Risk and Argument: A Risk-based Argumentation Method for Practical Security

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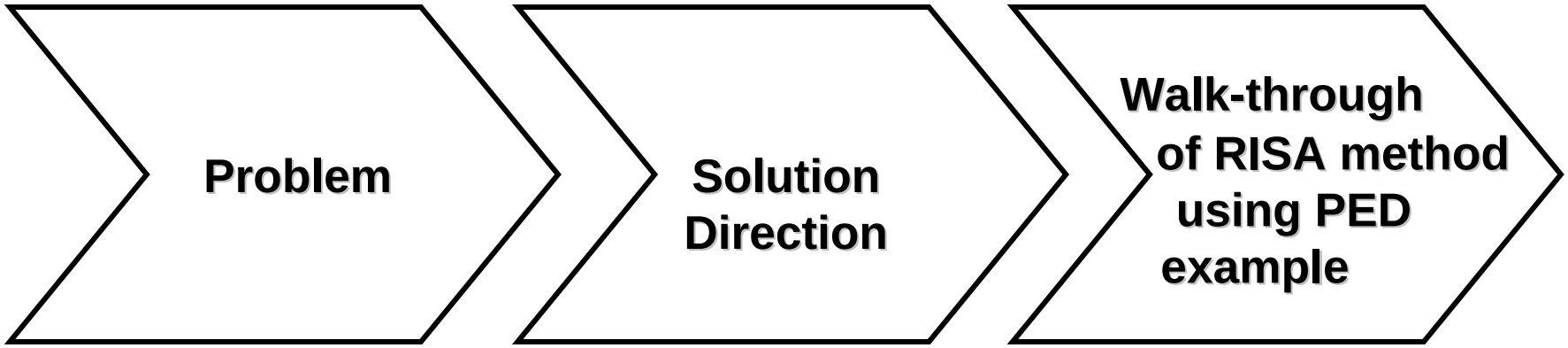
Agenda


Problem
Solution Direction
Walk-through of RISA method using PED example

Engineering of secure systems is bound by practical limitations

Limited resources

Uncertainties

Incomplete information

Unnoticeable, hardly measurable evidence

Consequence & Solution Direction

In practice:

