Supply-Chain Risk Analysis

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Report Documentation Page

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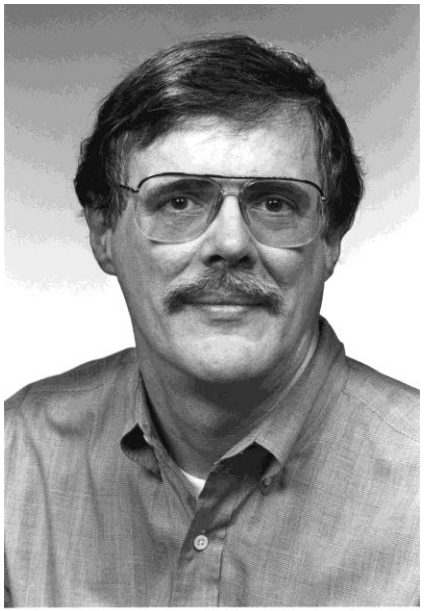
Biography: Bob Ellison



Bob Ellison is a senior member of the technical staff of the CERT program at the Software Engineering Institute. He is currently the technical leader of a DHS funded project on supply-chain risks. He participated in the design and development of the DHS Build-Security-In Web site and continues to contribute articles to it. His recent work includes the development of the Survivability Analysis Framework which considers the affects of security threats on complex operational business processes. He is a coauthor of the book “Software Security Engineering: A Guide for Project Managers” (Addison-Wesley 2008)

Polling Question #1

How did you hear about this webinar?

1. Social Media (i.e., LinkedIn, Twitter)
2. SEI Website
3. SEI Member Bulletin
4. Email invitation from the SEI
5. Website with webinar calendar (i.e.,www.webinar-directory.com)

Software Supply Chain

The network of stakeholders that contribute to the content of a software product or that have the opportunity to modify its content.

Comprehensive National Cybersecurity Initiative 11

Polling Question #2

Has your organization had a problem with software malware in the last year?

Answers:

- Yes
- No
- Do not know

What We Will Cover

Software supply-chain complexity: slides 6-8

Strategy: slides 10-18

Supply-chain risk example 20-40

Summary: slides 42-44

Supply-Chain Risk Examples

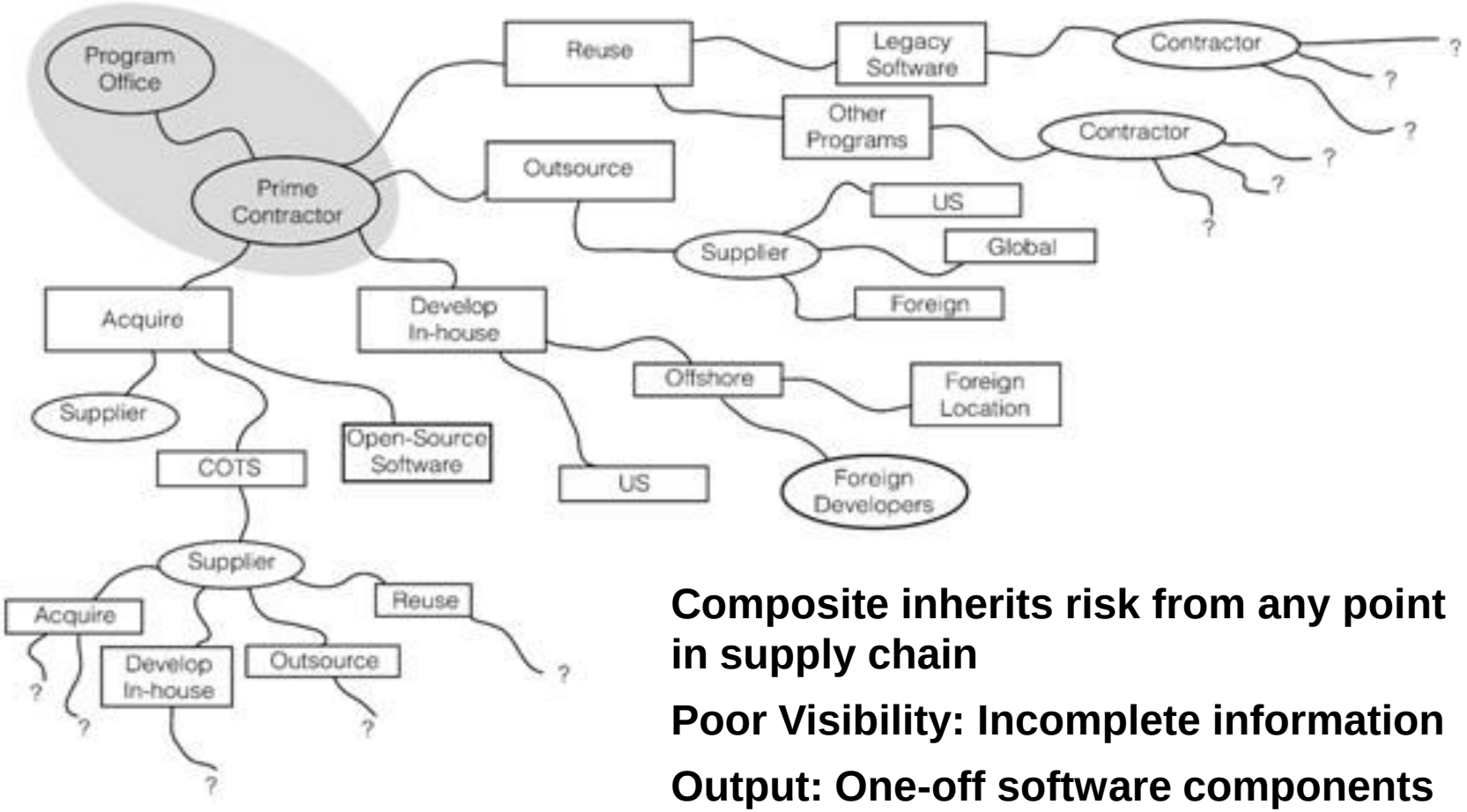
Hardware

- Manufacturing and delivery disruptions
- Manufacturing quality
- Counterfeit hardware estimated at 10%
- Decades of data collection for physical supply chains

