Tools and Techniques for Symbolic Protocol Verification

Muhammad Usama Sardar, Thomas Fossati, and Simon Frost
Ack: Nikolaus Thümmel, Ante Derek, Shale Xiong
Funding: CPEC, EuroProofNet WG3

Chair of Systems Engineering
Technische Universität Dresden

EuroProofNet WG3 meeting
Timisoara, Romania

February 8, 2023

Outline

Relevance for PV community

- Program $\rightarrow$ Product/service

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  - Identity of code?
  - Unspecified/not well-understood mechanisms
  - Closed-source nature of SCONE

Confidential Computing

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App. owner

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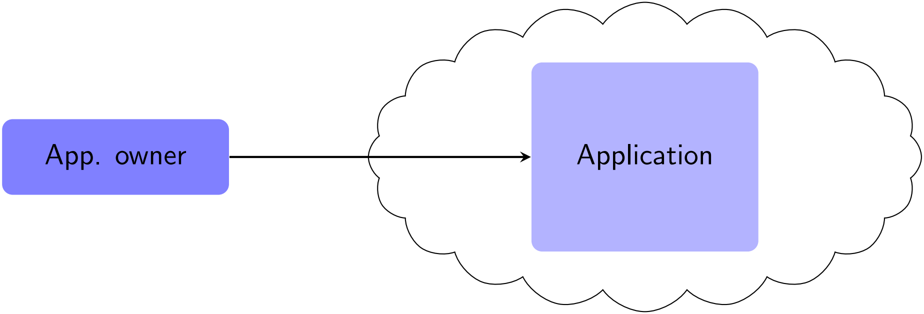

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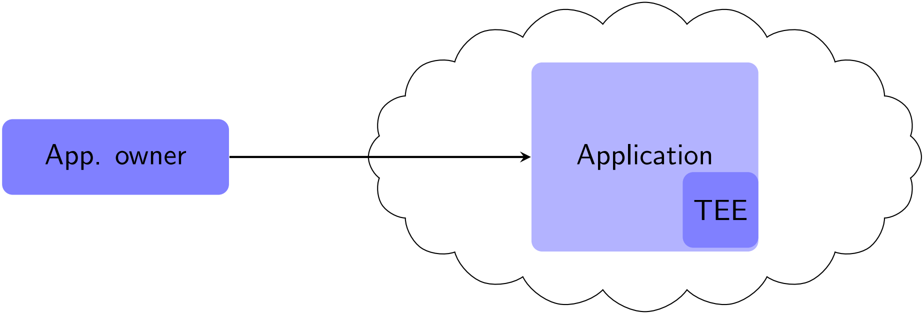
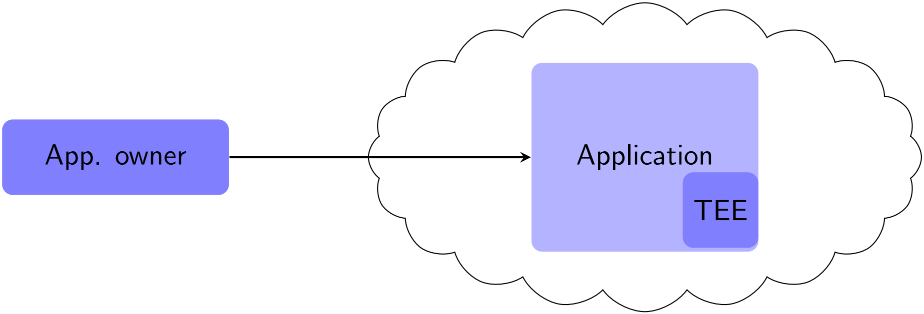


