

System Security Engineering: Whose Job Is It Anyway?

NDIA SE Symposium – SSE Track #18703 October 24, 2016



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Approved For Public Release #16-1910; Unlimited Distribution, Dated 10/3/16

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Cybersecurity is EVERYONE's Job

Systems Security Engineering: Whose Job Is It Anyway?

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ABSTRACT

This article delivers a look at current and evolving policy, guidance, and standards surrounding security activities in the systems engineering lifecycle. Emphasis is placed on systems security engineering (SSE) and how application of systems engineering concepts and processes in an agile manner (agile systems engineering) throughout the lifecycle is the way to deal with the dynamic and diverse world of cyber threats to a system (Dove 2014). This paper is a follow-on to "Response to Cyber Security Demands for Agility" (Nefib-Beyer 2014) published in the International Council on Systems Engineering (INCOSE) INSIGHT in 2014. The focus of that research was bringing attention to cyber security and the importance of other disciplines towards contributing to secure systems. Since that time many of these domains have further developed their own standards, processes, and guidance in the area of cyber security. What we require now is a way to take these domain-focused concepts and integrate them into and across a systems lifecycle. The best way to achieve this is as part of the systems engineering function. Designing and building secure systems requires a seamless integration of security into systems engineering processes and agile methodologies adopted to constantly revisit, reevaluate, and re-design as part of a risk management process. The framework that will be discussed in this paper will focus on taking currently evolving guidance in SSE and breaking that down into products and tools for systems engineers to easily determine the relationship and value between SSE and systems engineering. In addition, quick reference guides will further enhance and enable successful development and integration of SSE artifacts into systems engineering artifacts. One of the companion pieces needed in the existing SSE documentation is a mapping of work products/artifacts generated during the lifecycle/technical processes and the responsible and contributing parties. Critical to the success of the new guidance, such as the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-160, Systems Security Engineering, is a clear accountability and acceptance of all disciplines on their contributions and influence towards developing a secure system. We present an SSE roles and responsibilities framework concept for consideration. The framework is an implementation tool to be used along with existing guidance in the area of SSE and systems engineering to clearly demonstrate that program protection is not the responsibility of any one person or discipline, it is the responsibility of an entire learn of individuals planning, developing, deploying, operating & maintaining (O&M), and retiring a system. SSE is the "glue" that binds all of this together during the systems engineering lifecycle to enhance system security.

Integrating cybersecurity into the SE process is critical to ensuring a secure design



Recent paper published in INCOSE Insight Journal, July 2016 Volume 19 / ISSUE 2 2

Systems Engineering Approach to Cybersecurity is What is Needed

Progr DoDM 5200.01, V DoDI 5200.39	DoDI 8500.01 0.24 DoDI 8510.01			
Technology	Components	Information		
<u>What</u> : A capability element that contributes to the warfighters' technical advantage (CPI)	<u>What</u> : Mission-critical elements and components	<u>What</u> : Information about applications, processes, capabilities and end-items		
Who Identifies: System Engineers with CI/Intel and Security SME support ID Process: CPI Identification	Who Identifies: System Engineers, Logisticians	Who Identifies: All		
Threat Assessment: Foreign collection threat informed by Intelligence and Counterintelligence (CI) assessments	Threat Assessment: Defense Intelligence Agency Threat Analysis Center	Threat Assessment: Foreign collection threat informed by Intelligence and Counterintelligence assessments		
<u>Countermeasures</u> : Anti-Tamper, Classification, Exportability Features, Security, etc.	<u>Countermeasures</u> : SCRM, Cybersecurity, Anti- counterfeits, software assurance, Trusted Foundry, etc.	<u>Countermeasures</u> : Cybersecurity, Classification, Export Controls, Security, etc.		
Goal: "Keep secret stuff in" by preventing the compromise and loss of CPI	Goal: "Keep malicious stuff out" by protecting key mission components	Goal: "Keep critical information from getting out" by protecting data from our adversaries		

