Overview of the Afternoon

Session 1 (2:30 – 3:30) : STPA-Sec Overview – STPA within Secure Systems Engineering (and Cyber Security)

- Introduction
- Observations on Cybersecurity today
- System Thinking and Security
- STPA-Sec overview
- Summary and Conclusion

Session 2 (3:30 – 5:00): STPA-Sec Practice

- Overview
- Concept Analysis
- Architectural Analysis
- Design Analysis
- User Q&A
- Summary and Conclusion

To Maximize the Available Time, I Will Assume Basic Familiarity With STAMP, STPA an Will Leverage John Thomas's Example from this Morning

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System-Theoretic Process Analysis for Security (STPA-SEC): Secure Systems Engineering, Cyber Security and STPA

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Introduction

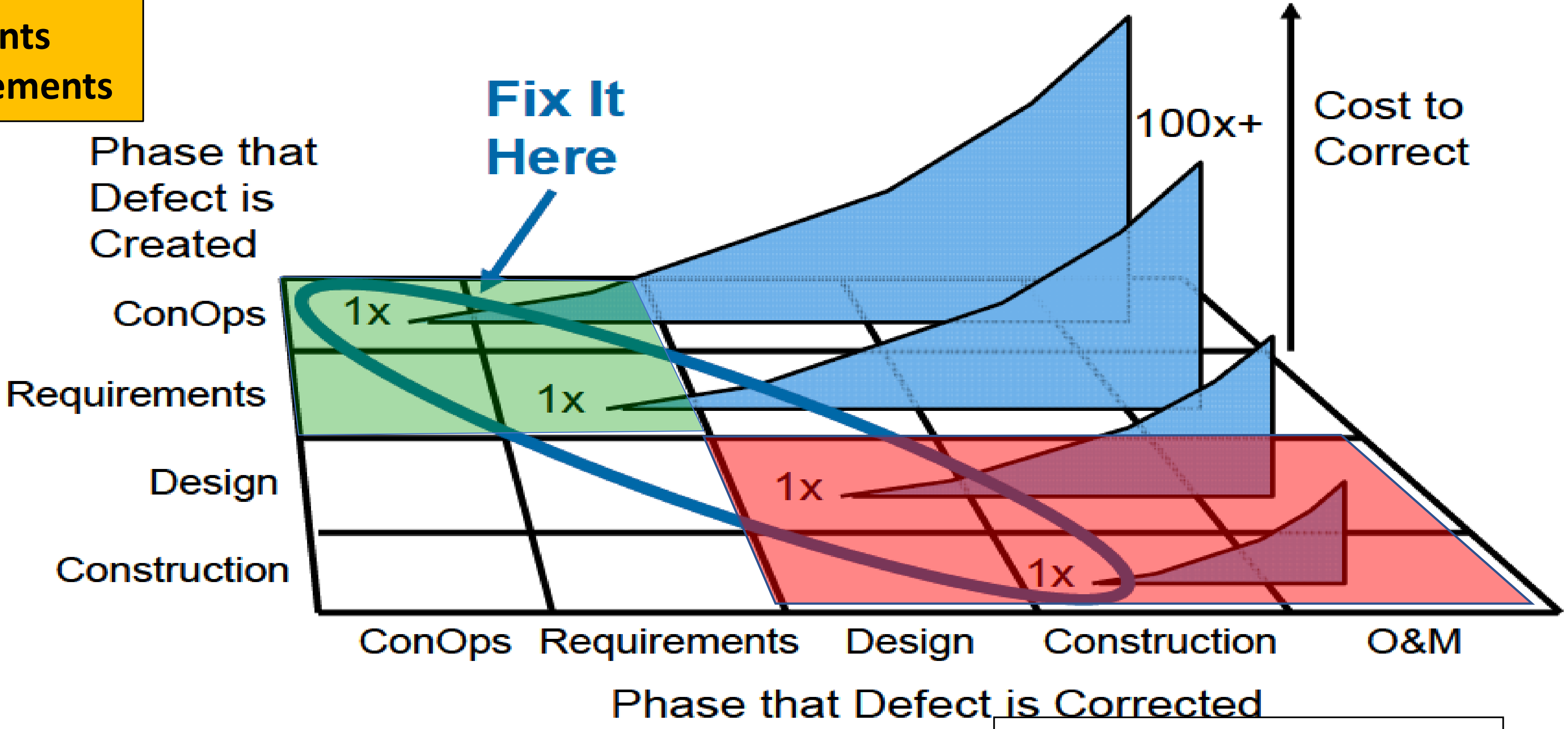
Introduction

- Losses are growing and current approaches to securing complex, software intense, designed physical systems do not appear to be working as well as desired
- Origins of losses fall into at least one of two categories:
  - Disruption prevents engineered system from fulfilling its designed purpose
  - Disruption does not necessarily prevent the engineered system from fulfilling its primary purpose, but it produces an unacceptable "by-product"
- The side with individuals best able to conceptualize the most creative ways to exploit device/designed system functionality has competitive advantage (tactics)