- No absolute security
- No 100% security requirements satisfaction

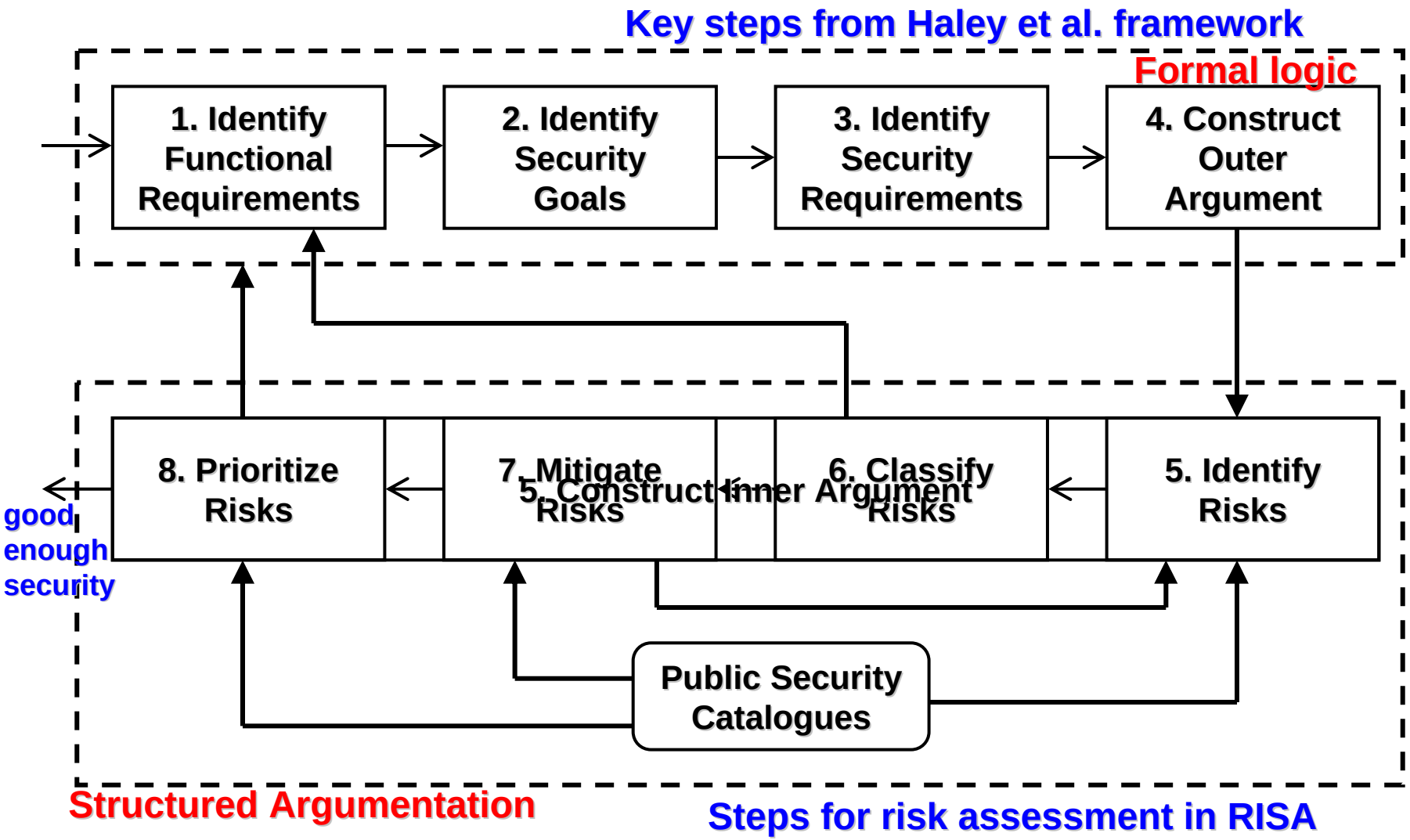
Way forward:

- Good enough security satisfaction
- As low as possible level of security risk

Our solution:

RISA – **RIsk assessment** in **Security Argumentation**

From Haley et al. framework to RISA method



PIN Entry Devices (PED) example

S.Drimer, S.J.Murdoch, and R.Anderson, Thinking Inside the Box: System-Level Failures of Tamper Proofing, in SP'2008, IEEE Press, pp. 281-295, 2008.

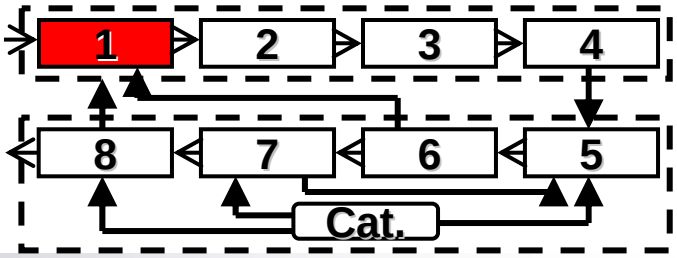
RISA step 1: Identify Functional Requirements

- **functional goal**

Provide convenient payment option at Points-Of-Sale to consumers

- **functional requirement**

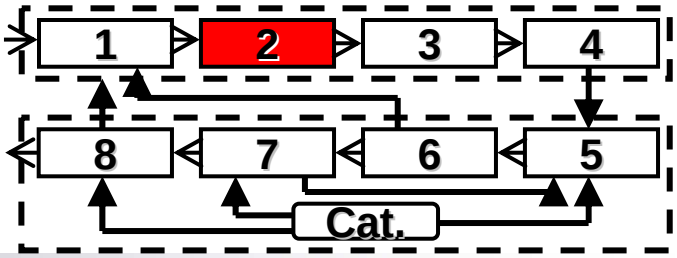
Allow consumers to pay at Points-Of-Sale with PIN