Software

- Third-party tampering during development or delivery
- Malicious supplier
- Compromised by inadvertent introduction of exploitable design or coding errors
- Very little data for software supply chains

Software Supply Chain Complexity[-1]



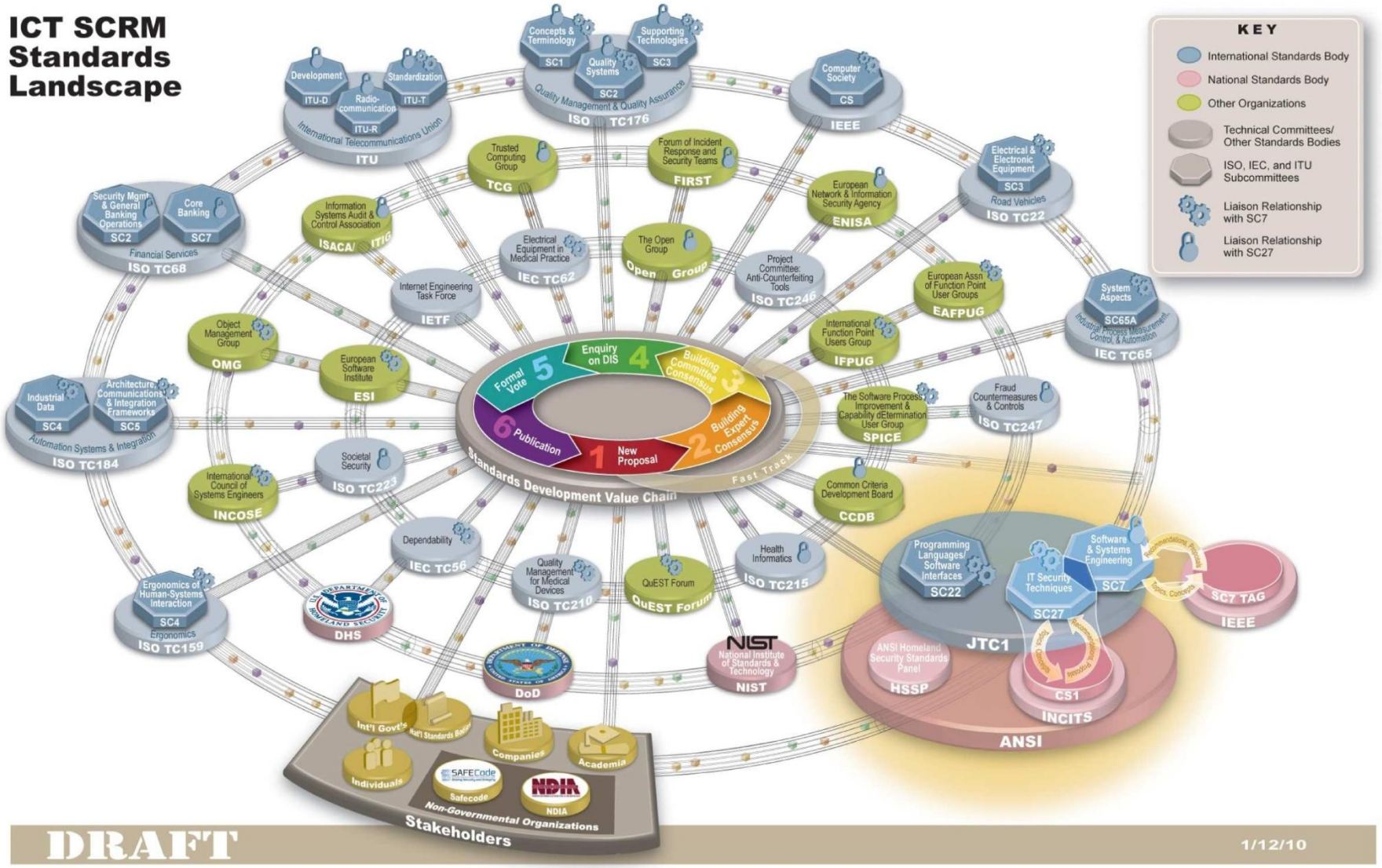
Composite inherits risk from any point in supply chain

