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Security-by-Contract for Pervasive Services

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Outline

- Motivation
- Security x Contract
  - Concepts
  - Workflow
- Policy/Contract Matching
  - Automata Modulo Theory
- Conclusions

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Motivation

- Today's smart phones/nomadic devices have more computing and communication power than PCs 20 years ago, but …
- Not even remotely the amount of third party software available for PCs at that time, and
- A long term market growth cannot be based on selling ring-tones as the only "added-value" services.

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Observations

- A validation infrastructure exists
  - A signature is checked on the device;
  - No semantics is attached to it.
- Some technologies exist
  - Static analysis to prove program properties
    [Leroy et al, and many others]
  - Monitor generation for complex properties
    [Havelund & Rosu, Erlingsson & Schneider, Krukow et al. Ligatti et al.]
- Security-by-Contract (SxC) puts them together
  - Use contracts as semantics for the signatures;
  - Use static analysis and monitors as basis;

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Key Concepts

- **Contract carried by application;**
  - Claimed Security behavior of application;
  - (Security) interactions with its host platform;
  - Maybe with Proof that code satisfies contract.
- **Policy specified by a platform.**
  - Desired Security behavior of application;
  - Fine-grained resource control
- **But I trust noboy, I just need policy monitor**
  - Monitoring ONLY a part of the story…

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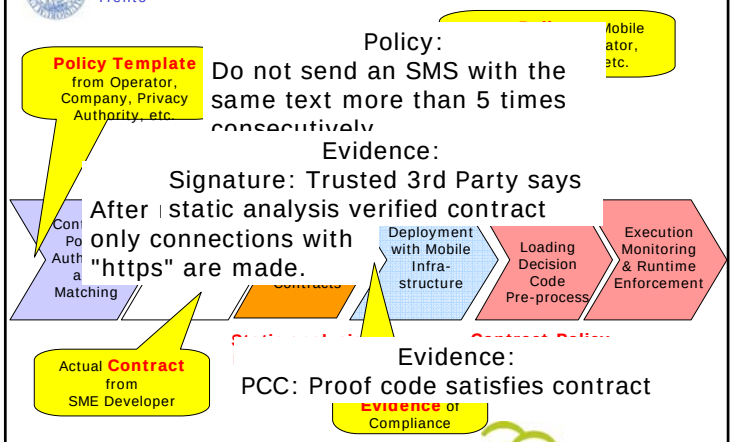

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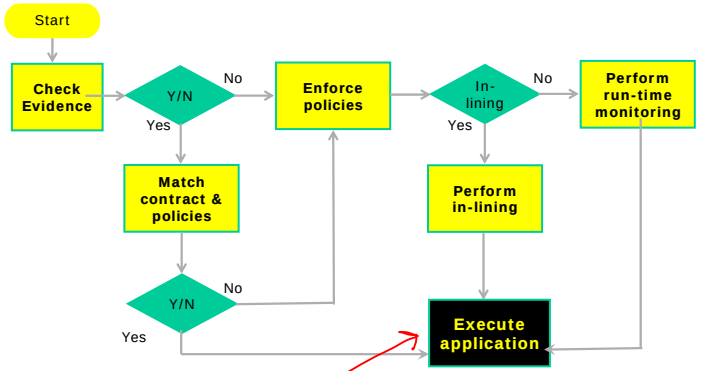
SxC Workflow – User's View



REMEMBER USERS WANTS TO GET THERE!

