Developing a Formal Security Policy Model for a Smart Card EAL6 Evaluation

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Motivation – Why EAL6?

- High Assurance
  - We want to give our customers a higher assurance that our new security IC satisfies the claimed security functional requirements.
- Documentation
  - Security Policy Model helps to have precise, clean, and consistent documentation.
- Security
  - Have an additional look from another perspective at the security functionality.

Overview

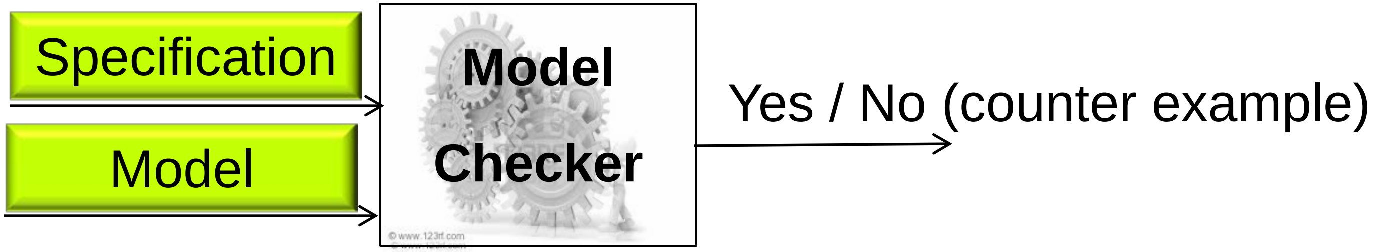
- Introduction to Formal Methods
  - Model Checking
- Common Criteria Certification EAL6 – Security Policy Model
  - What does it prove?
  - How do we implement it?
  - Example
- Conclusions

Formal Methods

Def.: Includes all mathematical techniques to specify and verify security and/or correctness of software or hardware.

- Formally specifying a system gives better understanding :
  - Forced to think about the details at the specification phase.
  - Forced to be precise at the specification phase.
  - No ambiguities, gives a common understanding of the TOE for architects, testers, developers ...
- Verification:
  - Gives a higher assurance of security and correctness.
  - Techniques:
    - refinement
    - theorem proving (natural deduction, math. induction -> proofs over infinite state space)
    - model checking, equivalence checking ...

Model Checking



Specification

Model

Model Checker

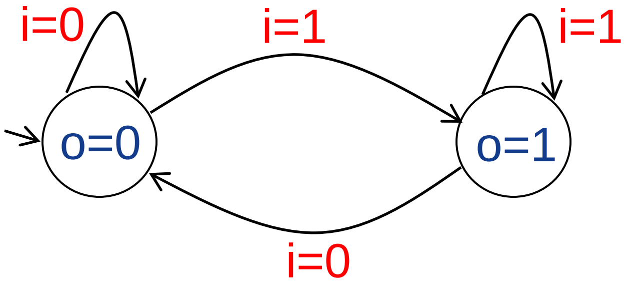
Yes / No (counter example)

- **Specification** describes the behavior of the hardware in terms of inputs and outputs.
  - For example as a temporal logic formula:

    always((i=1) -> next(o=1))

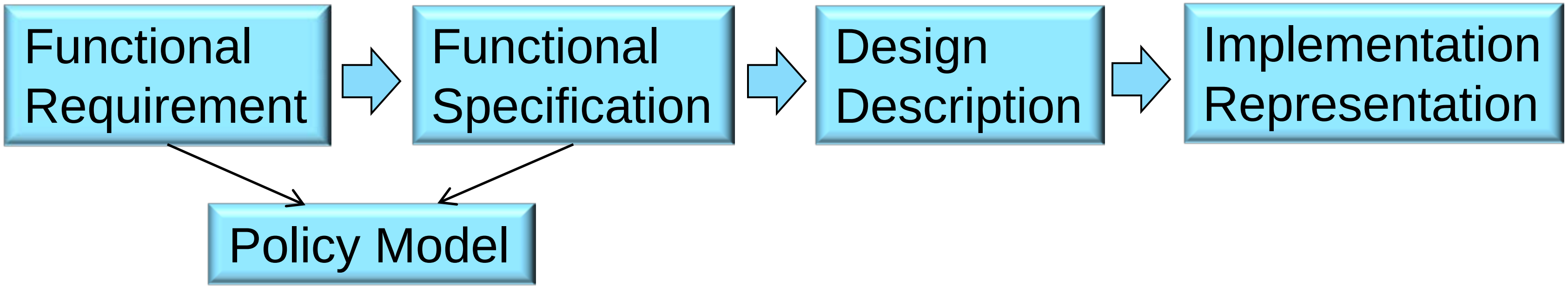
    ‚Every input i=1 must be followed by an output o=1.‘