- Protection of data in use

Confidential Computing



- Protection of data in use
- Adversary: root access

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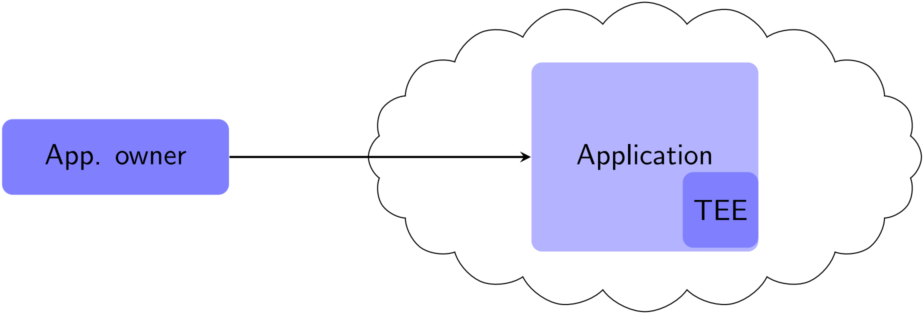

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- Isolation and attestability

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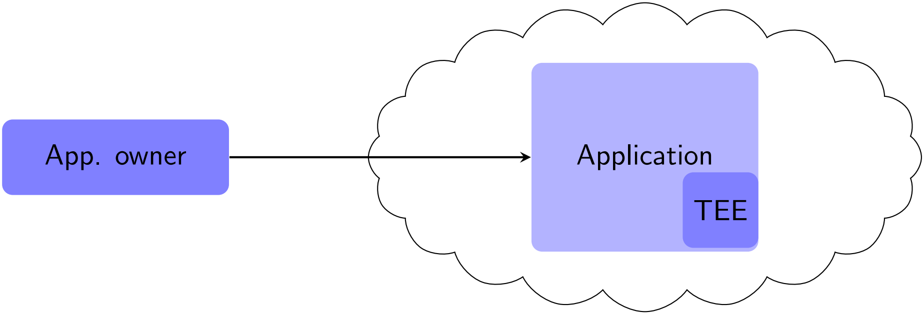

- Protection of data in use
- Adversary: root access
- Isolation and attestability
- Attestation: arguably the most critical but most misunderstood concept in CC

Attestation

- Trust to app owner: right app in right platform

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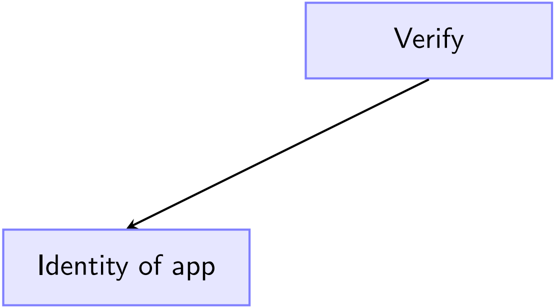

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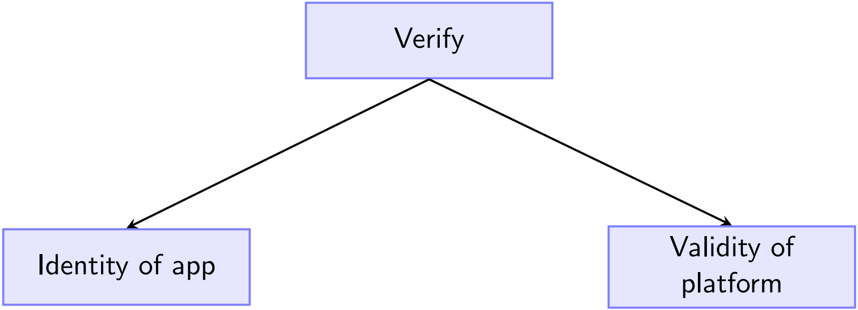

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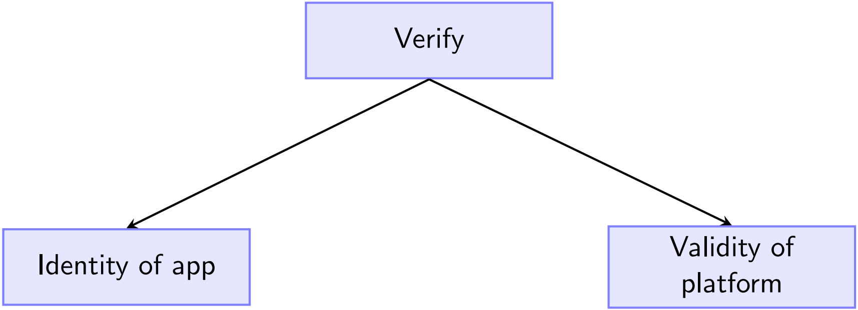