Poor Visibility: Incomplete information

Output: One-off software components

The Landscape

Complexity^{-3}



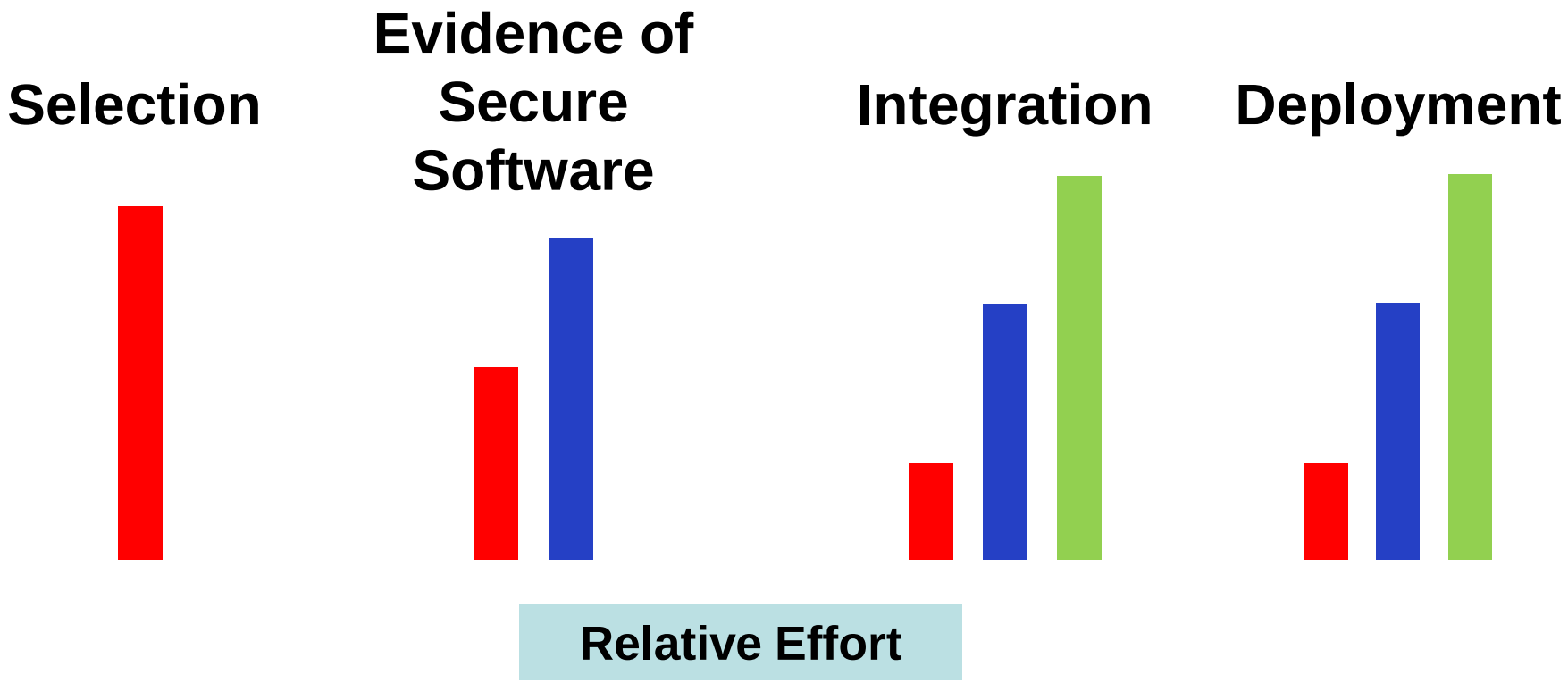
Systems and Software Technology Conference 2010, Don Davidson, Globalization Task Force, DoD

Strategy

Propagation of Supply-Chain Risks

Selection	Evidence of Secure Software	Integration	Deployment Over time
Construction Secure Development Practices **Governance** Training Supplier and subcontractor management Verification of third-party software	Supplier and independent verifications Used recommended mitigations from CWE Weaknesses and mitigations tested Systematic testing of invalid input Static analysis of source code	Mitigation of risks not adequately addressed by supplier Effects of component supply-chain risk on aggregate system Risks induced by integration: Assumption mismatches Verify that aggregate risk is still acceptable	Install supplier updates Periodically update risk assessment: changes in usage, attack patterns, product updates, suppliers Monitor operational system behavior for unexpected events: test of design assumptions

Information Needs by Activity



Supply-Chain Risk Categories

Category	Description
Acquirer Capability	Operational preparedness, acquisition task execution, event management
Supplier Capability	Governance, Construction, Verification, Deployment
Product	An assessment of the problems and issues associated with a software product
Product Logistics	Access control of the software product at each step in the supply chain
Operational Product Control	Implementation of appropriate operational configuration and monitoring controls to reduce the risk of unauthorized changes to software products

Strategy Outline-1

A solution depends on a combination of

- Supplier capabilities to create secure software
  - A necessity
- Product verification
  - What evidence shows that supplier expertise has been effectively applied to produce more secure software?
- Acquirer capabilities
  - Capability to manage multiple suppliers
  - Match software usage with supplier's intent
  - Manage changes in usage, suppliers, and attack patterns

Strategy Outline-2

Acquirer has to plan for security after deployment

- No guaranteed way to find maliciously inserted code
- Supply chain risk assessment can be invalidated by
  - New attack techniques and software weaknesses
  - Changes in acquirer usage that activate unused product features
  - Product upgrades that add features or change implementation
  - Increase in criticality with new or expanded usage
  - Changes in the supplier risk factors: mergers, corporate policies, staff training, development life cycle
- Operational management has to deal with incomplete supplier, product, and attack risk information

Polling Question #3

Does your organization consider a vendor's capabilities to produce secure software when purchasing COTS software or outsourcing software development?

Answers:

- Yes
- No
- Do not know

SEI Project

Supply Chain Risk Model

- Develop a model that helps to structure and simplify analysis
- Initial focus on software supply chain
- Software supply chain risk management is more than a supplier assessment
  - Manage supply-chain risks that continue into deployment
  - Need increased understanding of allocation of responsibilities among suppliers and acquirers

Supply Chain Drivers

A systemic risk assessment is based on a small set of factors that strongly influence the eventual outcome or result.

These factors are commonly referred to as drivers.

SEI experience shows that about 15-25 drivers are needed to establish a comprehensive profile of systemic risks to mission success.

These drivers reflect both supplier and acquirer factors.

General Set of Supply-Chain Drivers

1. Software Supply-Chain Objectives
2. Acquisition Plan
3. Contracts
4. Development Process
5. Acquisition Task Execution
6. Coordination
7. Software Supply-Chain Interfaces
8. Information Management
9. Technology
10. Facilities and Equipment
11. Environmental Conditions
12. Compliance
13. Event Management
14. Requirements
15. Architecture
16. Design, Code, and Test
17. System Functionality
18. System Integration
19. Operational Support
20. Adoption Barriers
21. Operational Preparedness
22. System Risk Tolerance
23. Certification and Accreditation
24. Sustainment

Software Supply-Chain Risk Example

A Supply-Chain Weakness

Existing vulnerabilities present easy and effective opportunities for attackers – errors support malicious activities

Can reduce likelihood of vulnerabilities with incremental changes in development practices

- Draw from
  - Microsoft's Secure Development Life Cycle
  - SAFECode
  - Build Security In Maturity Model (BSIMM)
  - Build-Security-In https://buildsecurityin.us-cert.gov/daisy/bsi/home.html

Prevalence of Software Errors

MITRE has documented software errors that have led to exploitable vulnerabilities: Common Weakness Enumeration (CWE)

CWE/SANS[1] Top 25 Most Dangerous Programming Errors published yearly by MITRE – 3/1/2010