Today, Security is Viewed Almost Universally as a Threat Problem

Flawed logic
Conflicting goals
Poor Assumptions
Wrong Problem
Missing requirements
Incomplete requirements

Introduction



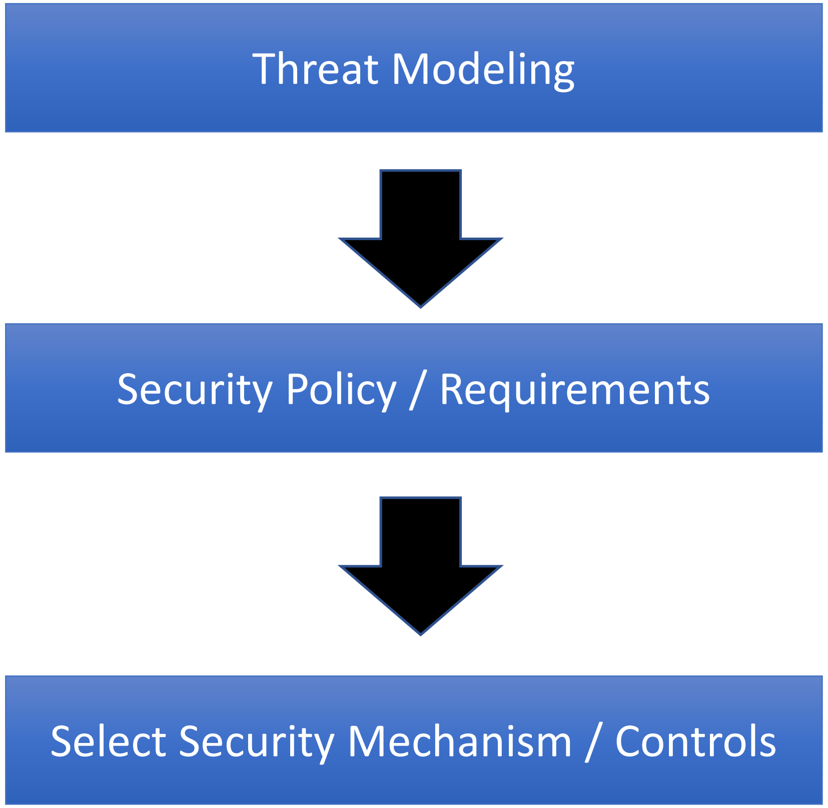
Design = Secure System Engineering
Construction = Secure System Development
O & M = Protect Data and IT Components

Ref: System Engineering For Intelligent Transportation Systems

Current Approaches Do Not Address Safety & Security Errors that lead to Losses When it is Most Effective and Cheapest to Do So

Observations on Cybersecurity Today

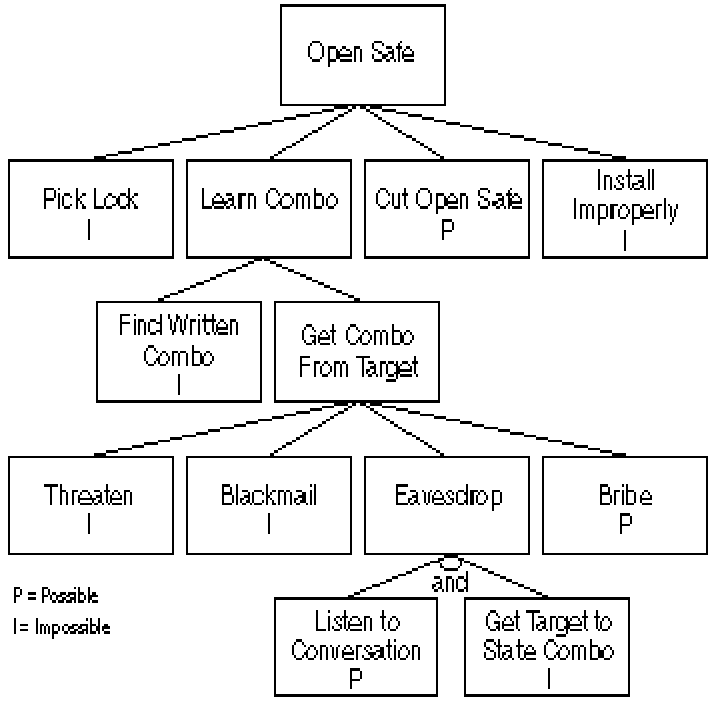
Threat Based Approach to Developing a “Secure” Architecture