- Secure channel creation

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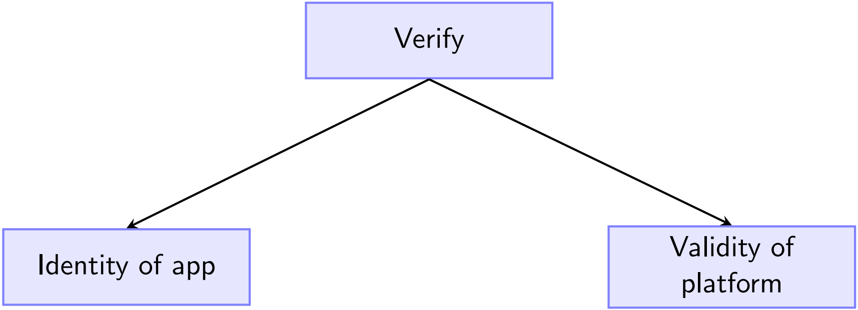
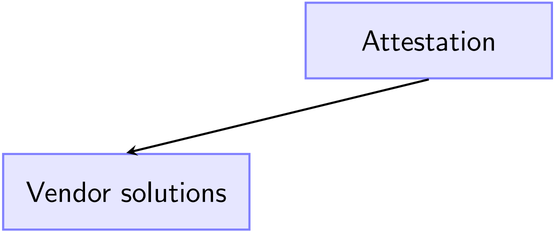


- Secure channel creation
- Provisioning of secrets and config.

Outline

Systemization for Attestation Mechanisms



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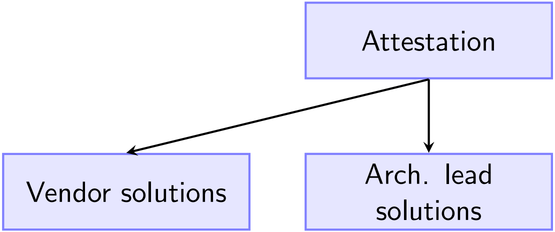

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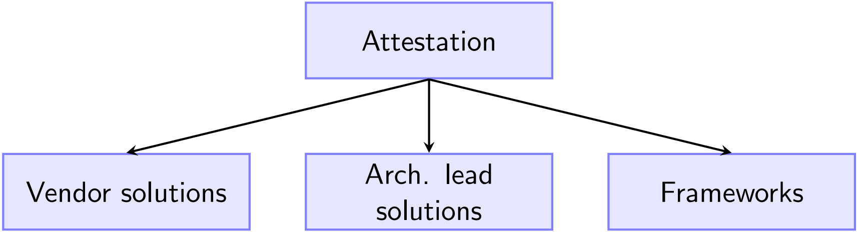

