RE-TRUST

PoliTO Prototypes Overview

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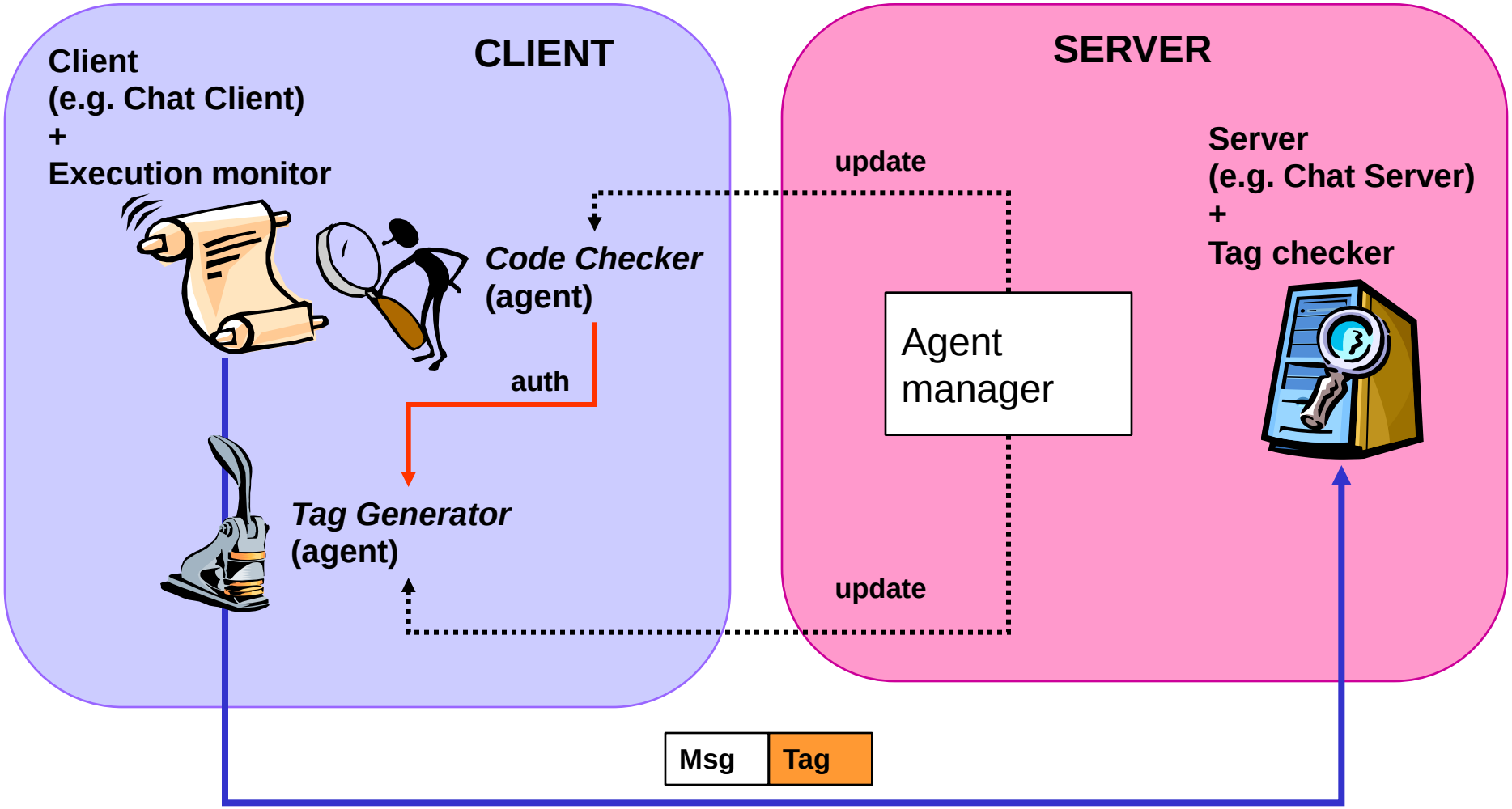
RE-TRUST Project

Many prototypes developed:

1. Mobile Code continuously replaced:
   a) Java Aspect on DynamicAOP –JVM
   b) Binary code on JVMTI interface– JVM5
   c) Binary code linked in EXE
2. Invariants checking
3. Control-Flow Checking