Threat Modeling
Security Policy / Requirements
Select Security Mechanism / Controls

Current Security Analysis Depends on Identifying the Right Threat (Tactics), But Does Not Help Address the Larger Mission Assurance Goal (Strategy)

Ref: (Anderson, 2010; Shostack, 2014; Swiderski & Snyder, 2004)

Schneier's Attack Tree Model is the Intellectual Foundation of Most Thinking on Cybersecurity

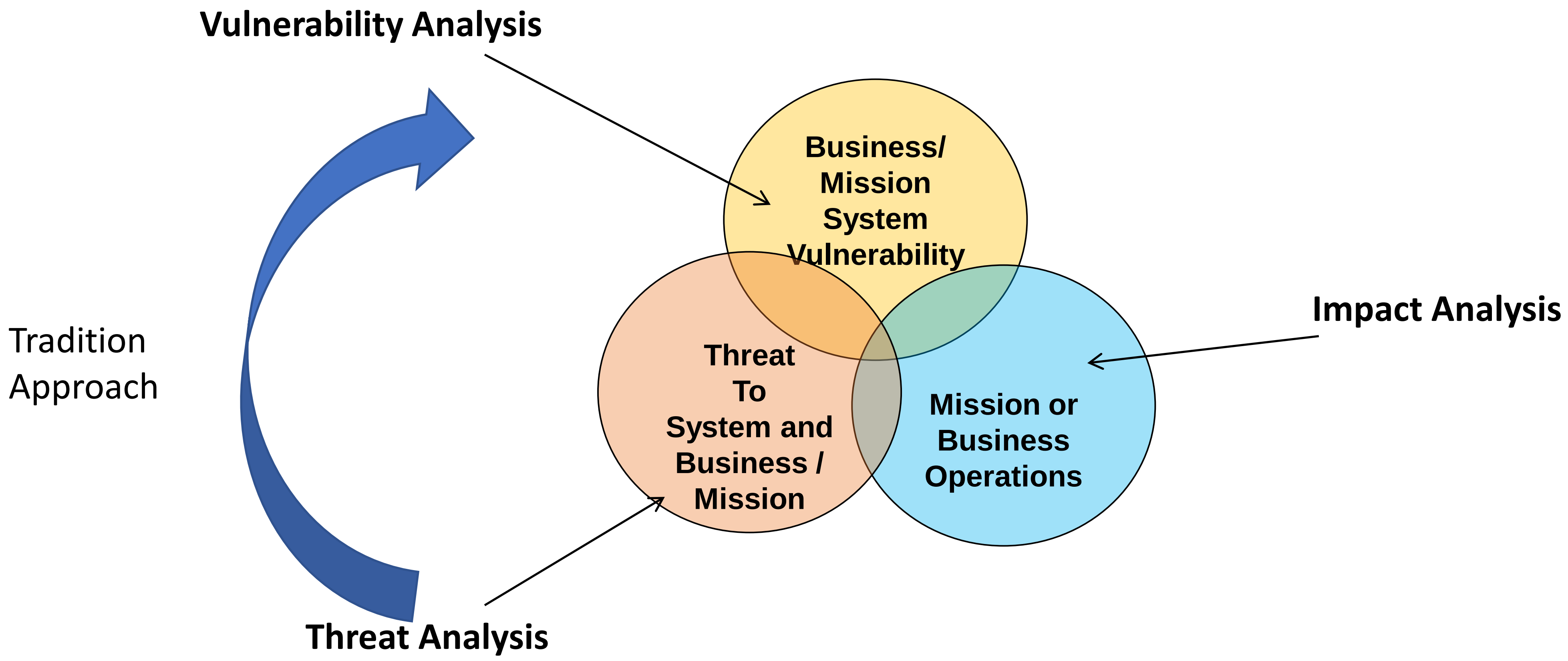


"Clearly, what we need is a way to model threats against computer systems. If we can understand all the different ways in which a system can be attacked, we can likely design countermeasures to thwart those attacks…Security is not a product -- it's a process. Attack trees form the basis of understanding that process."

Schneier Based His Security Attack Trees on Fault Trees He Saw Used for Safety

Ref; *Dr. Dobb's Journal*, December 1999

Cybersecurity Through Today’s Analytic Lenses


Vulnerability Analysis
Business/ Mission System Vulnerability
Impact Analysis
Tradition Approach
Threat To System and Business / Mission
Mission or Business Operations
Threat Analysis

The System Vulnerabilities are Driven by Threat Capability

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Current Security Analysis

“When you ask an engineer to make your boat go faster, you get the trade-space. You can get a bigger engine but give up some space in the bunk next to the engine room. You can change the hull shape, but that will affect your draw. You can give up some weight, but that will affect your stability. When you ask an engineer to make your system more secure, they pull out a pad and pencil and start making lists of bolt-on technology, then they tell you how much it is going to cost.”