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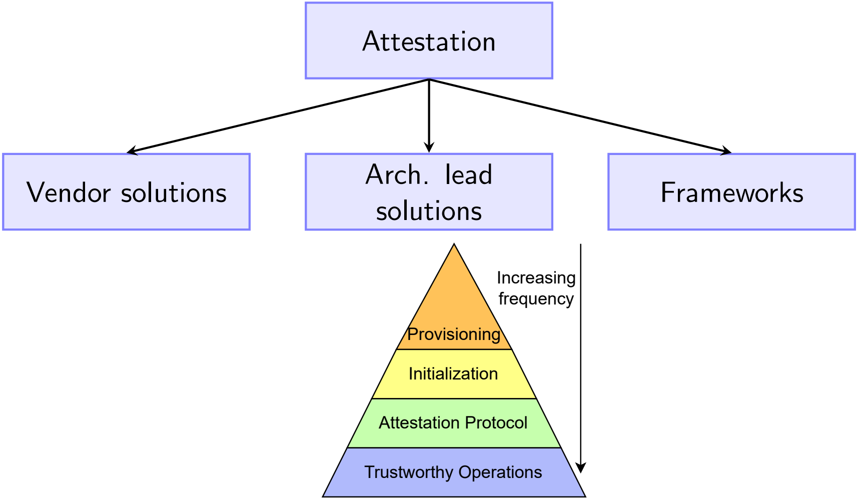
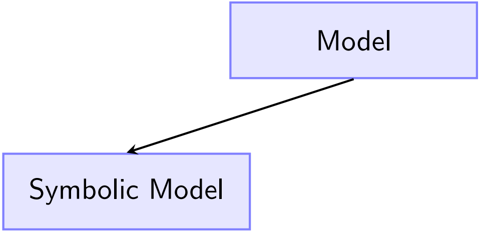


Model for Security Analysis[1]



- Formal model
- Messages represented by “Terms”
- What attacker can do

[1] Barbosa et al., “SoK : Computer-Aided Cryptography”, 2021

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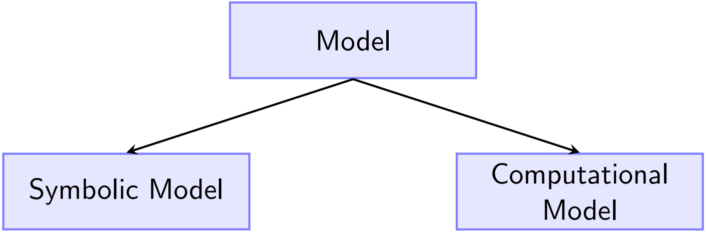

- Used by cryptographers
- What attacker cannot do

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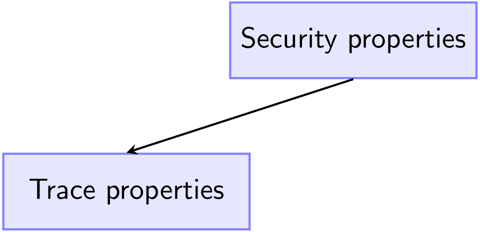
Threat Model for Symbolic Analysis

- "Dolev-Yao"[2] (symbolic) attacker
- Full control of communication network
- Unbounded number of sessions and messages
- Attacker behavior: Non-deterministic
- Assume cryptographic primitives are perfect

[2] Dolev and Yao, "On the security of public key protocols", 1983

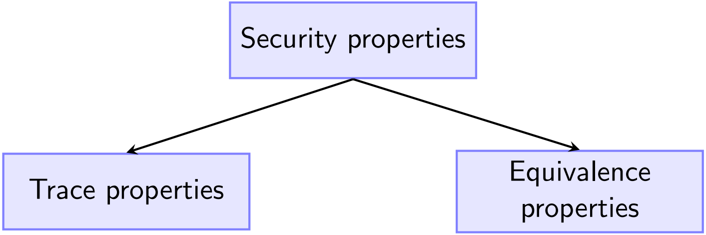
Security properties[3]



- Defined on each run of the protocol
  - Confidentiality/Secrecy
  - Authentication

[3] Blanchet, "Modeling and verifying security protocols with the applied pi calculus and ProVerif", 2016

Security properties[3]



- Adversary cannot distinguish 2 processes
- e.g., observational equivalence
- Tools: ProVerif, DeepSec (almost the same semantics)

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ProVerif[4] vs. Tamarin prover[5]

- More automation vs. user interaction

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- Supports equivalence properties

