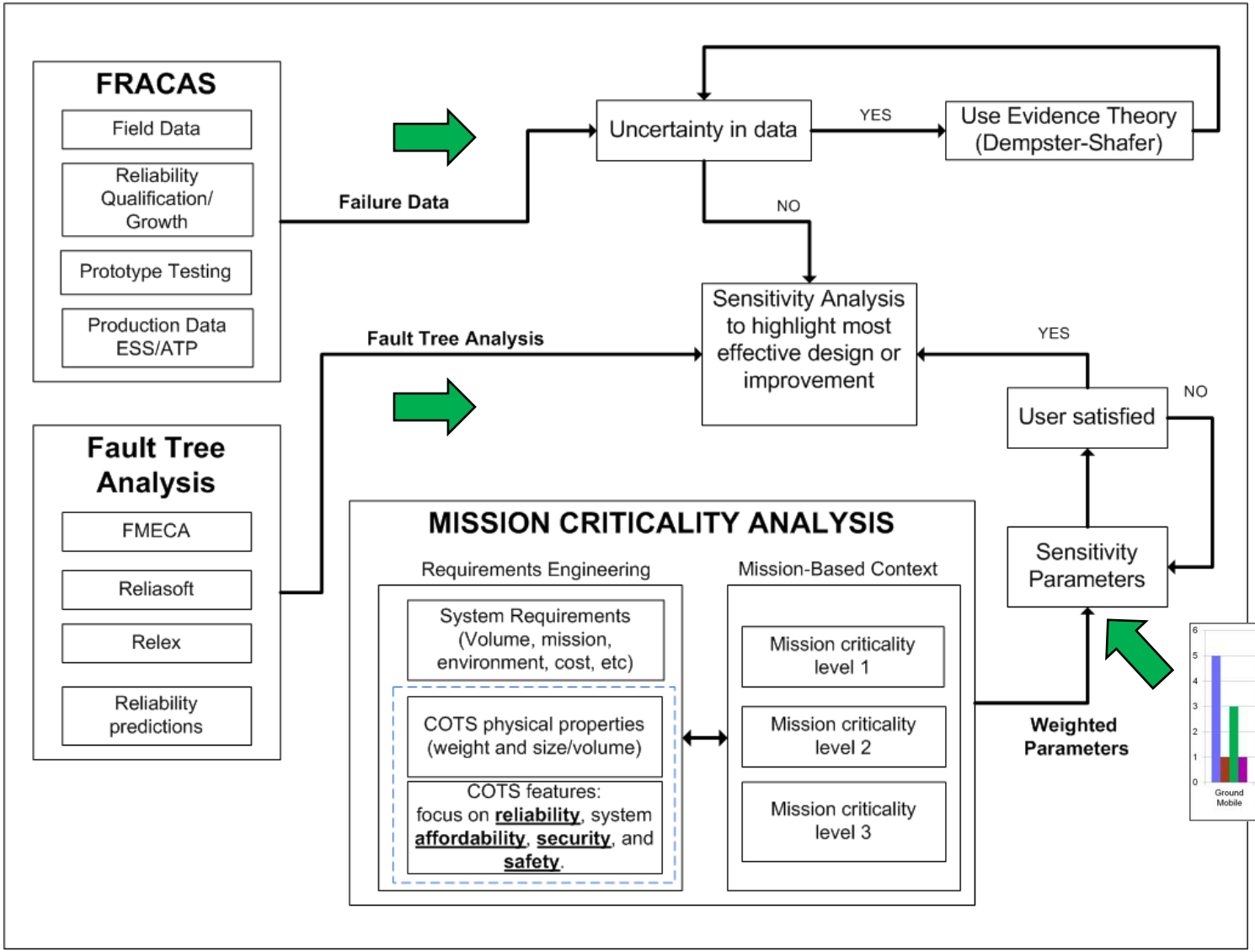
Model framework concept with weighted parameter inputs for COTS trade studies