Examples

Improper Input Validation	SQL Injection
Cross-site scripting	Use of Hard-coded Credentials
Download of Code Without Integrity Check	Improper Check for Unusual or Exceptional Conditions
Race Condition	Classic Buffer Overflow

1. http://cwe.mitre.org/top25/
SANS (SysAdmin, Audit, Network, Security) Institute

Veracode: State of Software Security

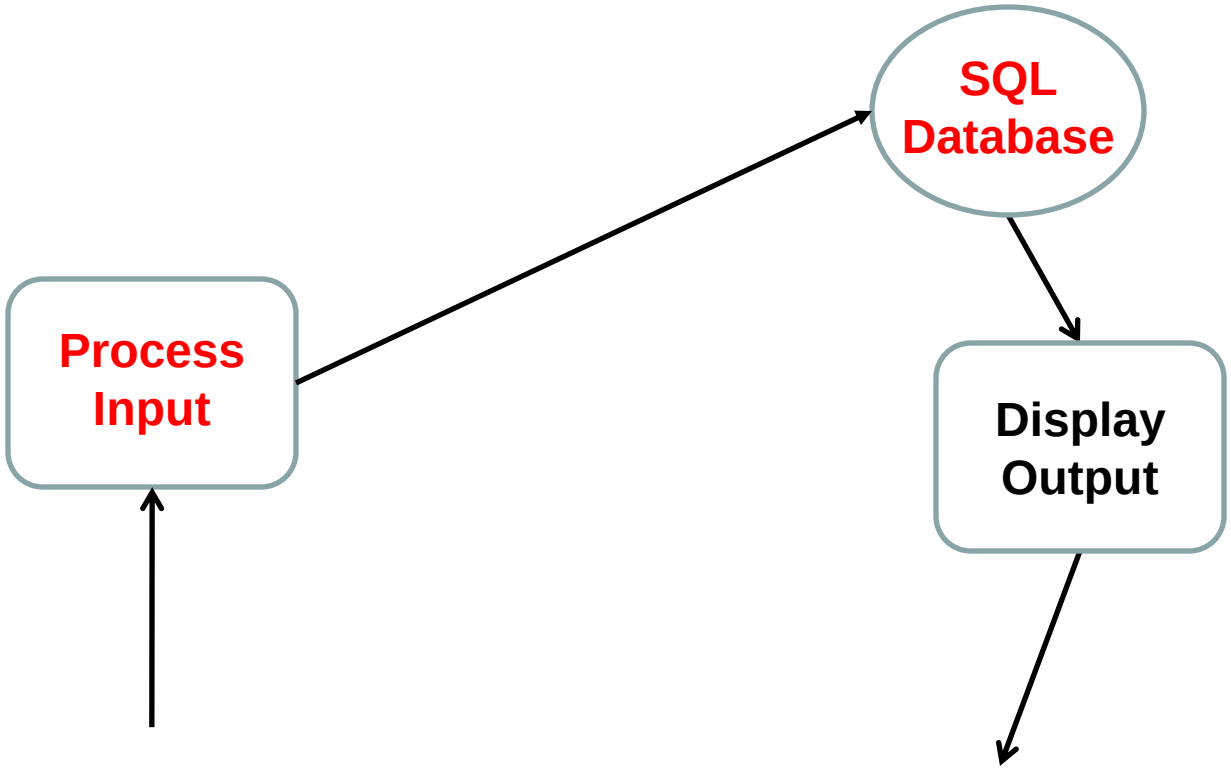
58% of all applications did not achieve an acceptable security score upon first submission – 3/1/2010

Measured Against CWE/SANS Top-25 Errors

Software Source	Acceptable
Outsourced	6%
Open Source	39%
Internally Developed	30%
Commercial	38%

Veracode: The pervasiveness of easily remedied weaknesses suggests developer training for secure software development is a critical supplier criteria.