- Prof Barry Horowitz, UVA

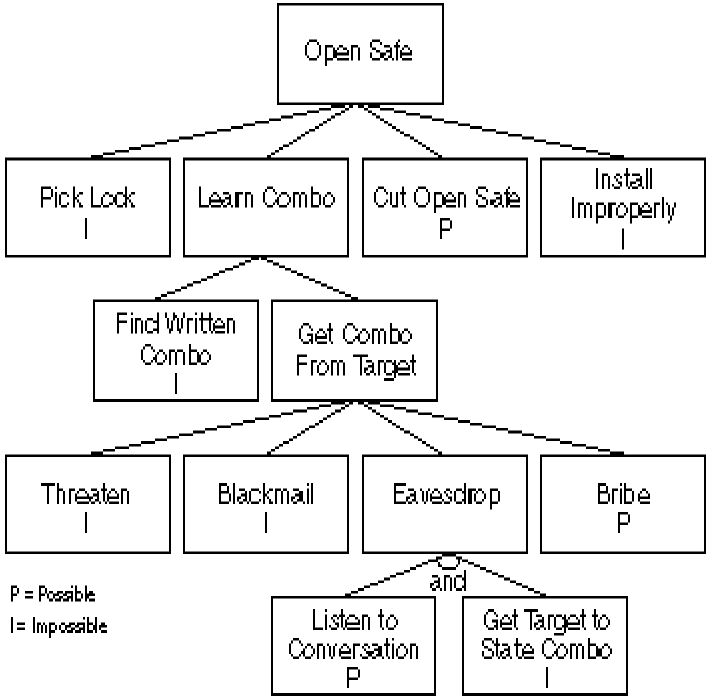
What We Need to Get to

“The first thing we need in this process is the ability to state computer security requirements clearly and precisely… so that a competent professional can study it for a reasonably short amount of time and, say, "Oh, yes, I agree. If you build that particular system to that particular requirement, it's secure enough for that particular purpose.”

- Donald Good "The Foundations of Computer Security, We Need Some"

SYSTEM THINKING & SECURITY

Relooking Schneier’s Words



“Clearly, what we need is a way to <u>model threats</u> against computer systems. If we can understand <u>all the different ways</u> in which a system can be attacked, we can likely design countermeasures to <u>thwart those attacks</u>…Security is not a product -- it's a process. STPA-Sec will form the basis of <u>understanding</u> that process.”

STAMP and STPA-SEC Provide us a Different Way to Understand (and Control) the Security Process

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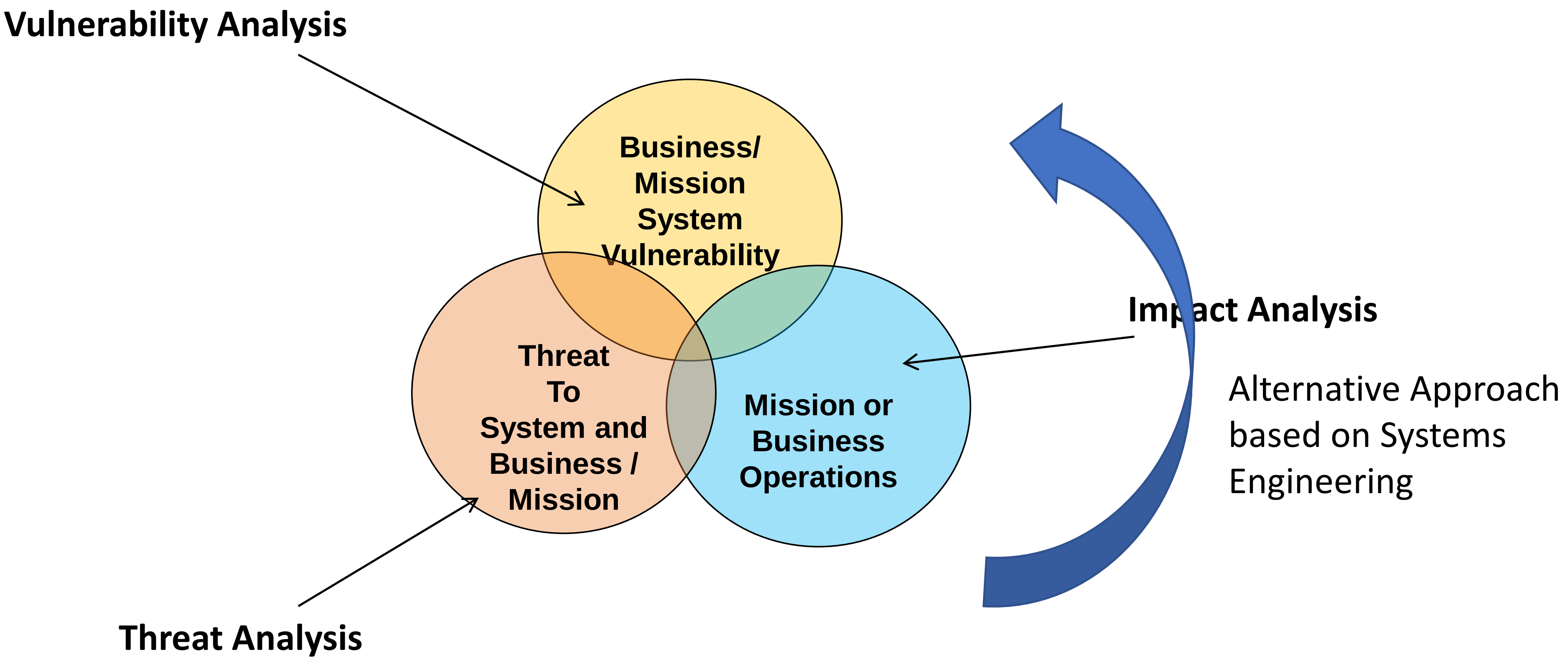
Cyber Security Through Different Analytic Lenses



