TOWARDS SCALABLE SOC SECURITY VALIDATION

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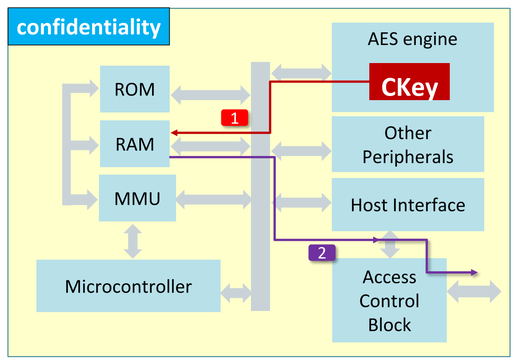
Introduction

- Confidentiality
  - secret information should not flow to untrusted region
- Integrity
  - no information flow from untrusted region to secure location



[Subramanyan, P., Arora, D., DATE'14])

Integrity is a *dual* of confidentiality

Confidentiality and integrity are 2-safety properties

- Properties refuted by observing ***two*** finite traces
- A ***trace*** is sequence of execution states, $t = s_0 s_1 \dots s_n$

- 2-safety property is from the class of Hyperproperties

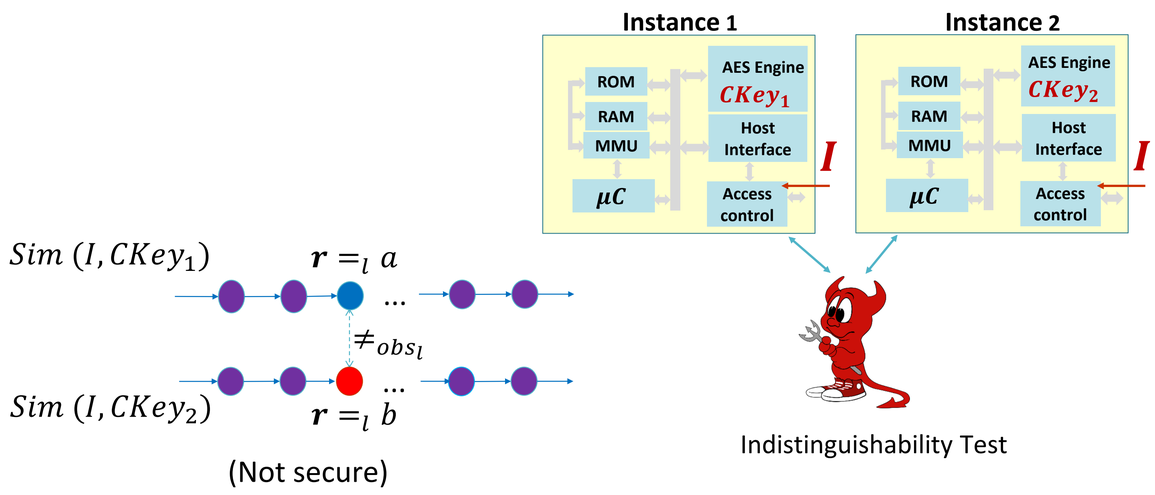
Problem Statement

Proving confidentiality and integrity

show system leaks no secret information

or

show execution traces are indistinguishable to untrusted entity



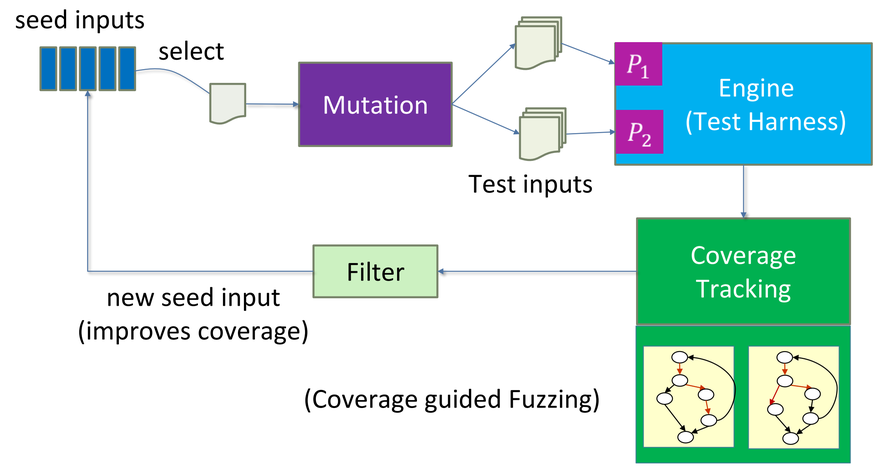
Goal :