RISA step 2: Identify Security Goals

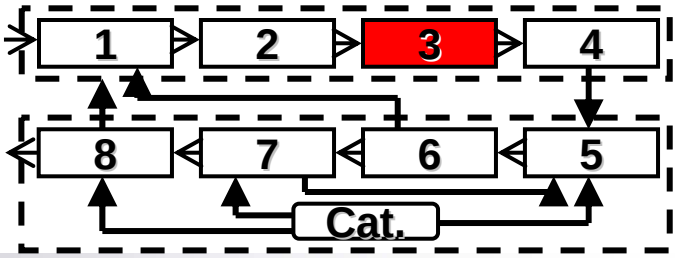
- **valuable assets**
  - **PIN**
  - card details
  - transaction value
  - design characteristics
  - smartcard itself
  - cryptographic keys
- **security goal**

Protect the PIN



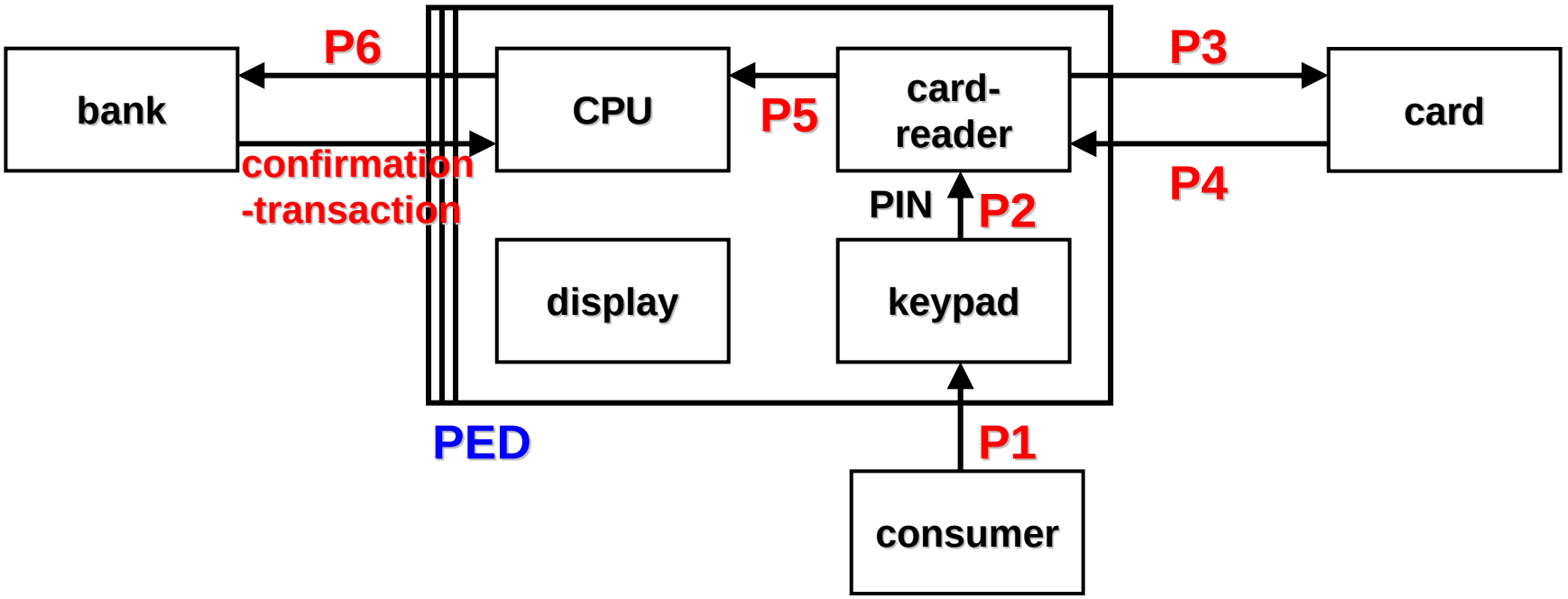
RISA step 3: Identify Security Requirements