Protecting Warfighting Capability Throughout the Lifecycle

Program Protection and Secure Systems is executed through SSE (Reed 2015) 3 Approved For Public Release #16-1910; Unlimited Distribution, Dated 10/3/16

INCOSE SSE/SE Roles & Responsibilities Framework - Origins

- Nejib/Beyer paper on agile security July 2014, INCOSE Insight Journal
- Suggested project during INCOSE IS 2014 SSE working group session
- Timely with new SSE guidance and documents coming out from NIST and OSD (SE)
 - New specialty SSE section in upcoming INCOSE SE Handbook v4
- Need an easy reference responsibility framework to map out relationship between SSE/SE
 - Understandable by both SEs and SSEs

Approach

- Research applicable published Standards and Guidance
 - NIST 800-160
 - ISO 15288
 - INCOSE SE Handbook

These all had major updates mid 2015 and 2016

- Work focused on taking SSE activities, tasks and deliverables/artifacts and developing framework that can be used across domains and clearly defines critical artifact roles and & responsibilities within SSE and SE
- Make it clear to SEs how to integrate SSE products into related SE products and the value in doing so to manage overall program/system design and risk

The **systems security engineering** discipline provides the **security perspective** to the **systems engineering** processes, activities, tasks, products, and artifacts, with emphasis on system security risk management.

Project Goals

- Integrate artifact roles & responsibilities framework into new INCOSE specialty engineering section on SSE – Chapter 10
- Develop framework so that it can easily be adopted into NIST SP 800-160

From DoD 5000 Program Protection Plan

Who is responsible for system security engineering? Describe the linkage between system security engineering and the Systems Engineering Plan. How will system security design considerations be addressed?

Progress to Date

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INCOSE SE Handbook & NIST SP 800-160 organized by Processes and associated Activities and Tasks

Systems Engineering Life Cycle Processes

Recursive, Iterative, Concurrent, Parallel, Sequenced Execution

Agreement Processes	Organization Project-Enabling Processes	Technical Management Processes	Technical Processes	Life Cycle Stages	;
 Acquisition Supply 	 Life Cycle Model Management Infrastructure Management Portfolio Management Human Resource Management Quality Management Knowledge Management 	 Project Planning Project Assessment and Control Decision Management Risk Management Configuration Management Information Management Measurement Quality Assurance 	 Business or Mission Analysis Stakeholder Needs and Requirements Definition System Requirements Definition Architecture Definition Architecture Definition Design Definition System Analysis Implementation Integration Verification Vralidation Operation Maintenance Disposal 	Concept Development Production Utilization Support Retirement	

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Security Built into DoD Acquisition Lifecycle



Cyber security activities integrated across the system acquisition lifecycle (DISA 2014)

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ID	PROCESS	ID	PROCESS
AQ	Acquisition	MS	Measurement
AR	Architecture Definition	OP	Operation
BA	Business or Mission Analysis	PA	Project Assessment and Control
CM	Configuration Management	PL	Project Planning
DE	Design Definition	PM	Portfolio Management
DM	Decision Management	QA	Quality Assurance
DS	Disposal	QM	Quality Management
HR	Human Resource Management	RM	Risk Management
IF	Infrastructure Management	SA	System Analysis
IM	Information Management	SN	Stakeholder Needs and Requirements Definition
IN	Integration	SP	Supply
IP	Implementation	SR	System Requirements Definition
KM	Knowledge Management	TR	Transition
LM	Life Cycle Model Management	VA	Validation
MA	Maintenance	VE	Verification

NIST 800-160 broken down by ISO 15288:2015/INCOSE SE processes – expressed in security activities and tasks

IP	Implementation
IP-1	PREPARE FOR THE SECURITY ASPECTS OF IMPLEMENTATION
IP-1.1	Develop the security aspects of the implementation strategy.
IP-1.2	Identify constraints from the security aspects of the implementation strategy and technology on the system requirements, architecture, design, or implementation techniques.
IP-1.3	Identify, plan for, and obtain access to enabling systems or services to support the security aspects of implementation.