Vulnerability Analysis

Business/ Mission System Vulnerability

Threat To System and Business / Mission

Mission or Business Operations

Impact Analysis

Alternative Approach based on Systems Engineering

Threat Analysis

In Systems Engineering, Threats are Just One of Many Trades

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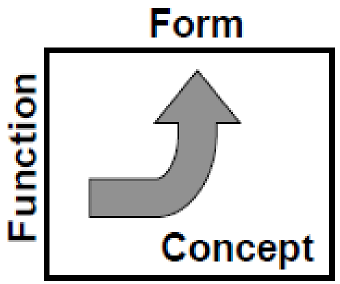
New Approach: Secure Form Simply Realizes Secure Function

- "Form follows function" is a central tenant of system engineering and architecture
- Generate secure Business & Mission Systems by first defining the secure functionality to be realized
- Get to security via
  - Identify functionality required to solve the problem at hand (But we must understand problem)
  - Implement all required functionality securely based on understanding problem and context
- Architecture Defined (Crawley)
  - The embodiment of concept, and the allocation of physical/informational function to elements of form, and definition of interfaces among the elements and with the surrounding context



From Security Defined by Threat to Security Defined in Terms of Delivering Secure Functionality Necessary for Mission or Business Operations

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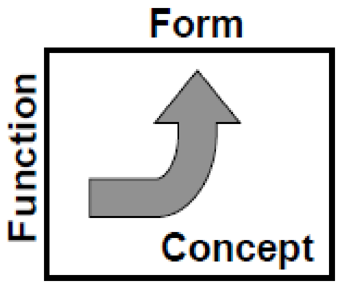


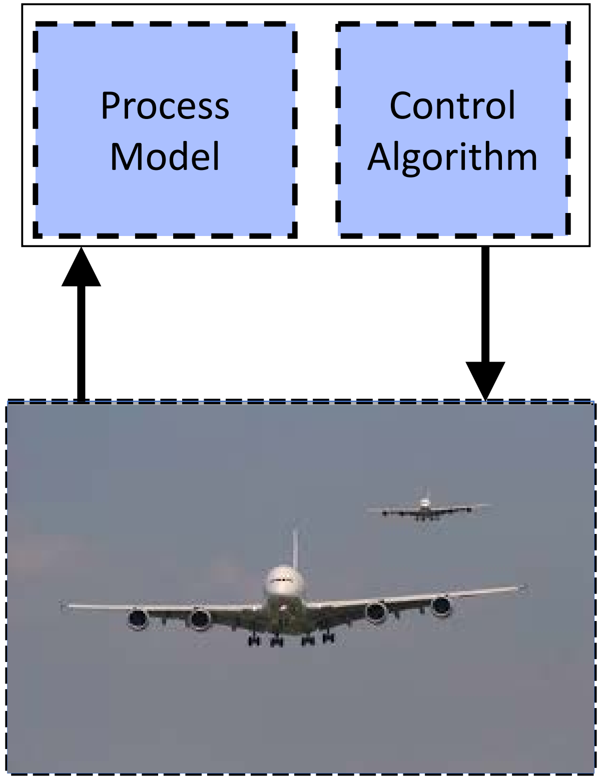
We Can Use STAMP Model to Help Craft the Security Concept