SQL Database Query

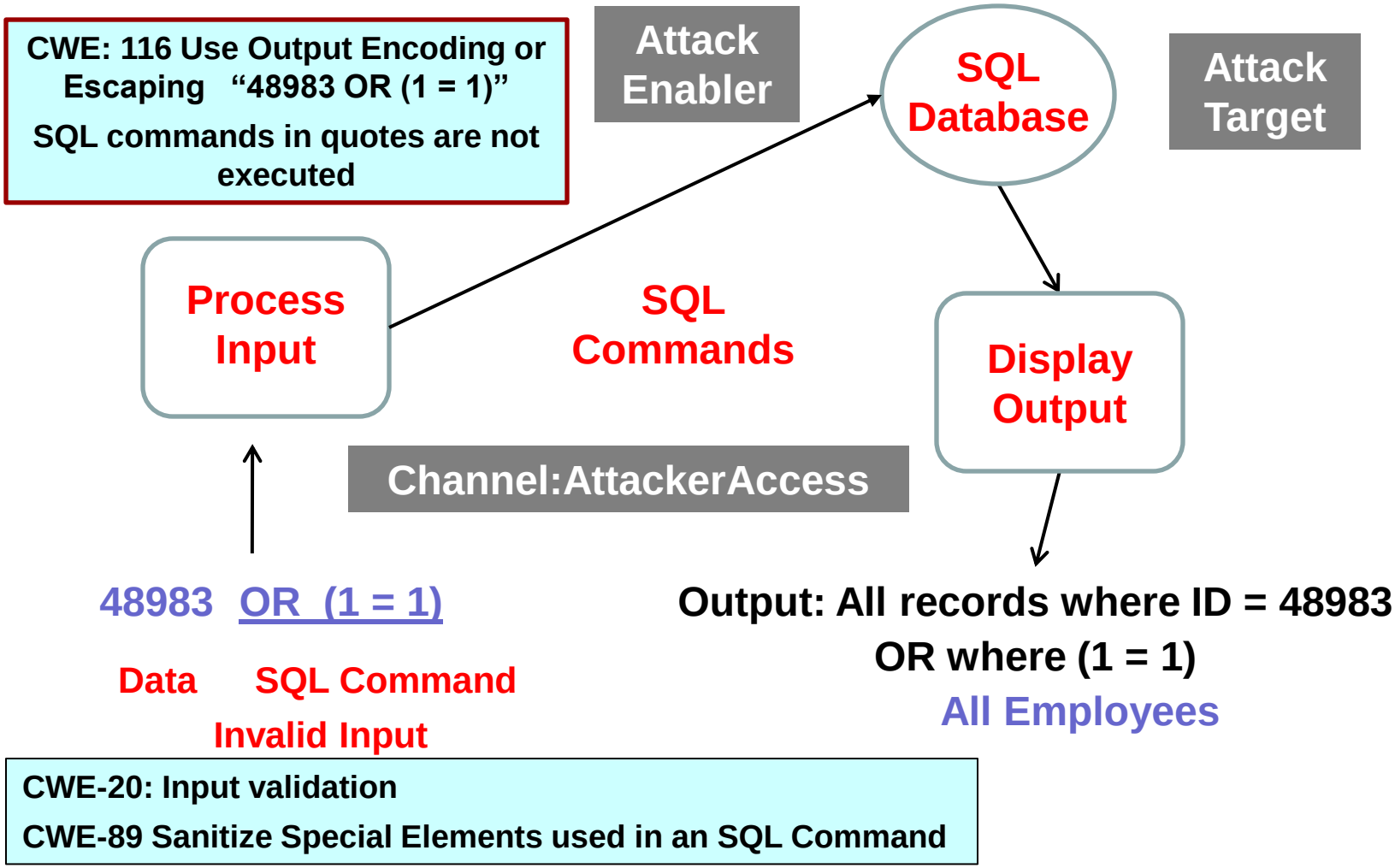


User Input
48983

Output: All records with ID = 48983
48983 Sally Middleton $74,210

Could involve multiple supply chains: web server, SQL database, and contracted software development

CWE-89: Attacker View - SQL Injection



Assessments By Activity

Selection

Relative Effort

Construction

Secure Development Practices

Governance

Training

Supplier and subcontractor management

Verification of third-party software

Knowledge of Supplier Capabilities

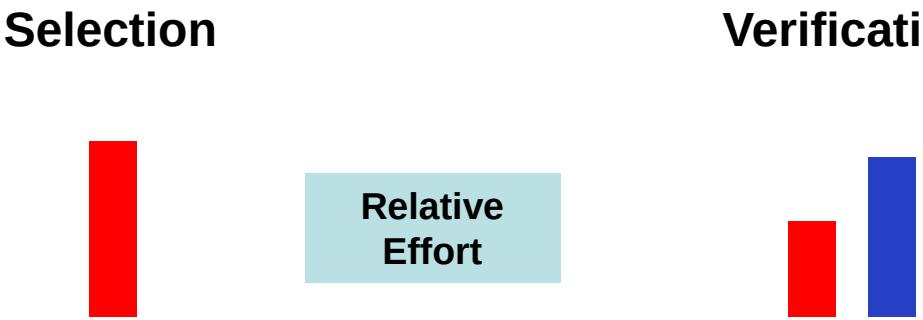
Knowledge of Product Attributes

Driver: Design, Code and Test

Is the code's quality sufficient to meet system requirements and provide the desired operational capability

Design reviews	Analysis of attack patterns
Source code reviews	Threat/vulnerability analysis
Coding practices	Software security testing
Static code analysis	Dynamic testing
Unit and integration testing	Code interfaces and dependencies
Analysis of common weaknesses	