- **Model** describes the hardware itself.
  - For example as a finite state machine:



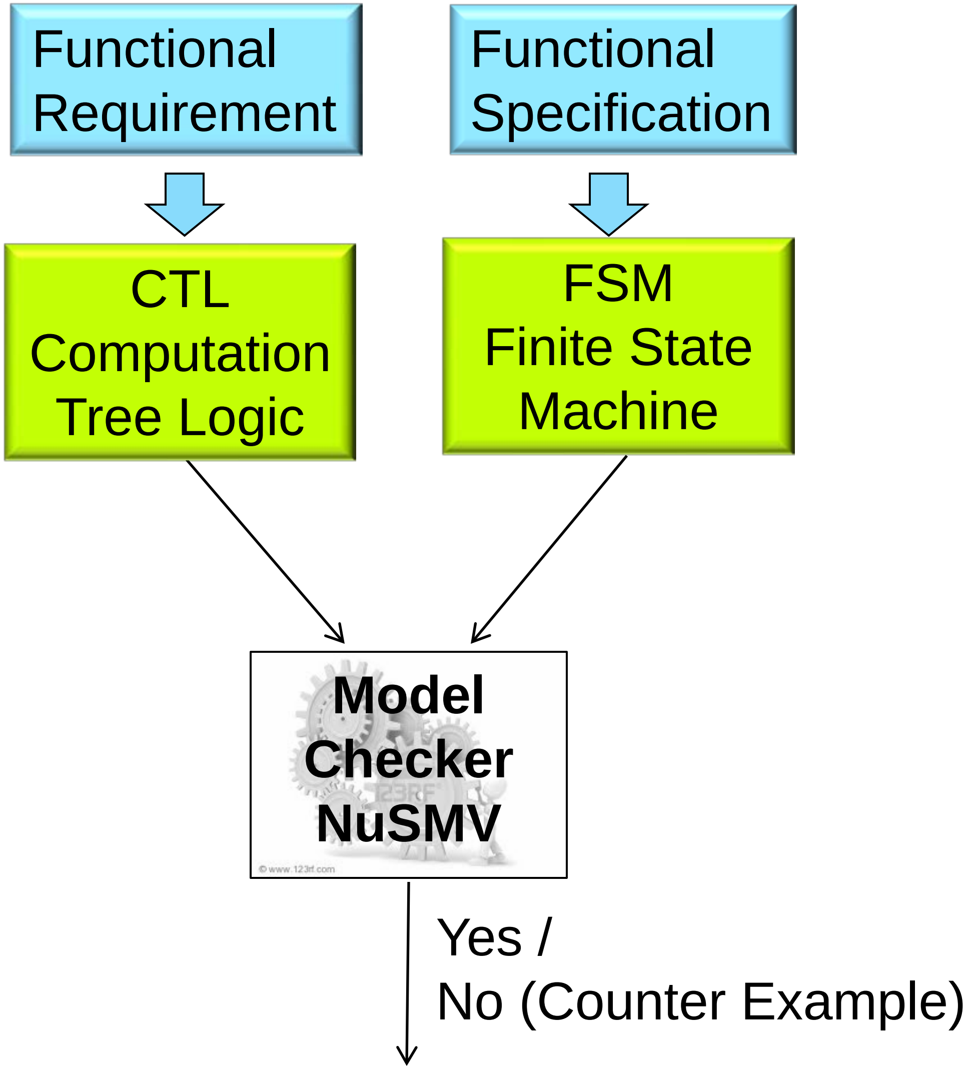
Common Criteria Certification

- Assurance Class Development:



- Use refinement to show that the implementation satisfies its security functional requirements.
- Gives higher assurance (EAL6).
- Show that the specification satisfies the (security policy related) requirements.
- Show that the specification has no inconsistencies.