STAMP Model & Security

- **Focuses on function, not threat to guide realization (form)**
  - **Separates problem space from solution**
  - **Allows us to reason about function (and critique a proposed functional decomposition based on security related concerns)**
- **Provides a means to define and specify secure function clearly, unambiguously, and in context of the mission**
- **Functional Control Structure is simply a means to help envision how the necessary functionality can be implemented in a way that prevents losses identified**

“Security” Losses Can Be Reframed as (Functionality) Control Problems

Cause a Mid Air Collision



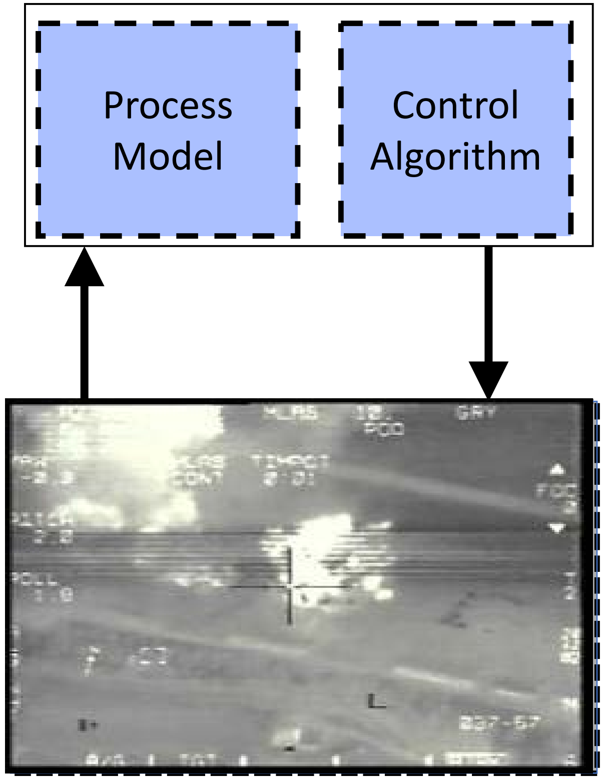
Process Model

Control Algorithm

Aircraft must maintain minimum safe separation

ENFORCE: Safe Separation

Cause Friendly Fire Loss



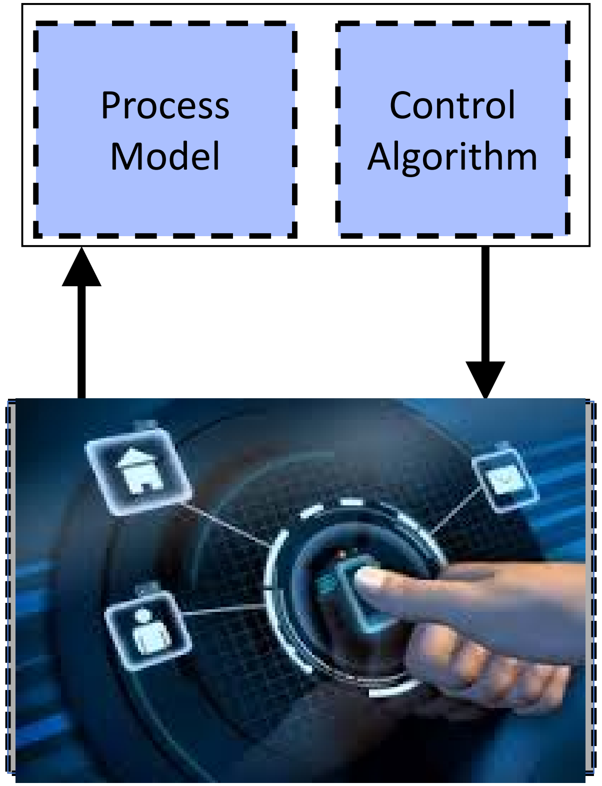
Process Model

Control Algorithm

Only hostile forces must be engaged

ENFORCE: Engagement Rules

Steal Customer PII



Process Model

Control Algorithm

PII must only be exposed to authorized entities

ENFORCE: Data Access Policy