Prototype 1 a-b



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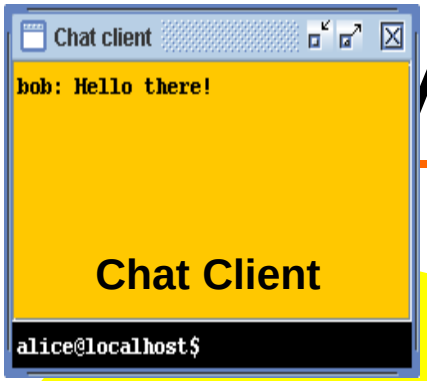
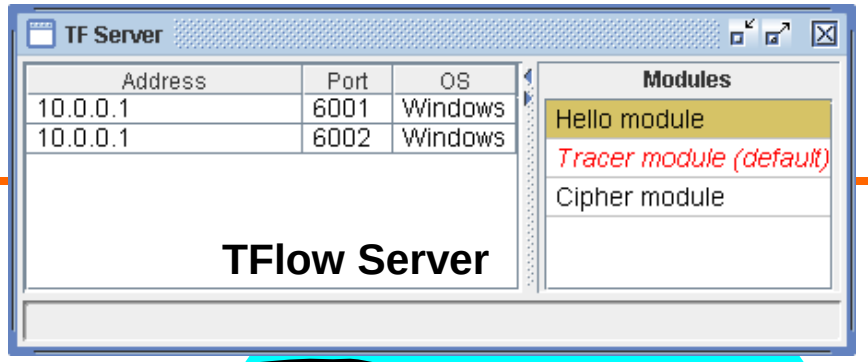
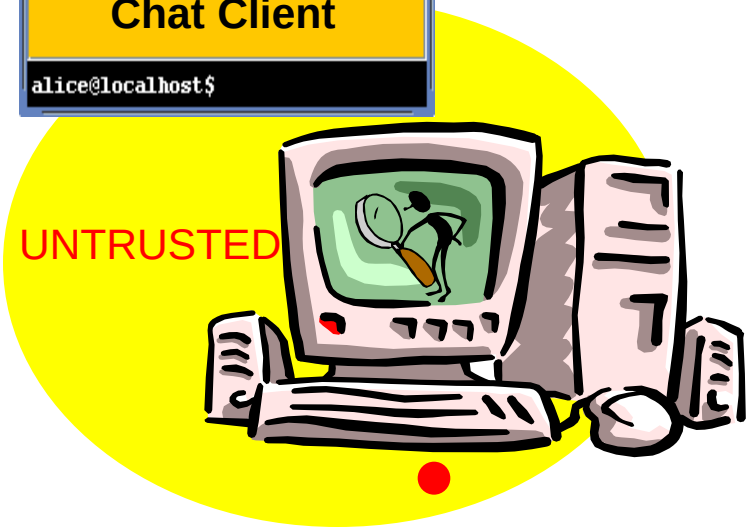
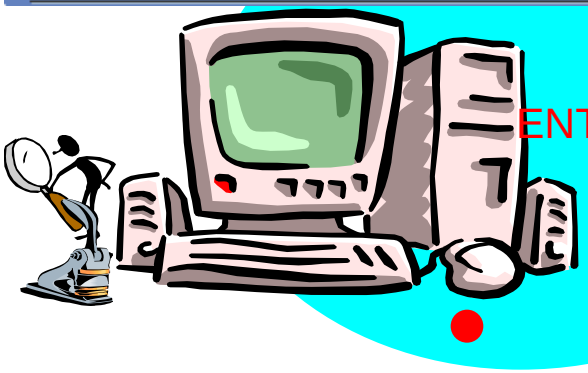
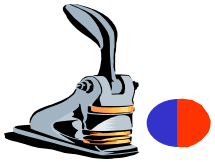
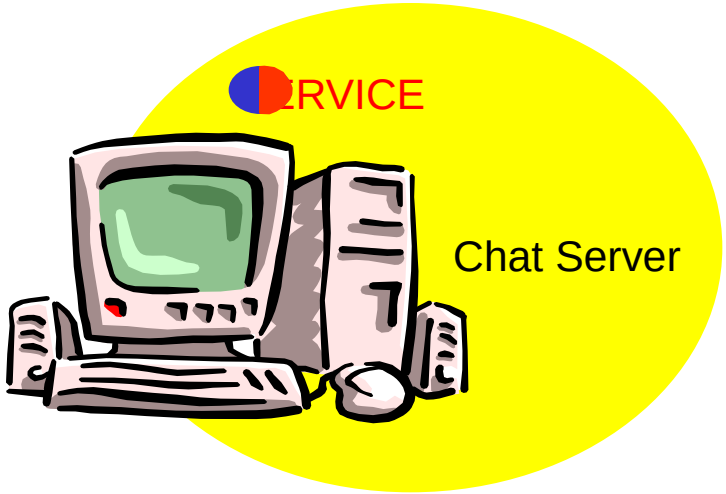