The goal is to generate weighted parameters by managing risk and cost responsibly

❑ Let's consider 3 general mission profiles for UAVs

- Critical missions

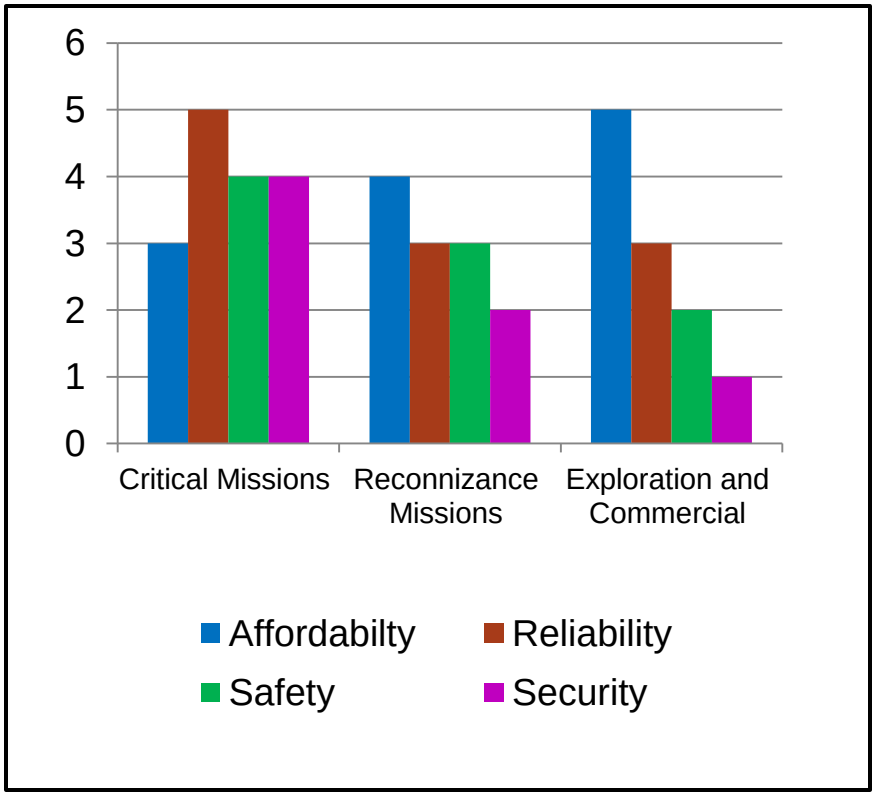
  - » **Military missions**
  - » **Weaponized systems**
  - » **Missions over populated areas**

- Reconnaissance missions

  - » **Some military missions**
  - » **Local law enforcement**
  - » **Border patrol/ Coastguard**

- Exploration and commercial missions

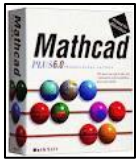
  - » **Forestry and agriculture**
  - » **Traffic monitoring**
  - » **Scientific missions**



Example of weighted parameters for UAVs

Problems and Challenges

- **Deciding on a modeling tool**
  - MATLAB® / MatCAD® / VBA® / iThink®



- **Underlying model challenges**
  - Appropriate failure distribution assumptions
  - Modeling cost parameters/functions
  - Future need to normalize metrics for COTS features and attributes

- **Availability of failure data**
  - Limited time to failure data for many systems
  - Fitting data to the appropriate distribution could be a challenge

Conclusion

- A model-based approach for trade studies involving COTS was described and an example was presented
- The model can help designers and systems engineers make informed decisions during COTS integration
- The model can also help in the renegotiation of unnecessary or unrealistic system requirements
- In the end, companies need to embrace innovation and solve the COTS selection puzzle to stay competitive

Q & A

Contact information for NDIA point of contact

Gabriel Lopez
George Washington University
gablop@gwmail.gwu.edu
Mobile: 202.494.7227
Work Phone: 410.765.8067