Evidence of Secure Software



Evidence of Secure Software

Supplier and/or independent verifications

Used recommended mitigations

Likely software weaknesses and mitigations tested

Systematic testing of invalid input

Static analysis of source code

Knowledge of Supplier Capabilities

Knowledge of Product Attributes

Product Evidence: Testing

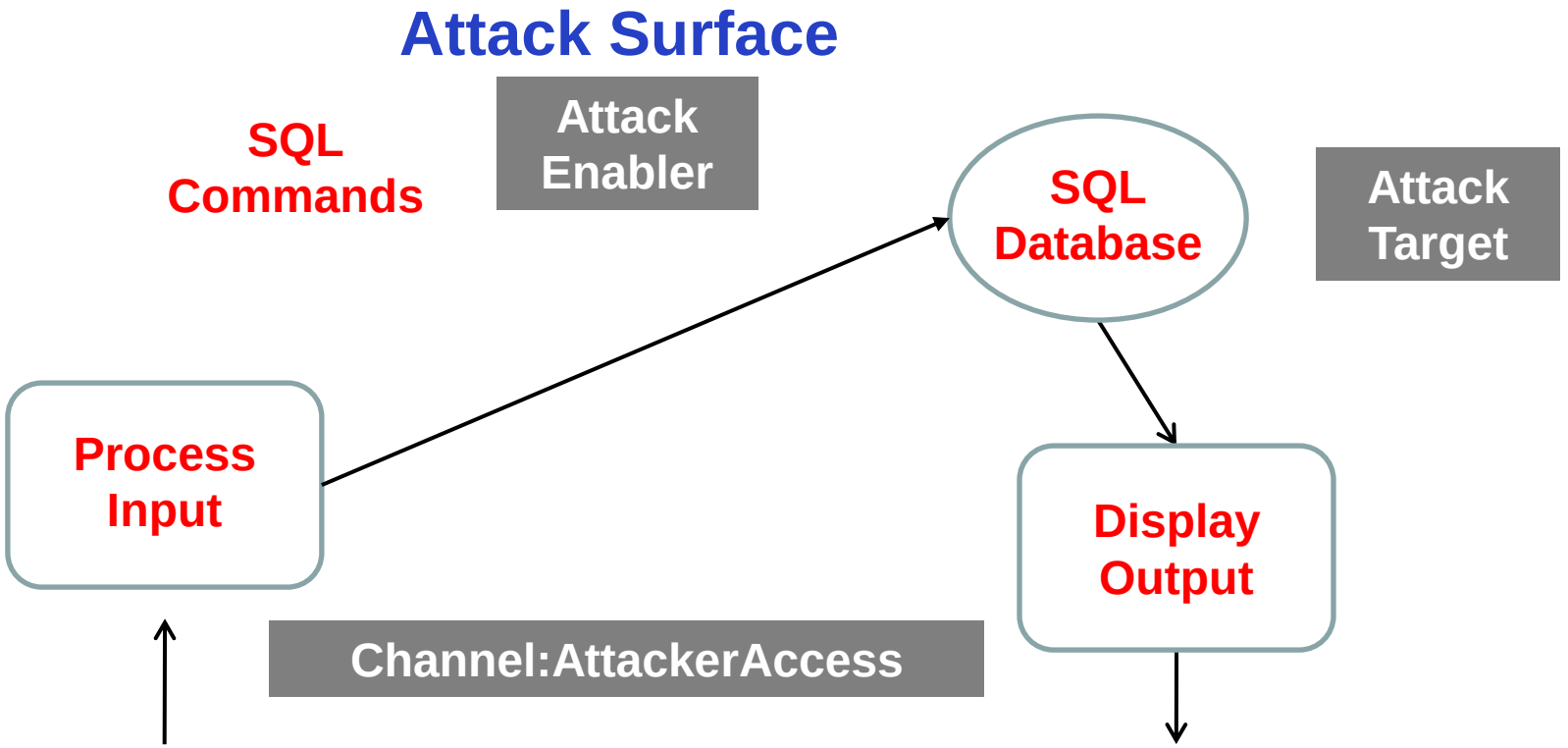
Security Testing

- Potential software weaknesses and mitigations tested
- Systematic testing of invalid input – fuzz testing
- Static analysis of source code

Testing is increasingly automated and outsourced

- Limited value for risk analysis:
  - We know neither the consequences or likelihood for any remaining vulnerabilities nor the costs and effectiveness of possible mitigations
- Expensive redesign and mitigations: Veracode statistics on initial failures for security testing.

Product Evidence: Attackability



A system with more targets, more enablers, more channels or more generous access rights provides more opportunities to the attacker.

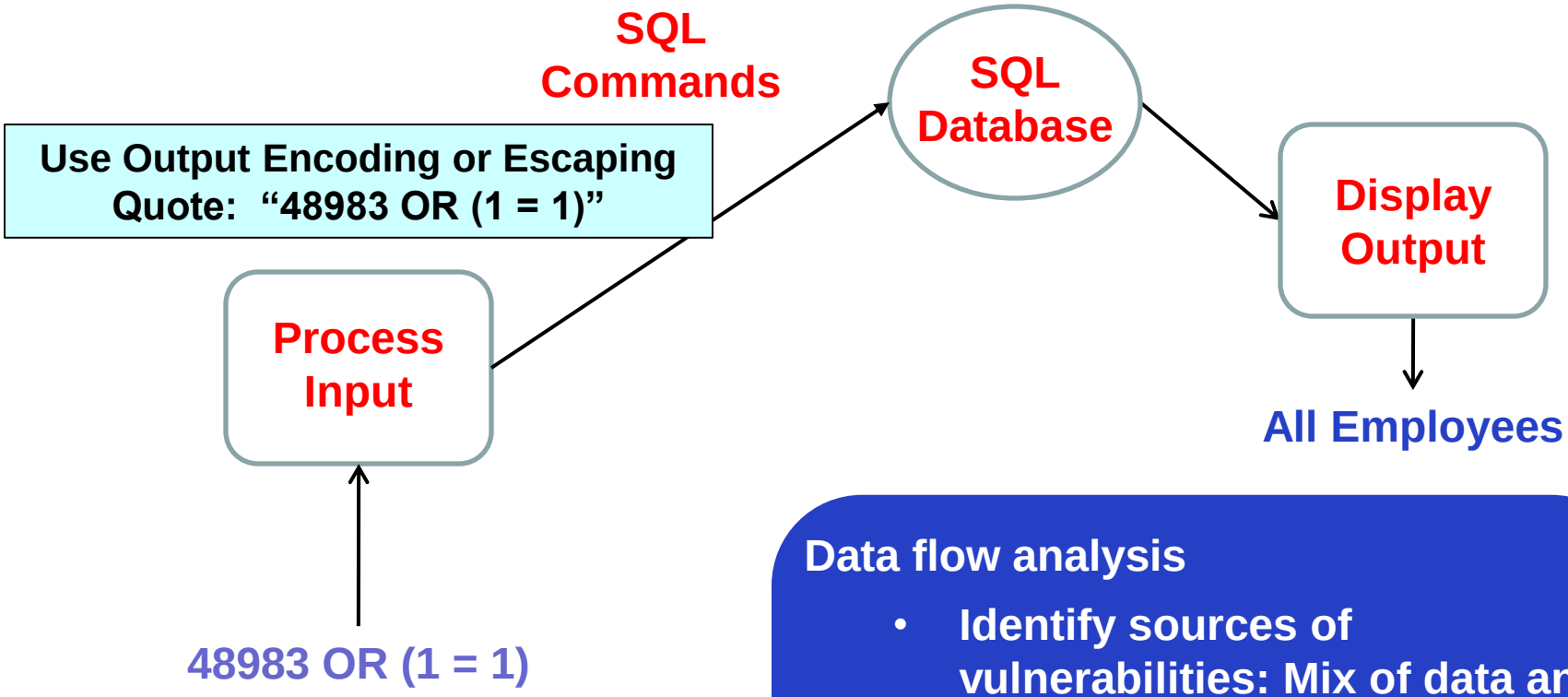
Attack surface: targets, enablers(exploitable features), communication channels, and access controls

Using Attack Surface Analysis

Reduce Attack Surface

- Remove or change system features or re-architect the implementation to avoid attack enablers or unnecessary channels.
- Revise use of an emerging technology where there is limited knowledge of the potential exploits and mitigations
- Review requirements or implementation if existing mitigations are costly or do not provide the necessary assurance