Chat client
bob: Hello there!
Chat Client
alice@localhost$


TF Server
Address
Port
OS
10.0.0.1
6001
Windows
10.0.0.1
6002
Windows
Modules
Hello module
Tracer module (default)
Cipher module
TFlow Server


UNTRUSTED


ENTRUSTER




RVICE
Chat Server

Integrity check

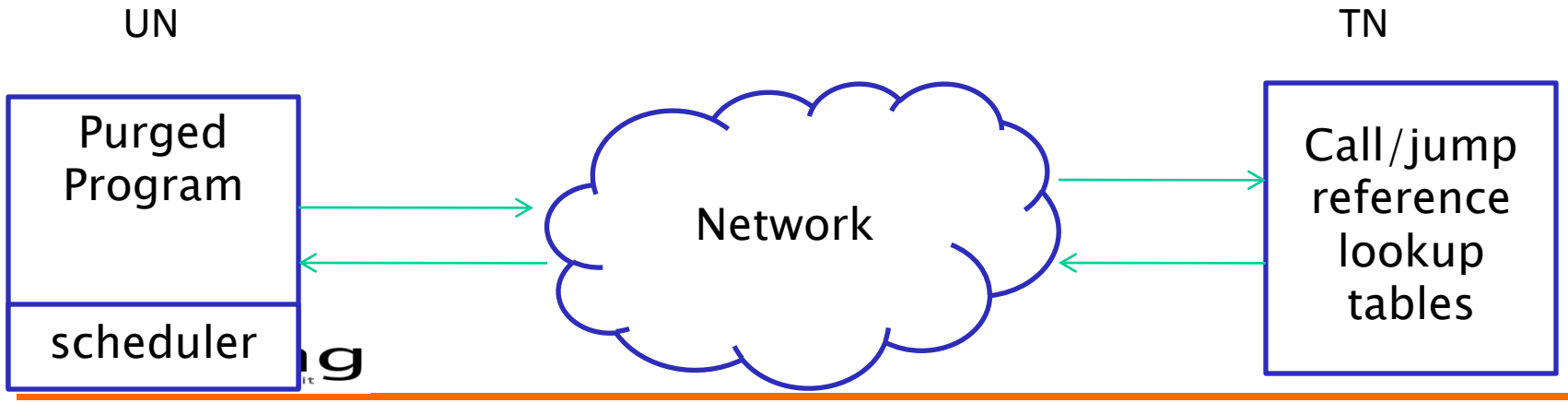
- Module contains
  - List of crypto hashes (each method)
  - Symmetric key
- Keyed hash recomputed each time a method is called
- Hash compared with “good” copy
- New Module checks previously deployed ones

Prototype 1a-b

- Execution interception
  - Module calculates proof
  - Seamless replacement at run-time
  - Slow start-up
- Transparent tag insertion
  - Call to socket write are intercepted and data buffer is tagged
- Client code:
  - Its image is checked in memory (JVMTI)
  - can be sandboxed (AOP)

Prototype 1c

- The application is deployed incomplete
- Some binary code blocks are downloaded and linked in memory at start-up
- The memory layout si decided by the server, and it changes at every run
- Useful to defeat static analysis



Program Instrumentation step

- PE header patch
  - make code segment writable at runtime;
- Disassembling the executable collecting information about control-flow
  - Instructions calls, jump, ret;
- Functions “to be protected” are purged
  - They won’t be available in client application;
- Patching of calls/jumps referring to purged functions:
  - they will now point to scheduler()

Runtime

- When scheduler is invoked ->it send caller address to trusted node
- The TN uses its lookup tables to find out if the caller needs some purged code to be sent to the UN
- The scheduler in UN
  - receives the necessary code
  - Allocate it in memory
  - then executes it

Remote Control Flow Checking

- Split the program integrity verification among the untrusted and the trusted node:
  - Program execution performed on the untrusted node
  - Control flow validation performed on the trusted node