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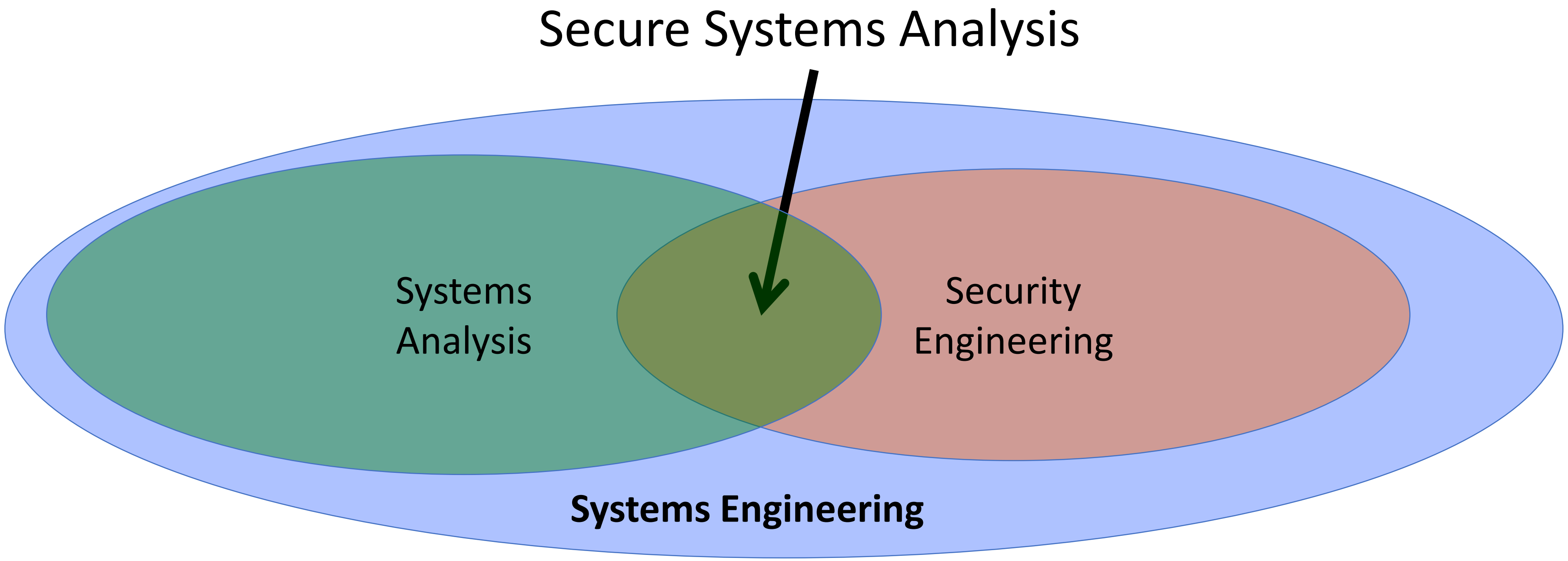
From Systems Analysis to Secure Systems Analysis

"A systematic examination of a problem of choice in which each step of the analysis is made explicit wherever possible."

Malcom W. Hoag, "An Introduction to Systems Analysis" RAND Research Memorandum, RM-1678, 18 April 1956

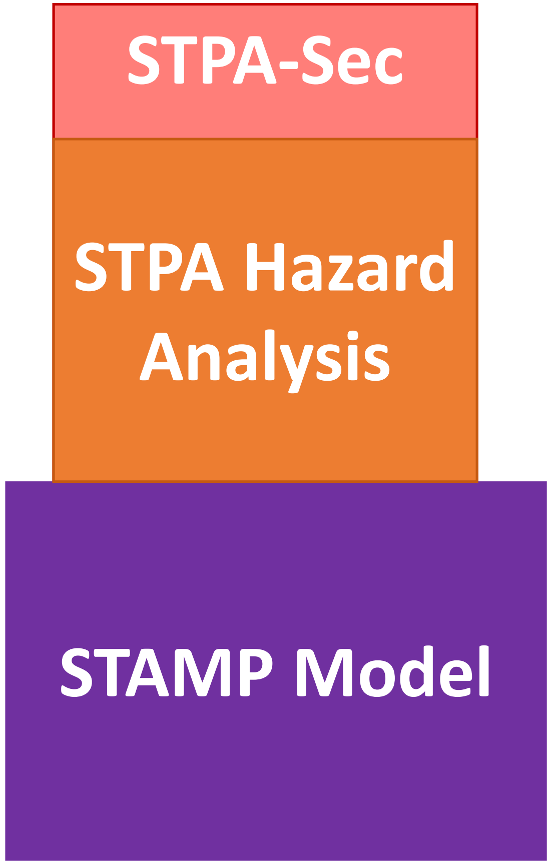


STPA-Sec Allows the Systems Analysis Framework to be Applied to Security

STPA-Sec

- **Analysis process to generate a security concept and framework**
- **Examines a functional process through a security lens to gain insights and craft artifacts to enable additional reasoning**
- **Threats are just another environmental hindrance to function**
  - **In fact, the threats themselves don't really matter…it's the functional disruption they can deliver**
  - **We can engineer our systems to handle the most important functional disruptions**
- **Analysis methodology supports learning and facilitates stakeholder debates and trades (can imagine "what might be")**