Data Flow Analysis



Input validation

Sanitize Special Elements used in an SQL Command

Data flow analysis

- **Identify sources of vulnerabilities: Mix of data and commands**
- **Consider consequences**
- **Analyze mitigations**
- **Provide architecture and design guidance**

Data Flow Analysis Benefits

Supports

- Objective trade-off discussions involving security risks during initial development or with later upgrades
- Supply-chain risk management – consequences and mitigations
- Traceability and business justifications
- System integration – insight into design assumptions, attack patterns considered and mitigation strategy
- Operational monitoring – design assumptions about expected behavior

Threat Modeling

Threat Modeling: During a data flow walk through

- Document security assumptions and trust boundaries
- Consider known weaknesses and attack patterns
- Consider deployed configuration and expected usage
- Analyze the interfaces to other components (inputs and outputs)
- Analyze possible mitigations

Value recognized – Microsoft's SDL, BSIMM collection of current practices drawn from thirty firms

See Stevens (references) for adoption considerations

Driver: Acquisition Task Execution

Are tasks and activities performed effectively and efficiently?

Experience and expertise of management and staff	Sufficient experience in software security, reliability, and safety engineering
Resources allocated to tasks and activities	Experience with software supply chains

Polling Question #4

Do your suppliers and in-house developers incorporate threat modeling as part of the vulnerability analysis?

Answers:

- Yes
- No
- Do not know

Incorporate into Acquisition: RFP

RFP: ask for evidence

- Development staff training
- Documentation of potential attacks and mitigations
- Supplier capabilities as demonstrated with development of other systems
- For contracted development, require application of threat modeling to analyze risks associated with architecture and design decisions

Driver: Contracts

Are the contract mechanisms with each participating group or team sufficient?

Includes suppliers contracts with their suppliers or subcontractors

Acquisition and development strategies	Sufficient focus on software security, reliability, and safety
Resources	Contracts with each participating group or team
Funding	Schedule
Intellectual property considerations	Alignment among the contracts of participating groups or teams
Licensing agreements	Roles and responsibilities

Integration and Deployment

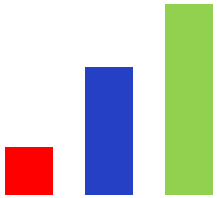
Relative Effort

Knowledge of Supplier Capabilities

Knowledge of Product Attributes

Operational Capabilities

Integrate: Multiple Suppliers



Mitigation of risks not adequately addressed by supplier

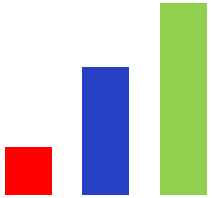
Effects of component supply-chain risks on aggregate system

Risks induced by integration: Assumption mismatches

Verify that aggregate risk is still acceptable

Deployment

Over time



Install supplier updates

Periodically update risk assessment: changes in usage, attack patterns, product updates, suppliers

Monitor operational system behavior for unexpected events: test of design assumptions

Driver: System Integration

Will the system sufficiently integrate and interoperate with other systems when deployed?

Interfaces	COTS software
Applications	Performance, security, reliability, and safety of the integrated system
Tools	Failure analysis
Hardware	Security testing
Data	Legacy systems

Driver: Event Management

Does the software supply chain have sufficient capacity and capability to identify and manage potential events and changing circumstances?

Expected and unexpected potential events and changing circumstances	Program continuity, disaster, and contingency plans
Changes in personnel or suppliers	Issue/problem management plan, process, and tools
Changes in product usage	Changes in requirements

Summary

Manage Supply-Chain Risk

Operational Context, e.g., usage, requirements, operational preparedness, risk tolerance

Acquisition Scope, e.g., product, system, system of systems, major upgrade, component replacement

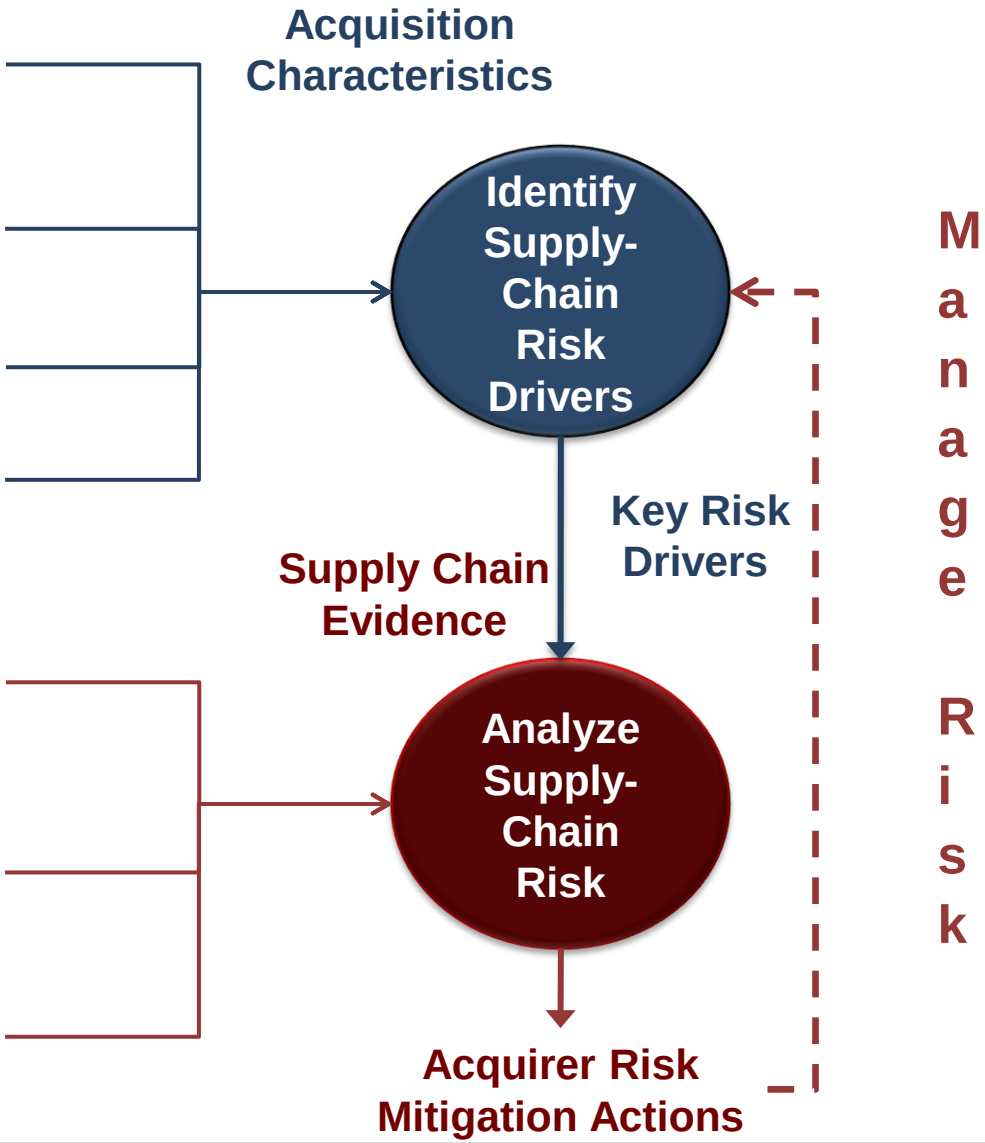
Supplier Capability Data, i.e., guidance for supplier evaluation