Implementation	Approved For Public Release #16-1910; Unlimited Distribution, Dated 10/3/16 GOAL
Prepare for the security aspects of implementation	Realizes the security aspects of all system elements The resultant system element satisfies the security architectural design requirements and satisfies security requirements, architecture and design
Perform	ACTIVITIES
Manage	 Prepare for the security aspects of implementation Perform the security aspects of implementation Manage results of the security aspects of implementation
INPUTS	Security relevant trade space of cost, capability and assurance(h/w, s/w, firmware, services) Supplier agreements, legislation and organizational policy Security architecture and security design
OUTCOMES	Security aspects of implementation that constrain the requirements, architecture or design are identified Security-relevant or security-informed system element is realized System elements are securely packaged and stored Enabling systems or services needed for the security aspects of implementation are available Traceability of the security aspects of the implemented system elements is established
ROLES	SSE (process owner), IA/CS engineer - SE, HW Engr, S/W Engr, Supply Chain/logistics (contributors)

NIST 800-160 SSE – ISO/INCOSE SE Mapping

(NIST SP800-160) SSE Outcomes set protection priorities and protection assurances are	Outcome of (NIST 800-160) Process Stakeholder Needs and Requirements	Informs (NIST 800-160) Process	Documented by (INCO)	SE SE Handbook) Artifact	Output of (INCOSE) Process	Input to (INCOSE) Process		INCOSE Artifact Definition	- î	
set protection priorities and protection assurances are	Stakeholder Needs and Requirements	Informs (NIST 800-190) Process Documented by (INCO		(INCOSE SE Handbook) Artifact Output of (INCOSE) Process			INCOSE Artifact Definition			
1 (1) (1) (1) (1) (1) (1) (1) (1	Definition Process (4.1) Definition Process (4.2)		Preliminary MOE Data		Business or Mission Analysis Process (4.1)	Stakeholder Needs and Requirements Definition Process 14, 71	Preliminary data provided for the iden	tified measurement needs.	1	
remenez. Stakeholder protection needs are transformed into stakeholder carby requirements.	Stakeholder Needs and Requirements		Stakeholder Requirement	Stakeholder Needs and Requirement Definition Process (4.2)		System Requirements Definition Process [4.3] Validation Process (4.11)	Requirements form various stakeholde capabilities, functions, and/or services, constraints. Stakeholder requirements Seecification (1965).	en that will govern the project, including: required system i; quality standards; system constraints; and cost and schedule i may be captured in the Stakeholder Requirements		
Security-driven and security-informed constraints on a system e identified.	Definition Process (SN) (3.1.2)		initial Requirements Verifi Matrix (RVTM)	cation and Traceability	Stakeholder Needs and Requirements Definition Process (4.2)	System Requirements Definition Process [4.3]	The validation oriseria (the measures 5 validation environments of the system	be assessed), who will perform validation activities, and the of interest.		
curity-oriented performance measures are defined.	Stakeholder Needs and Requirements Definition Process (SNI (3.1.2)		MOE Needs		Stakeholder Needs and Requirements Definition Process (4.2)		Identification of the Measures of Effect Information needs of the decision mak expectations.	ctiveness (MOEs) (Roedler & Jones, 2006), which define the kers with respect to system effectiveness to meet operational	1	
der agnement that their protection needs and fore are adequately reflected in the accurity requirements		Validation Criteria			Stakeholder Needs and Requirements Definition Process 14, 21	Validation Process (4.11)	The validation oriteria (the measures 5 validation environments of the system	to be assessed), who will perform validation activities, and the polyinterest.		
akeholder agreement that their protection needs and pectations are adequately reflected in the security requirements activeed.	Stakeholder Needs and Requirements Definition Process (SN) (3.1.2)		Validated Requirements		Validation Process (4.11)	Stakeholder Needs and Requirements Definition Process (4.2) Project Assessment and Control Process (5.2)	Confirmation that the various requirer	ments will satisfy the business and stakeholder requirements.	Ì	
eed. United to support the security Stakeholder Needs and Requirements of the security Stakeholder Needs and Requirements definition are (NIST SP800+160) SSE Outcomes			System Function Identifica	ition	Stakeholder Needs and Requirements Definition Process (4.2)	System Regularements Definition Process [4.3]	identification of the system functions.		j	
(NIST SP800-160) SSE Outcomes		Outcome of (NIST 800-	160) Process	Informs (NIST	800-160) Process	Documented by (INCOSE S	5E Handbook) Artifact	Output of (INCOSE) Process		
		Implementation Process	(IP) (3.1.7)					Implementation Process (4.7)		
The security aspects of the implementation strategy are developed.		Implementation Process	(IP) (3.1.7)			Implementation strategy		Implementation Process (4.7)		
The security aspects of implementation that constrain the equirements, architecture, or design are identified.		Implementation Process (IP) (3.1.7)			Implementation Constraints			Implementation Process (4.7)		
A security-relevant or security-informed	system element is					System Elements		Implementation Process (4.7)		
The security aspects of the implementation strategy are developed. The security aspects of implementation that constrain the requirements, architecture, or design are identified. A security-relevant or security-informed system element is realized. System elements are securely packaged and stored. Any enabling systems or services needed for the security aspects of implementation are available.		Implementation Process	(IP) (3.1.7)			System Element Documentat	ion	Implementation Process (4.7)		
System elements are securely packaged	and stored.	Implementation Process	(IP) (3.1.7)			Implementation Report		Implementation Process (4.7)		
Any enabling systems or services needed of implementation are available.	for the security aspects	Implementation Process	(IP) (3.1.7)			Implementation Enabling Sys	tem Requirements	Implementation Process (4.7)		
Fraceability of the security aspects of the	e implemented system	Implementation Process	(IP) (3.1.7)			Implementation Traceabilty		Implementation Process (4.7)		
elements is established.		 				Implementation Record		Implementation Process (4.7)		