- **security requirements**
  - confidentiality of PIN
  - integrity of PIN
- **security functions**
  - enclosure of PED components provides **tamper detection & response** mechanisms to resist physical attacks
  - **encryption/decryption of PIN** ensures that the PIN is encrypted within the PED immediately after PIN entry
- **system context diagram**



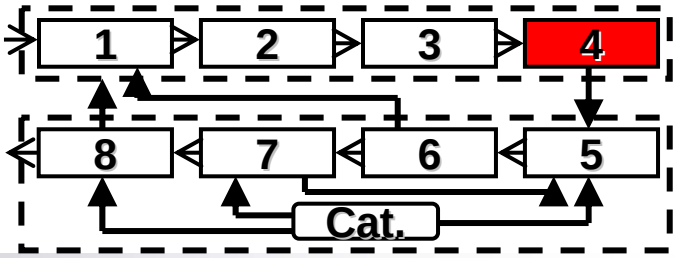
RISA step 4: Construct Outer Argument

Formal proof that behavior of PIN related to confidentiality is satisfiable



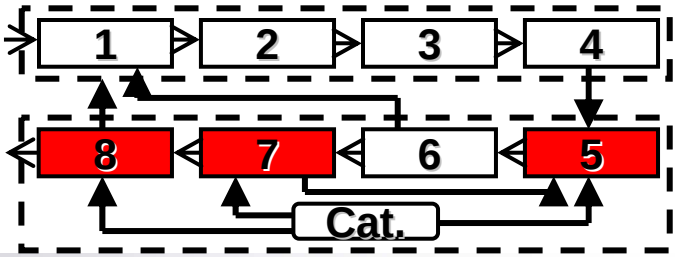
Outer argument for confidentiality of PIN:

