

# Network Modeling Panel

NSF Workshop on Enterprise Network Models for Counterfeit  
Part Supply Chains

# Panelists

- Dr. Doug Bodner, Moderator
  - Principal Research Engineer, Georgia Institute of Technology
- Dr. Judith Dahmann
  - Technical Fellow, The MITRE Corporation
- Dr. Michael Pennock
  - Principal Systems Engineer, The MITRE Corporation

# Agenda

- Opening (Doug Bodner)
- Sociotechnical systems and systems-of-systems (Judith Dahmann)
- Modeling approaches, challenges and opportunities (Michael Pennock)
- Questions and discussion

# Socio-technical Networks

- Society is increasingly networked and interdependent
- Socio-technical systems impact society in major ways
  - Healthcare
  - Disaster response
  - National security
  - Retail sector
  - Smart cities
- Federated actors perform roles without central command and control
- Behavior and performance “emerge” rather than being “designed”
- How do we understand and influence behavior and performance?

# Enterprise Networks

- An enterprise system is...

“a goal-directed organization of resources—human, information, financial, and physical—and activities, usually of significant operational scope, complication, risk, and duration”\*

- Enterprise systems are where the complicated meets the social
- Socio-technical interaction creates complexity and determines outcomes

- \*W. B. Rouse, “Enterprises as systems: Essential challenges and approaches to transformation,” Systems Engineering, Vol. 8, No. 2, pp. 138-150, 2005.

# Enterprise Network Models

- As engineers, we can develop models to understand and design these types of systems! We do it all the time.
- What do we model?
  - Do we really understand all the stakeholders and phenomena in these systems, what motivates the stakeholders, how they interact and react?
  - How do we reconcile the different time scales of behavior in these systems?
  - How do we reconcile the different scopes of resolution in these systems?
- What is the input to such models?
- What should be the output?

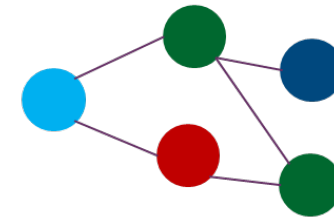
# Counterfeit Parts as an Exemplar

- Multi-tiered supply chain with limited visibility
  - Behavior of programs/suppliers, motivations and influencers
- Suppliers leave the eco-system as systems age
  - Where do we get replacement parts?
  - Trusted sources?
- Counterfeiters enter the supply chain
  - We have your replacement parts!
- Counterfeiters adapt technologies and strategies/networks
- Recycled electronics drive part of the problem
- Policy, customs, testing and law enforcement have impacts – how do we quantify?

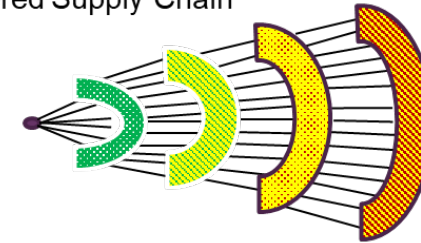
# Networked Model Elements

- Networked eco-system
  - Programs, suppliers (arranged in tiers), distributors, law enforcement, customs, DoD policy
- Information and incentives
- Products/systems
  - WBS
  - Electronic components versus major sub-systems
- Large-scale agent-based model
- System dynamics composed into to model electronics recycling

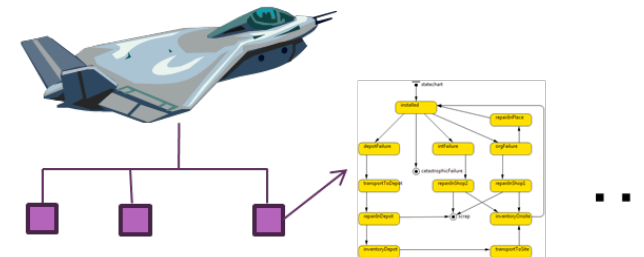
Semi-Autonomous Organizations



Tiered Supply Chain



System & WBS





# New Technologies

- The real world
  - Real-time supply chain visibility as a decision aid
  - Blockchain and other technologies for traceability/security
- The model
  - Reinforcement learning
  - Adversary modeling and game theory
  - Distributed modeling

# Where Do We Get the Data?

- Hesitancy to call a counterfeit a counterfeit
  - Proprietary information concerns
  - Classified data and other national security concerns
  - Understanding motivation of actors
  - Behavior of actors that we cannot access – counterfeiters
  - Cost of countermeasures – distributed among eco-system actors
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- Can we generate realistic but not actual datasets?
  - Can we have the model learn as more data becomes available?
  - Do we have the imagination to generate the right scenarios?

# Who Uses the Model and How

- Different stakeholders with different needs
  - Different questions
  - Different time scales
  - Different levels of resolution
- Does my preferred solution solve the problem?
- How does one stakeholder understand the effects of a “solution” on others?
- How is the model calibrated/designed for use in different time scales and levels of resolution?
- Fast model execution for rough-cut analysis vs. detailed analysis with many different experimental factors