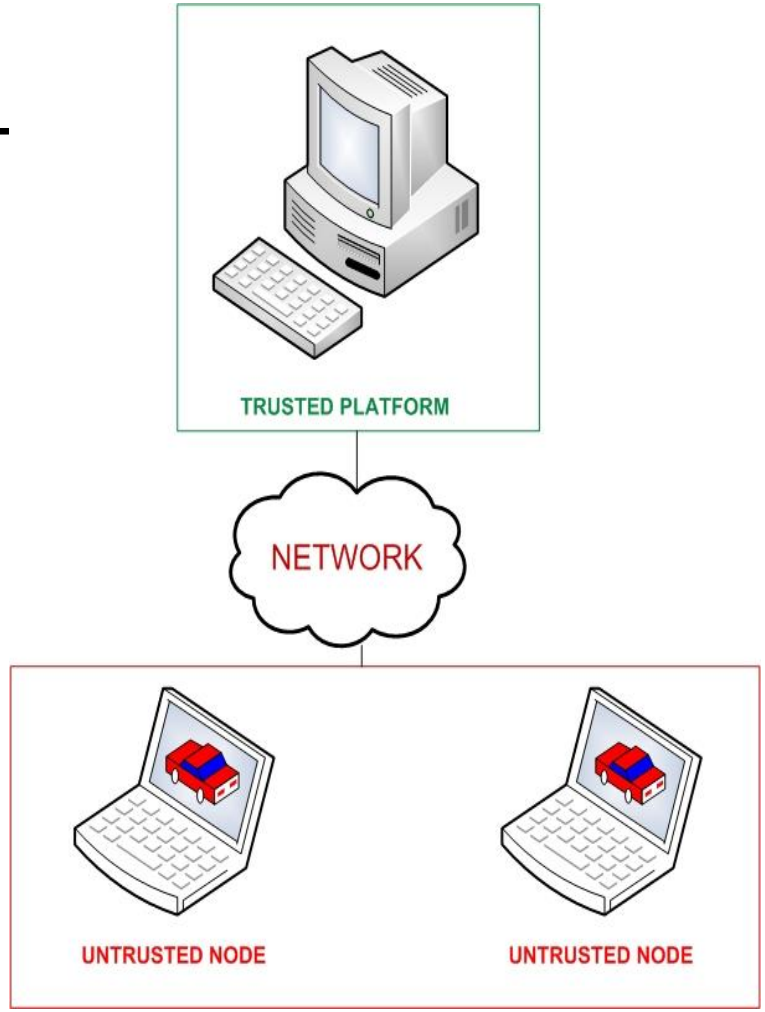
Remote Control Flow Checking

- Basic flow:
  - The target application collects information (traces) about executed instructions
  - Traces are transmitted from the untrusted node to the trusted node
  - The trusted node validates the control flow of the application
  - Any violation is detected as an attack

- The trusted node is in charge of:
  - Monitoring the flow of instructions received from the untrusted node (correct sequence of basic blocks)
  - Validating the checksum of each basic block (correct instructions opcode)

Invariants Prototype: Car Race

- Language: C++
- Graphic Library: Open GL
- IDE: Visual Studio 2003
- One Server, 2 players



Prototype: Car Race

- There are 10 check points.
- Every check points has a particular picture with DRM

Car Race: Security

- Security:
  - Secure Protocol
  - Invariants Checks
  - Mobile Code
  - Mutual Authentication
- Invariants Check
  - To protect algorithm
  - To protect DRM

Car Race: Security

- Mobile Code
- Mutual Authentication → A client needs the server authentication, in fact without this “ACK”, the trusted platform uses a wrong key to crypt information.

Initial Analysis

SOftEng
http://softeng.polito.it

Open issues with mobility

- How to protect mobile modules?
  - Obfuscation
- How often a module is replaced?
  - It depends on time needed to understand it and implement an attack
- How to measure this Time-2-Break-It?
  - Metrics
  - Empirical Evaluation

Obfuscation Metrics

- Source Code complexity
  - Potency and other metrics (Collberg et al.)
  - Depth of Parse Tree (Goto et al.)
  - DeObfuscation Time (Udupa et al.)
- Binary Code complexity
  - Confusion Factor (Linn et al.): % of code that cannot be disassembled
- Compare Obfuscations (Anckaert et al.)
  - Code & control flow metrics
  - Data and data-flow metrics

Empirical Evaluation of Obfuscation

- Complexity of reverse engineering binary code
  - Asking a group of 10 students to perform static analysis, dynamic analysis and change tasks on several C (compiled) programs.
  - They found that the subjects' ability was significantly correlated with the success of reverse engineering tasks they had to perform.
  - I. Sutherland, G. E. Kalb, A. Blyth, and G. Mulley. An empirical examination of the reverse engineering process for binary files. *Computers & Security, 25(3):221–228, 2006.*
- Complexity of Java id-renaming source code obfuscation:
  - Controlled experiment of Master and Ph.D students to crack 2 apps (one clear , one obfuscated)
  - Calculate statistical effect size of the applied obfuscation
  - M. Ceccato, M. Di Penta, J. Nagra, P. Falcarin, F. Ricca, M. Torchiano, and P. Tonella. Towards experimental evaluation of code obfuscation techniques. In *Proc. of the 4th Workshop on Quality of Protection. ACM, Oct 2008*

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