LISSOM, A Source Level *Proof Carrying Code* Platform for the Safe Execution of Mobile Code

Daniel Martins[1] Simão Melo de Sousa[1]

[1]Computer Science Department
University of Beira Interior, Portugal

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Outline

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Security Issue in Code Mobility

Mobile Code Paradigm

- Interconnected World = Reality $\Longrightarrow$ Computer = One Execution Node;
- Mobile code paradigm $\Longrightarrow$ security issues.

Problem: Mobile Code

- can come from unknown source;
- can be produced by unknown means;
- can be modified during its life cycle;
- or, simply, can be malicious.

Classical Solutions

- Code Signing;
- Sandboxing;
  - Runtime Checking;
  - Software Fault Isolation;
- Firewall;
- Static Analysis of Code.

The Actual Picture

Runtime Verification

- Performance penalty;
- Checks performed for every execution.

Static Verification

- Static Checking = Static Security Policies;
- Changing the Security Policy $\Longrightarrow$ complete re-implementation.

Outline

The Actors

The Code Consumer

- Knows better what is safe for him;
- Require services from outside;
- Must verify if these services are compliant with its own safety requirements.

The Code Producer

- Knows better how its code is built and behaves;
- Must ensure that its code is safe.

The Game

- The Code Producer must provide to the Code Consumer a certificate that its code is safe;
- After successful verification the Code Consumer can safely run the code (with no runtime verification).

Certificates of Innocuousness

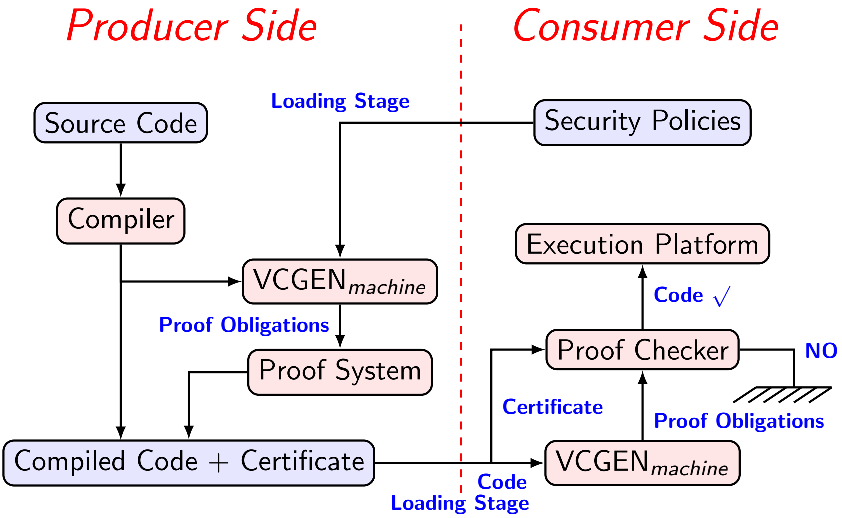
Certificates = Proof Objects

- Computer objects that represents proofs;
- As in real life: potentially difficult to build, easy to verify.

Proof Systems

- Several proof systems support proof objects;
- provide a formal language for the expression of security policies;
- provide means for the construction and the verification of formal proofs of security policy compliance.

Machine Level PCC in a Picture



Machine Level PCC

Architecture “à la” Necula

- Machine Level PCC architecture for Java;
- Automatic certificate generation;
- Trusted Computing Base (TCB) relatively important;
- Security policies are somewhat low level (by nature).

Skip Example

Machine Level PCC

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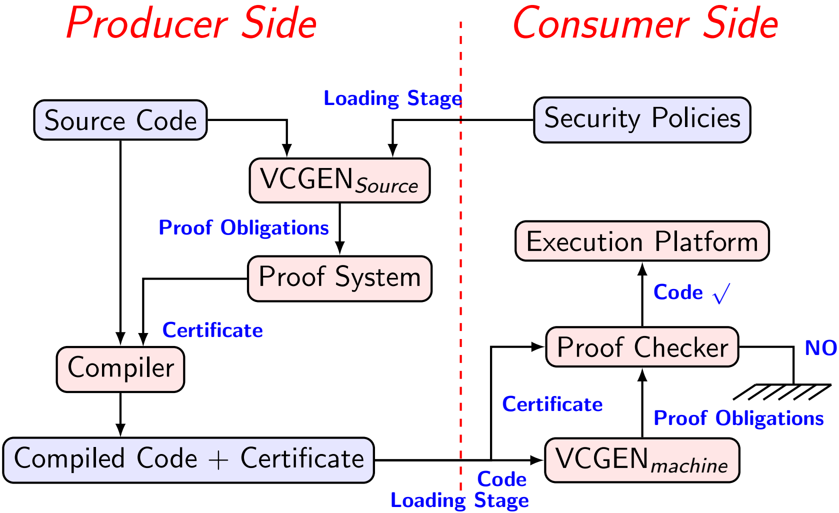
Security Policy Examples:

There is no “write” operations on “read-only” register

or, more formally

$$\forall r_i, r_j \in Registers,\ \texttt{store}\ r_i\ r_j \implies r_i \in Writable\_Registers$$

Source Level PCC in a Picture



Source Level PCC

Highlights

- The security policy compliance is ensured at source code level;
- Needs 2 VCGENs (proof obligations generators);
- The compiler must be able to translate certificates;
- At this time, there is no complete PCC architecture of this paradigm.

Skip Details

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Security Policy Example

- There is no information flow from the variable x to the variable y;
- There is no transitive information flow from the applets A, B and C.

Achievements

The first compiler with certificate translation: Spring 2005 by the *Everest* team from INRIA-France

Outline

Our Focus

Claims:

System Designers (the code producers) care about high (source) level concept and source code. *Source Level PCC is the way*

Facts:

- There is no complete source level PCC (again);
- There are very good tools for the (annotated) source code formal verification (e.g. Java Modeling Language (JML) and friends, Spec#, etc.).

Status

LISSOM, A work in progress source level PCC platform.

LISSOM Architecture

Highlights

- Compiler = LISS language and compiler (available);
- $VCGEN_{source}$ = the WHY Tool (available);
- Proof System and Proof Checker = the COQ Proof Assistant (available);
- Execution platform = a stack based virtual machine (like the Java VM) (available);
- $VCGEN_{machine}$ for the VM language (*to do*);

LISSOM Architecture

Highlights

- JML-like Anotation Language for LISS upon the WHY Tool (in progress);
- Design of a Proof System for LISS upon the COQ Proof Assistant (in progress);
- Design of a Certificate Translator for the LISS compiler (in progress);
- Design of a Proof System for virtual machine upon the COQ Proof Assistant (*to do*).

Design implications

Trusted Computing Base: The COQ Proof Checker

Outline

Conclusion

About LISSOM

- LISSOM is an attempt to fill the gap between seducing concepts and real life needs;
- LISSOM is at an early development stage.

Actual Focus

The compiler with certificate translation + JML-like annotation system.