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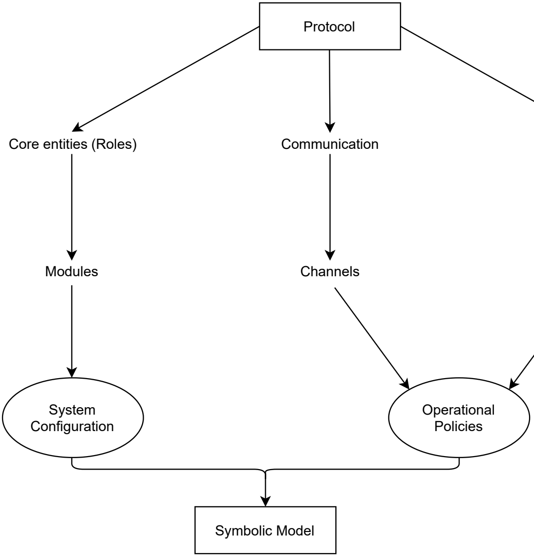
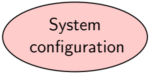
Overview of Approach



Workflow of the Analysis Approach



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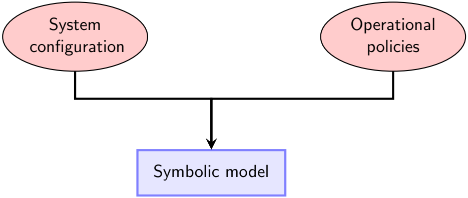

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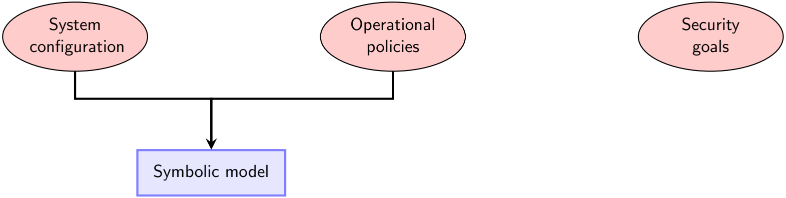

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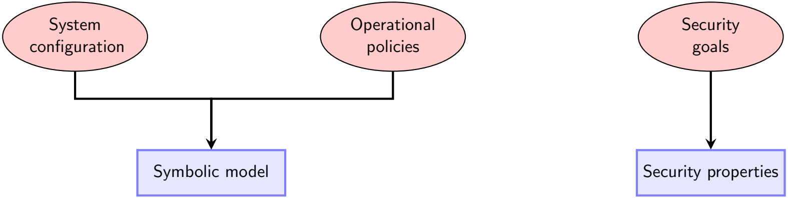

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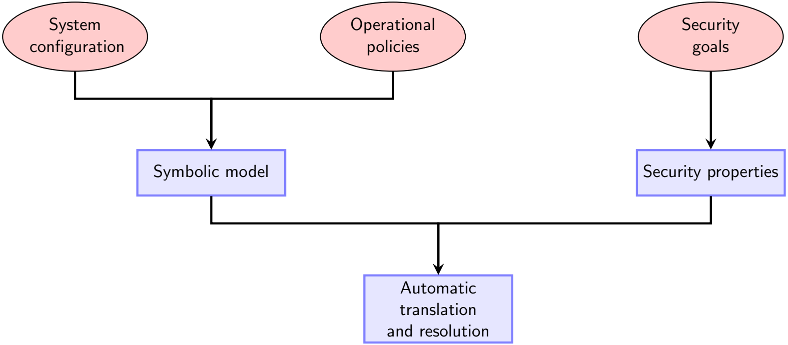

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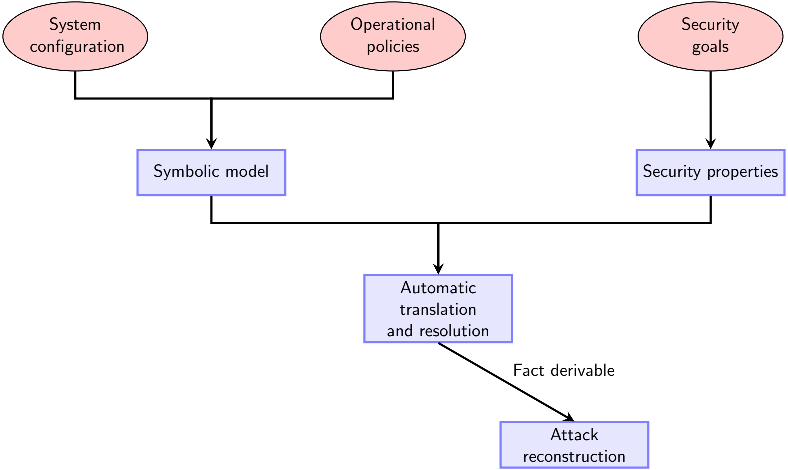