Preliminary Product Data, i.e., guidance for product evaluation

Supplier Product Development Information, e.g., architecture, design-code-test, compliance, supply- chain interfaces, event management

Acquirer Information, e.g., acquisition plan, acquisition task execution, event management

Operational Product Control, i.e., monitoring and configuration control of software products



Summary

Supplier, acquirer, and operator all have roles to ensure good practices are applied!

A supply-chain risk model helps to manage complexity and provides a structure for risk analysis

Example: Remove widely exploited software weaknesses with known mitigations

- Feasible
- Incremental changes to existing software development and acquisition life cycles
- Demonstrated value

Sources

Evaluating and Mitigating Software Supply Chain Security Risks

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Attack Surface

- Michael Howard, 2003, http://msdn.microsoft.com/en-us/library/ms972812.aspx

Threat Modeling

- Frank Swiderski, Window Snyder, *Threat Modeling*, 2004
- Michael Howard and Steve Lipner. *The Security Development Lifecycle,* 2006
- James McGovern, & Gunnar Peterson. “10 Quick, Dirty, and Cheap Things to Improve Enterprise Security.” Security & Privacy, IEEE, March-April 2010
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- John Stevens, “Threat Modeling— Perhaps It’s Time”, Security & Privacy, IEEE, May-June 2010

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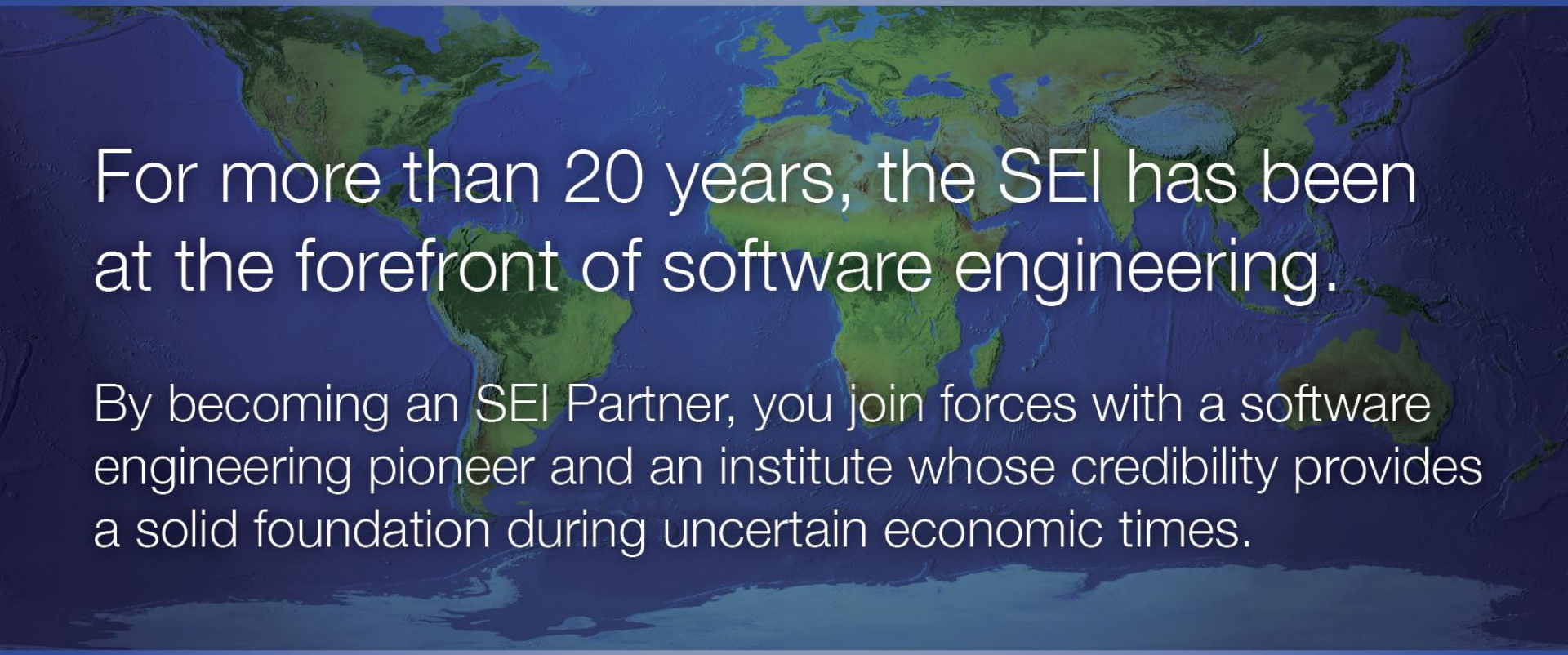

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