(Behavioral premises) P1, P2, P3, P4, P5, P6
├ confirmation-transaction

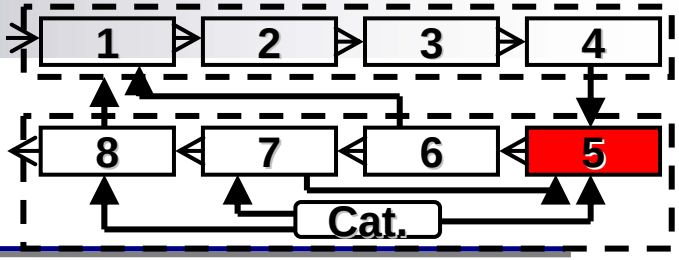


Risk assessment steps of RISA are supported by the CAPEC & CWE public catalogues

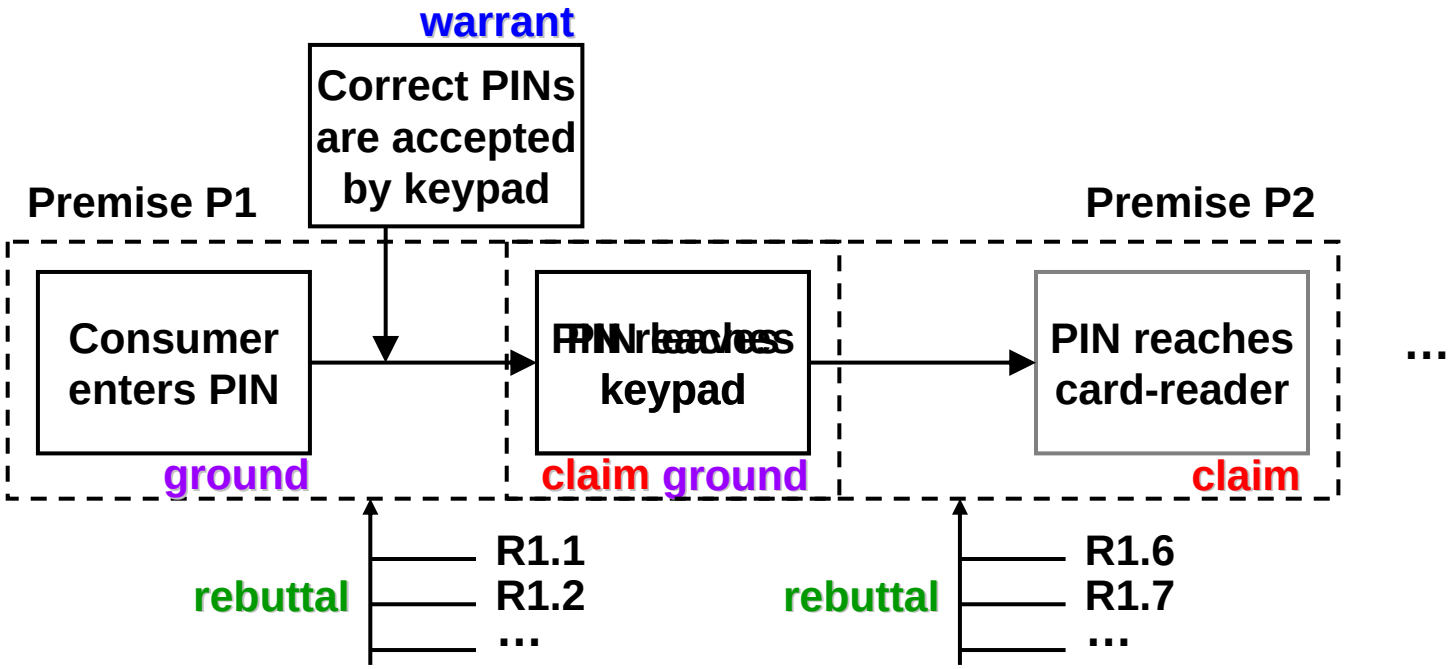
http://capec.mitre.org/
http://cwe.mitre.org/



RISA step 5: Identify Risks



Structured argumentation used to challenge behavioral premises in practice via risk assessment



Challenged	Risk	Reference
Premise P2	R1.6: PIN is revealed if sent unencrypted within the PED and the PED enclosure can be tampered	CWE-311 & CAPEC-436

CWE List
Full Dictionary View
Development View
Research View
Reports
About
Sources
Process
Documents
FAQs
Community
Related Activities
Discussion List
Research
CWE/SANS Top 25
CWSS
CWRAF
T-Shirt
News
Calendar
Free Newsletter
Compatibility
Program
Requirements
Coverage Claims

CWE-311: Missing Encryption of Sensitive Data

Missing Encryption of Sensitive Data

Weakness ID: 311 *(Weakness Base)* **Status:** Draft

Description

Description Summary

The software does not encrypt sensitive or critical information before storage or transmission.

Extended Description

The lack of proper data encryption passes up the guarantees of confidentiality, integrity, and accountability that properly implemented encryption conveys.

Time of Introduction

- Architecture and Design
- Operation

Applicable Platforms

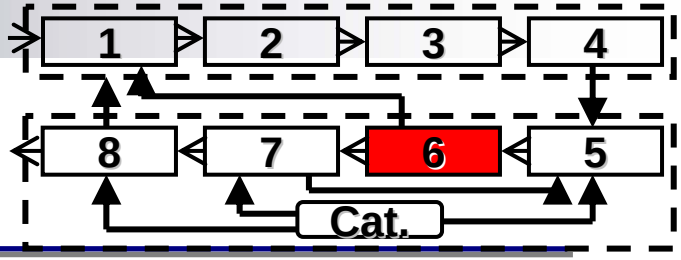
Languages

Language-independent

Common Consequences

Scope	Effect
Confidentiality	**Technical Impact:** *Read application data*
	If the application does not use a secure channel, such as SSL, to exchange sensitive information, it is possible for