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SxC Services

Action	Input parameters (partly)	Output p. (partly)
get(Code, Contract)	Code identifier, developer or third party identifier	Code, contract
analyse(Code, Contract)	Code, Contract	Yes or No
inline(Code, Contract)	Code, Contract	Modified code
inline(Code, Policy)	Code, Contract	Modified code
match(Contract, Policy)	*Contract, Policy*	*Yes or No*
monitor(Code, Policy)	Code, Policy	N/A (halt)
prove(Contract, Code)	Code, Contract, Proof	Yes or No
check(Code, Contract, Proof)	Code, Contract	Proof of compliance
manage(Policy)	Policy	Modified policy

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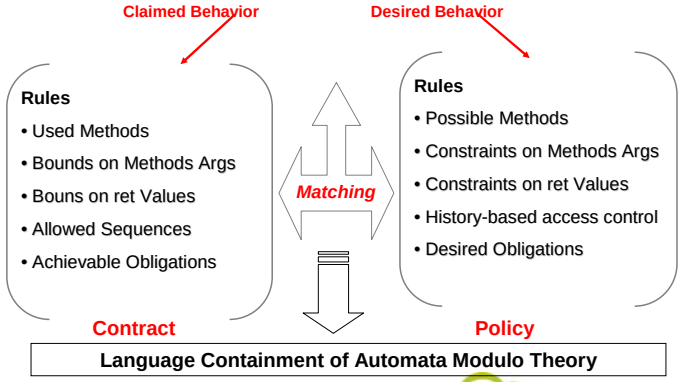
Contract vs Policy



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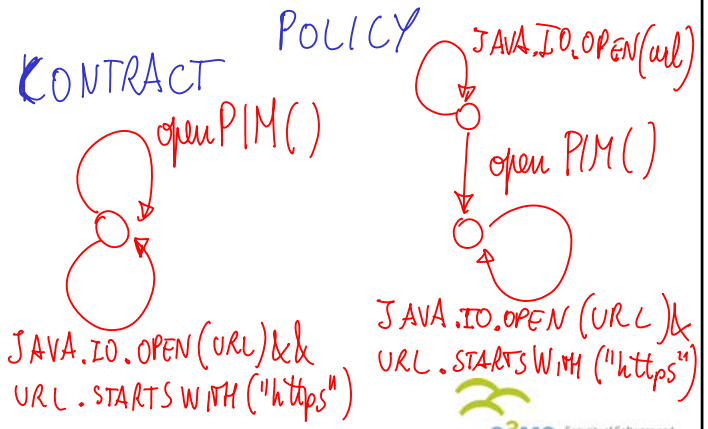
Sample Automata



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What's Automata Modulo Theory?

- **Finite State Automata**
  - They represent the security behavior (claimed or desired)
  - You should know that…
- **With "Infinite" Edges**
  - Url starting with "https://" are not that few…
  - Battery Levels less than 30%
- **BUT Finitely represented with Expressions**
  - m=Java.IO.Connector &&
  - protocol(x)==https && protocol(x)==http
  - appType(x)!=jpg || appType(x)=appType(y)
- **Decidable theory for satisfiability of expressions**

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Why Modulo Theory

- **Matching = Language Containment**
  - Actions allowed by contract ⊆ actions allowed by policy
  - Exists Classical nested DFS
- **Search for counterexamples**
  - Path allowed by contract but NOT allowed by policy
  - Path allowed by contract and allowed by NEG policy
- **Path allowed by contract and by neg policy**
  - At run-time: two sequence of actions
  - Symbolically: two sequences of expressions
  - IF conjuction of pair of expressions SAT (modulo theory)
  - THEN exists common action…

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Summary

- **Security-by-Contract**
  - Ideas stolen from Design-by-Contract (Bertrand Meyer) and Model-Carrying-Code (Sekar et al.)
- **Security must account complete lifecycle**
  - Enforcement and Development & Matching
- **Matching Policy and Contract**
  - Mapped into FSA with expressions on edges
  - If theory for deciding edges polynomial (most cases) => Practical
- **EuroPKI'06 & NordSec'07**

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To-Do-List

- **Not all properties currently captured**
  - Connect only to an url that you have seen at the beginning of the session (or in the jar manifest etc.)
  - Requires history-dependent automata
- **More faithful to Design-by-Contract**
  - Precondition = security properties platform must guarantee (missing but easy)
  - Invariant = security behavior
  - Postcondition = services that midlet delivers? or obligations left to the platform?
- **Negotiate security vs services?**

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