Security Policy Model



Functional Requirement

Functional Specification

CTL Computation Tree Logic

FSM Finite State Machine

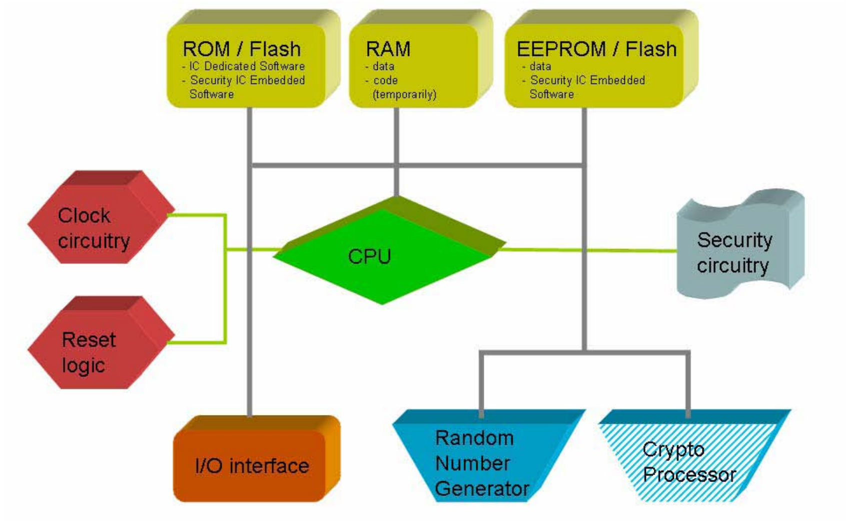
Model Checker NuSMV

Yes /
No (Counter Example)

SPM – Step by Step

- Temporal Logic Formulas:
  - Identify security policies (sets of Security Functional Requirements)
  - Translate SFRs into temporal logic formulas
  - For all policies that are not relevant for the model argue why they are not relevant.
- Finite State machine:
  - Identify relevant parts of the TOE security functionality (ADV_FSP).
  - Translate the relevant parts of the functional specification into Finite State Machines.
- Model Checker:
  - Use the model checker to verify that the FSM satisfies the Temporal Logic Formulas.

Example – Security IC



- Security Policies:
  - Hardware Access Control
  - Application Management Access Control

  ...
  - Identification and Authentication:
    - FMT_SMF.1.1[APP]: ‘The TSF shall be capable of performing the following management functions:

      Authenticate a user,

      Invalidate the current authentication state based on the functions: reset, … ‘

eventually(authenticated)

always(reset -> next(!authenticated))

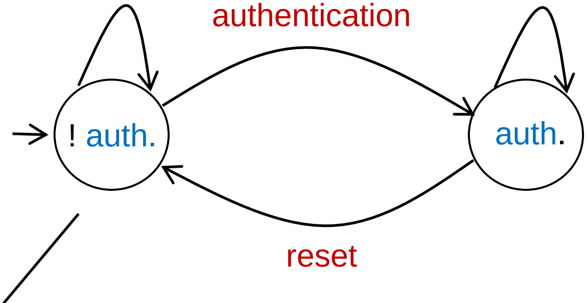
Example

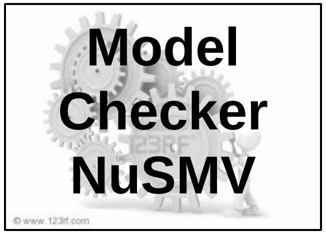
Functional Requirement

Functional Specification

eventually(authenticated)

always(reset -> next(!authenticated))





Model Checker NuSMV

Yes

Conclusions

- Formal modeling leads to new insights into the working of the TOE.
- Helps improve documentation (consistency, completeness, unambiguity).
- Gives higher assurance that the claimed Security Functional Requirements are met by the Target of Evaluation.

‚*Use of formal methods does not a priori guarantee correctness. However, they can greatly increase our understanding of a system by revealing inconsistencies, ambiguities, and incompletenesses that might otherwise go undetected*.‘ Ed Clarke and Jeannette Wing