STPA-Sec Extends STPA

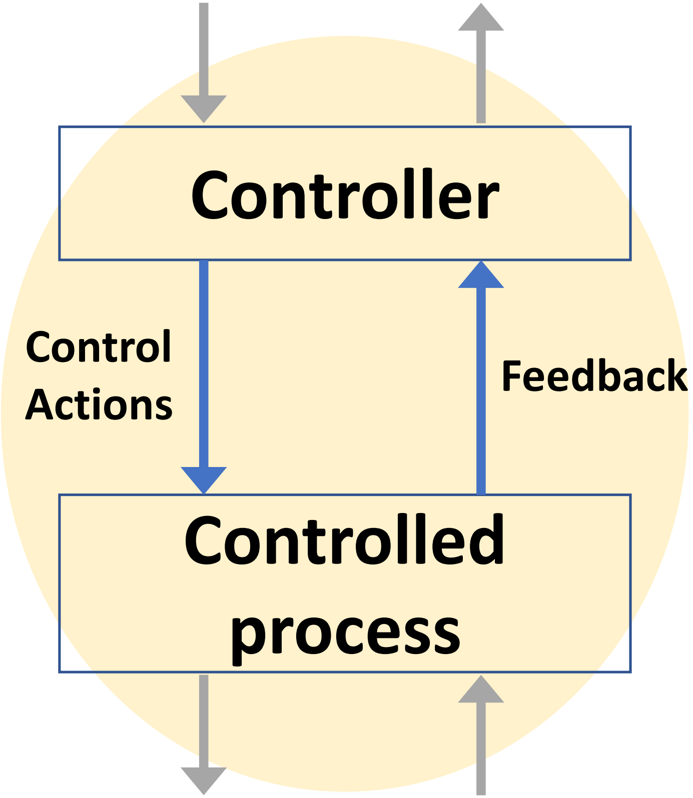


STPA-Sec

STPA Hazard Analysis

STAMP Model

- **Synthesize (frame) the security problem**
- **Define purpose of the analysis**
- **Model the Control Structure**
- **Identify unsafe/unsecure control actions**
- **Step 2: Identify loss scenarios**
- **Wargame**



Controller

Control Actions

Feedback

Controlled process

Security-related material or techniques

Summary and Conclusion

- Security engineering and underlying systems thinking offers an alternative to address the challenge and bring strategy to bear
- Growing realization that security engineering must begin before architecture development…but we need a Security Engineering Analysis methodology
  - All analysis is based on models, so we require a model of how losses occur
  - Default model today is "threats cause our security-related losses" (but we don't generally get to control the threats)
- STPA-Sec applies the STAMP model to provide a methodology to place security within a systems engineering context
  - Define "secure" functionality
  - Guide the development of an architecture to realize the functionality
  - We DO get to control our systems engineering

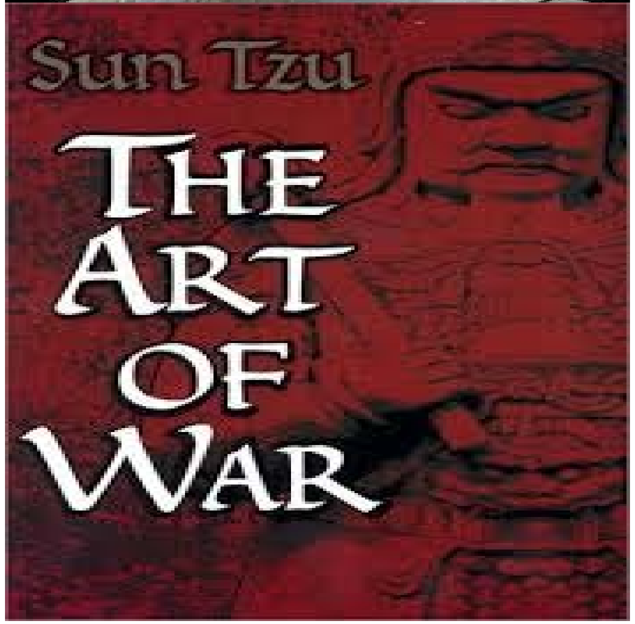
We Must Ensure That We Are Defining and Solving the Right (Engineering) Problem

Concluding Thoughts from Sun Tzu

The opportunity to secure ourselves against defeat lies in our own hands.

The supreme art of war is to subdue the enemy without fighting.

Strategy without tactics is the slowest route to victory.
Tactics without strategy is the noise before defeat.



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