RISA step 6: Classify Risks



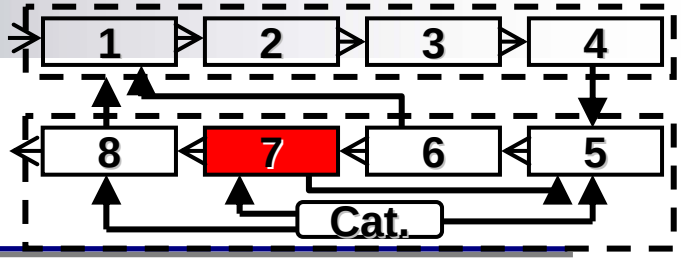
Risks are classified in terms of:

- **risks transferred to system context**
- **risks to be mitigated by the system**

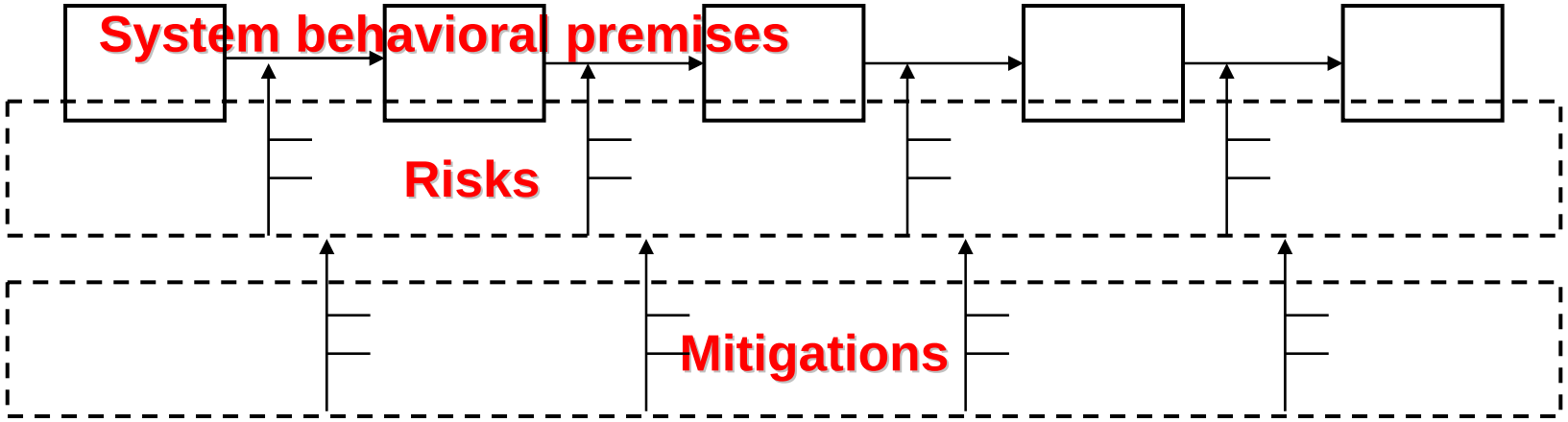
Possibilities:

- risk to be completely mitigated by the PED
- risk to be completely mitigated by the PED context
- risk to be partially mitigated by both

RISA step 7: Mitigate Risks



Mitigations restore the satisfaction of security requirements by rebutting risks



Risk	Mitigation
R1.6 & R1.7 & R1.8	M2.4: Any transmission of PIN should use well-vetted encryption algorithms & recommended key sizes

	to replay (CWE-294).
CVE-2007-4786	Product sends passwords in cleartext to a log server.
CVE-2005-3140	Product sends file with cleartext passwords in e-mail message intended for diagnostic purposes.

Potential Mitigations

CWE-311

Phase: Requirements

Clearly specify which data or resources are valuable enough that they should be protected by encryption. Require that any transmission or storage of this data/resource should use well-vetted encryption algorithms.

Phase: Architecture and Design

Strategy: Threat Modeling

Using threat modeling or other techniques, assume that your data can be compromised through a separate vulnerability or weakness, and determine where encryption will be most effective. Ensure that data you believe should be private is not being inadvertently exposed using weaknesses such as insecure permissions (CWE-732).