- automated technique for finding 2-safety hyperproperty violations
- language for specifying security properties

Prior Art

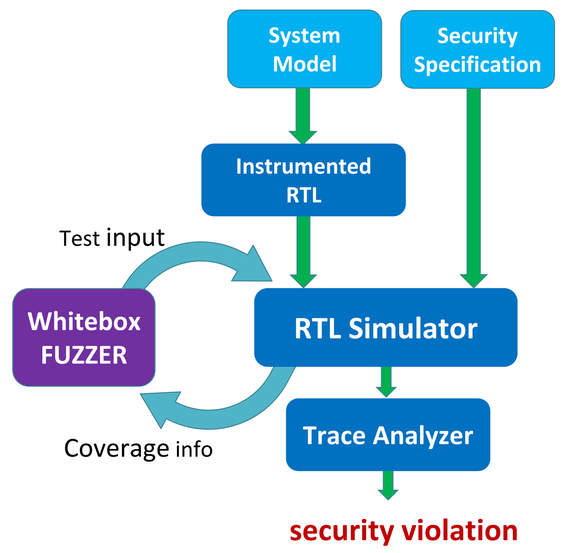
SPECIFICATION	Non-interference Observational Determinism HyperLTL HyperCTL*	❑Goguen, J. A., & Meseguer, J. Security policies and security models. ❑Zdancewic, S., et al. Observational determinism for concurrent program. ❑HyperLTL and HyperCTL* are extension of LTL and CTL* [CFK+14]
VERIFICATION	Information Flow Tracking (GLIFT, HDL LIFT)	❑Hardware design is converted to a **GLIFT** logic for verification [HOI+11] ❑SecVerilog, Caiosson and Sapper uses information flow type systems at HDL **GLIFT : much overhead** **HDL LIFT : doesn't guarantee no violations in runtime**
	Model Checking	❑Barthe, et al. "Secure information flow by self-composition." ❑Terauchi, T., & Aiken, A. "Secure information flow as a safety problem." ❑Sousa, M., & Dillig, I."Cartesian hoare logic for verifying k-safety properties." ❑Subramanyan, P., et al."Verifying information flow using symbolic execution." **computationally expensive ➔ not scalable**
FUZZING	American Fuzzy Lop (afl)	❑Fuzzing is used for finding software vulnerabilities ❑AFL uses genetic algorithm to discover new test inputs [Zal14] **can't be used for 2-safety violation SoCs** **scalable**

Technical Challenges



- Specification Language
- Mutation Algorithm
  - Need new algorithms to generate inputs that trigger 2-safety violations
- Test harness
  - Modify test harness engine to work with two system instances
- Coverage tracking
  - Mechanism to find new seed inputs
  - Ensures fuzzer does not revisit inputs
  - Need new coverage metrics to explore product state space

Proposed System Architecture



Hardware modeling

- **Verilog** implementation

Intermediate representation

- Instrument Verilog model to collect simulation metric

Fuzzer

- A variant of AFL to be used along with Hyperproperties

Conclusion

- Existing solutions for SoC security validation are not effective
- Fuzzing has the potential to be scalable.
- It has been successful in finding many software vulnerabilities.
- HYPERFUZZING leverages power of fuzzing to find security violations in SoCs.

References

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2. Bounimova, Ella, Patrice Godefroid, and David Molnar. "Billions and billions of constraints: Whitebox fuzz testing in production." Proceedings of the 2013 International Conference on Software Engineering. IEEE Press, 2013.
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