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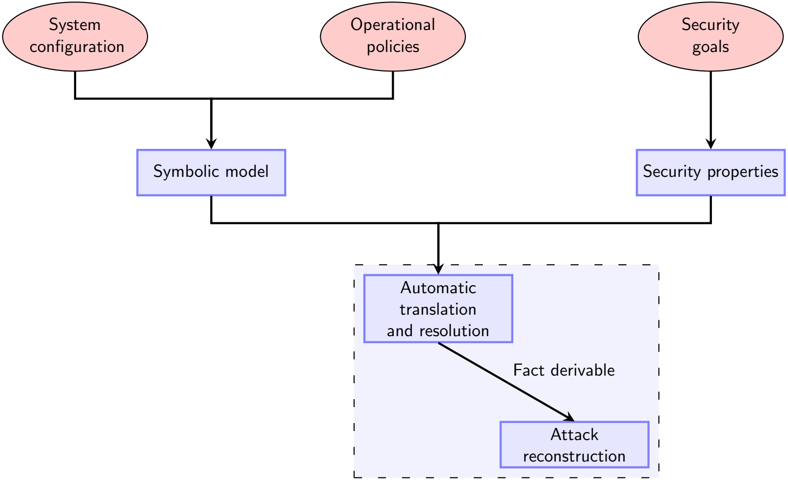

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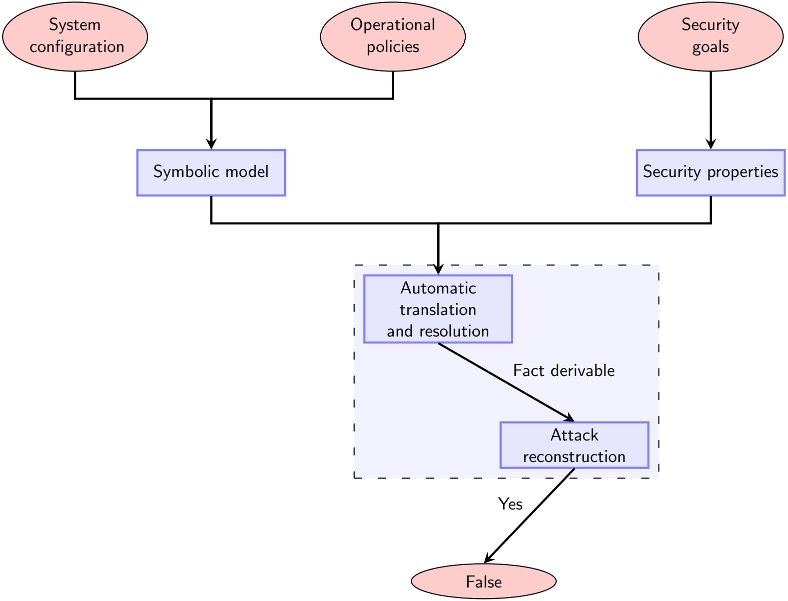