Phase: Architecture and Design

Ensure that encryption is properly integrated into the system design, including but not necessarily limited to:

- Encryption that is needed to store or transmit private data of the users of the system
- Encryption that is needed to protect the system itself from unauthorized disclosure or tampering

Identify the separate needs and contexts for encryption:

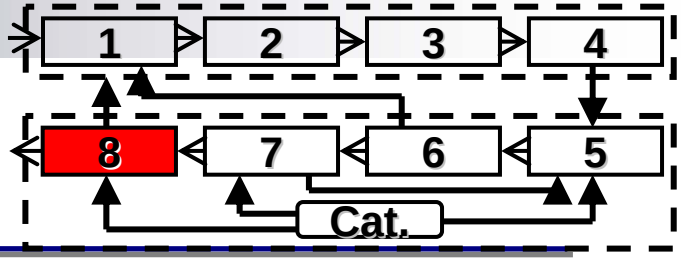
- One-way (i.e., only the user or recipient needs to have the key). This can be achieved using public key cryptography, or other techniques in which the encrypting party (i.e., the software) does not need to have access to a private key.
- Two-way (i.e., the encryption can be automatically performed on behalf of a user, but the key must be available so that the plaintext can be automatically recoverable by that user). This requires storage of the private key in a format that is recoverable only by the user (or perhaps by the operating system) in a way that cannot be recovered by others.

Phase: Architecture and Design

Strategy: Libraries or Frameworks

Select a well-vetted algorithm that is currently considered to be strong by experts in the field, and select well-tested implementations. As with all cryptographic mechanisms, the source code should be available for analysis

RISA step 8: Prioritize Risks



Empirical data about typical severity of risks or likelihood of exploit can also be found in the catalogues

Risk	Mitigation	Typical risk severity
R1.6 & R1.7 & R1.8	M2.4: Any transmission of PIN should use well-vetted encryption algorithms & recommended key sizes	Low to very high

Interpretation of risk severity depends on many factors

Languages

Language-independent

Common Consequences

Scope	Effect
Confidentiality	**Technical Impact:** *Read application data* If the application does not use a secure channel, such as SSL, to exchange sensitive information, it is possible for an attacker with access to the network traffic to sniff packets from the connection and uncover the data. This attack is not technically difficult, but does require physical access to some portion of the network over which the sensitive data travels. This access is usually somewhere near where the user is connected to the network (such as a colleague on the company network) but can be anywhere along the path from the user to the end server.
Confidentiality Integrity	**Technical Impact:** *Modify application data* Omitting the use of encryption in any program which transfers data over a network of any kind should be considered on par with delivering the data sent to each user on the local networks of both the sender and receiver. Worse, this omission allows for the injection of data into a stream of communication between two parties -- with no means for the victims to separate valid data from invalid. In this day of widespread network attacks and password collection sniffers, it is an unnecessary risk to omit encryption from the design of any system which might benefit from it.

Likelihood of Exploit

High to Very High

CWE-311

Detection Methods

Manual Analysis

The characterizaton of sensitive data often requires domain-specific understanding, so manual methods are useful. However, manual efforts might not achieve desired code coverage within limited time constraints. Black box methods may produce artifacts (e.g. stored data or unencrypted network transfer) that require manual evaluation.