Initial Mapping done by Ken Kepchar, INCOSE SSE WG Co-Chair

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SSE Task/Artifa ct	Project Planning	Project Assessment and Control	Decision Management	Risk Management	Configuration Management	Information Management	Measurement	Quality Assurance	Process/ Task owner	Supporting Roles	SE Related Artifact
Program Protection Plan/Security Plan	0								SSE or CS/IA Engr	S/W, H/W, SE, SC	SEMP
											Project Performance Measures
											Decision Strategy & Report
Security Risk Management Plan				0					SSE or CS/IA Engr	S/W, H/W, SE, IT/SA	Risk Management Report
											Configuration Management Baselines & Report
											Information Repository
											Measurement Repository
											QA Plan & Report

<u>Legend:</u> O – Process Outcome I – Input to Process

H/W – hardware engr S/W – software engr SE – system engr SSE – sys security engr IA/CS – Info assurance/cybersecurity IT/SA – IT/sys admin

SC- supply chain/logistics

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SSE Task/Artifa ct	Business or Mission Analysis	Stakeholder Needs & Reguirements	System	Architecture Definition	Design Definition	System Analysis	Implementation	Integration	Verification	Transition	Validation	Operation	Maintenance	Disposal	Process/ Task owner	Supporting Roles	SE Related Artifact
Mission Security Requiremen t	0																Mission Requirement s
Security RVTM		0													SSE or IA/CS Engr		Initial RVTM
Updated Security RVTM			0														Updated RVTM
Security Architecture				0													System Architecture
Security Design					0												System Design
Security Analysis						0	I										System Analysis
Security Implementa tion							0		I		Ι				SSE or IA/CS Engr	SE, H/W, S/W, logistics, SC	Implementati on Report
Security Integration Report								0									Integration Report
Final SVRTM									0								Final VRTM
Security Transition Report										0							Transition Report
Security Validation Report											0						Validated System
Security Operation Report												0					Operation Report
Security maintenanc e Report													0				Maintenance Report
Security Disposal Report														0			Disposal Report

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References

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- Slide 9 DISA. 2014. Risk Management Framework Implementation. Information Assurance Support Environment. 4 April. <u>http://iase.disa.mil/rmf/Pages/rmf-training.aspx</u>.
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