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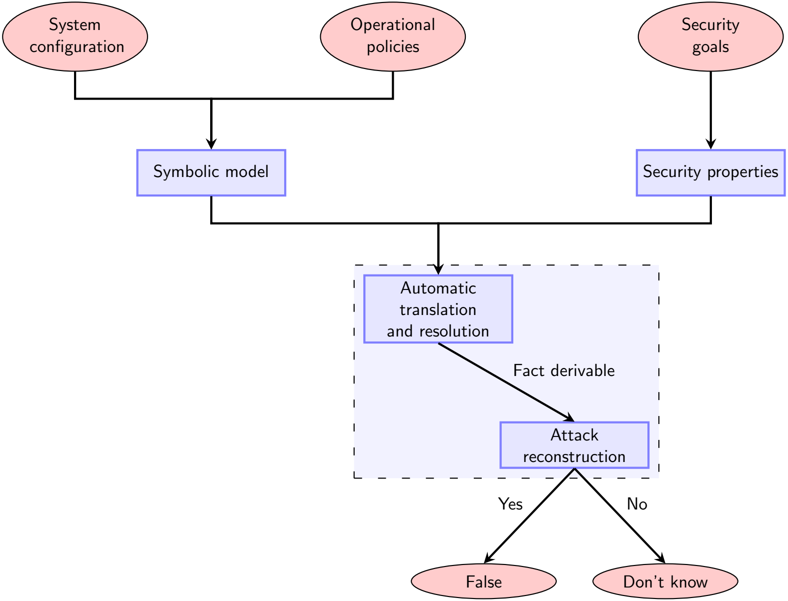

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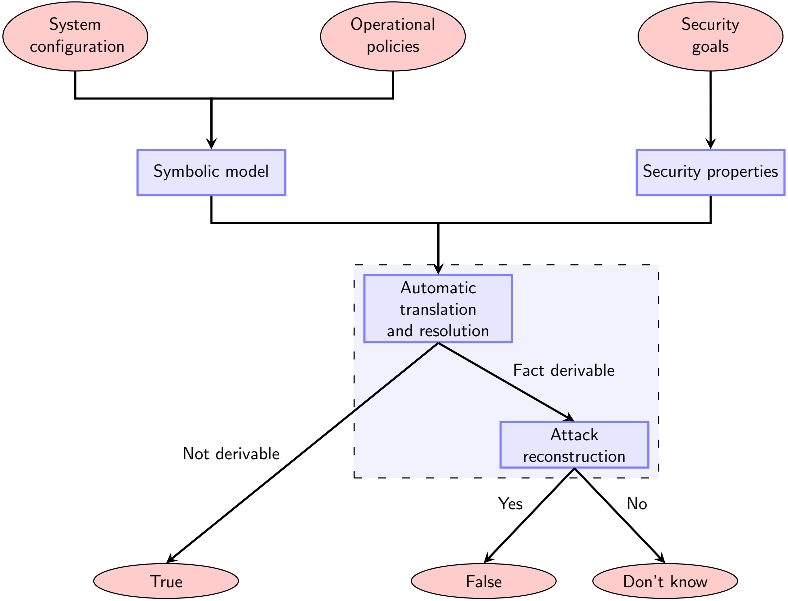

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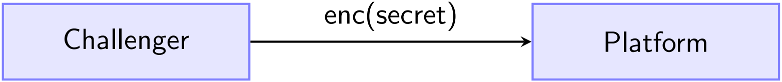

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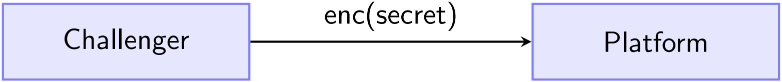

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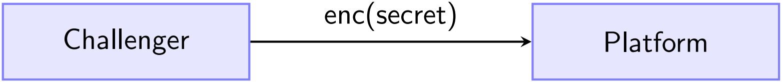

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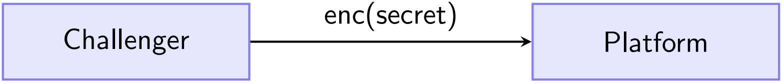

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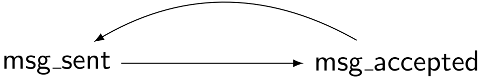

Specification of Security Goals

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$$\boxed{\text{Challenger}} \xrightarrow{\text{enc(secret)}} \boxed{\text{Platform}}$$

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$$\begin{tikzcd} \text{msg\_sent} \arrow[r] & \text{msg\_accepted} \arrow[l, bend right] \end{tikzcd}$$