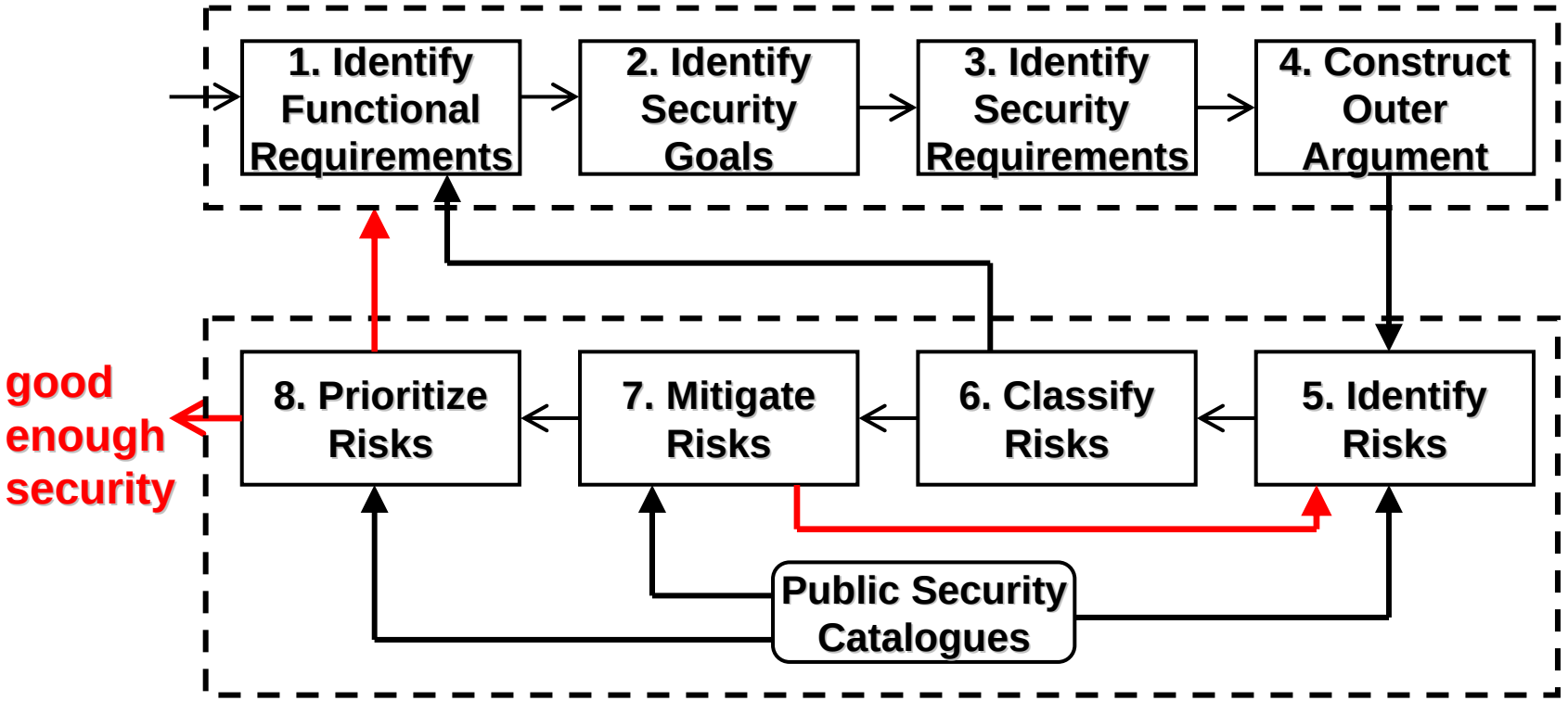
Effectiveness: High

Automated Analysis

Automated measurement of the entropy of an input/output source may indicate the use or lack of encryption, but human

RISA recursion

- Other rounds of argumentation may follow
- recursion stops when the system security is considered good-enough and/or resources for analysis of security have been used



Opportunities for future work

- Addressing residual risks
- Improvement to estimation/prioritization of risks
- Tool support for the method: OpenArgue tool to be adapted
- Validation in the field with industrial case studies
- Addressing impact of transferred risks in terms of system mitigations
- Support to search catalogues for risk identification

Conclusion: Mutual benefits

- **Satisfaction analysis (SA) benefits from risk assessment (RA)**
  - RA provides systematic input for security argumentation in SA
  - RA allows prioritization of arguments and security requirements from prioritization of risks
  - RA scales the process of argumentation with breadth-first approach
- **Risk assessment (RA) benefits from satisfaction analysis (SA)**
  - SA provides systematic description of system context: source of risks
  - SA provides top structure for RA
  - SA argumentation organizes several rounds of RA & facilitates traceability

Questions?

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- S.Toulmin, R.Rieke, and A.Janik, *An Introduction to Reasoning*, Macmillan, 1979.