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$$\texttt{query } x_1 : t_1, \ldots, x_n : t_n \, ;$$
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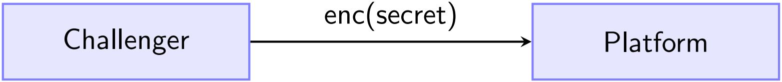

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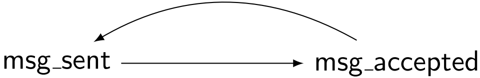

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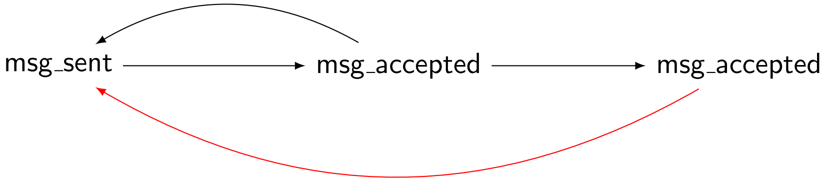

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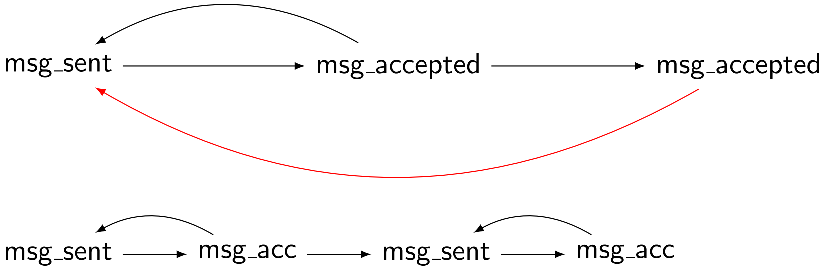

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$$\begin{tikzcd}
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\end{tikzcd}$$

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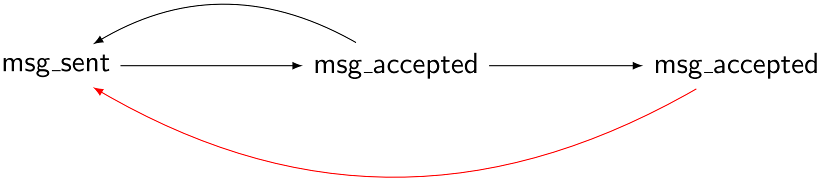

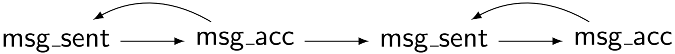

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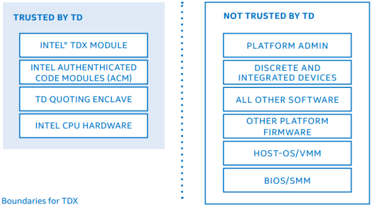

Figure 5.1. Trust Boundaries for TDX

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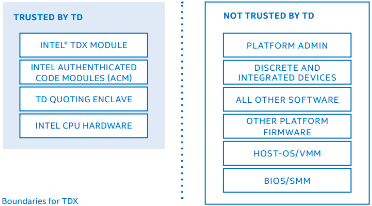

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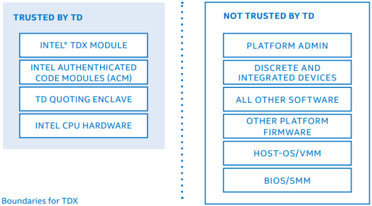

Figure 5.1. Trust Boundaries for TDX

- SCONE: when do we say that something is attested?
- Arm CCA: authentication properties

$$\begin{aligned}&\texttt{query}\ \ data : bitstring\,;\\ &\texttt{event}\ \ (accepted(data))\ \texttt{==>}\ \texttt{inj-event}\ \ (sent(data)).\end{aligned} \tag{3}$$

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Take-home

- Towards TEE-agnostic verification infrastructure for transparency and interoperability

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  - Analysis and categorization of Claims

Key References

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Contributions/collaborations welcome

link here