e-Smart

Security-by-Contract for Open Multi-Application Smart Cards

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e-Smart'2011
September 21-23, Sophia-Antipolis

secure CHANGE

COOPERATION

UNIVERSITÀ DEGLI STUDI DI TRENTO

Trusted Labs

gemalto
security to be free

Plan of the talk

- Motivations
- Java Card
- The Security-by-Contract solution
- Technical obstacles for prototype implementation
- The implementation highlights
- Conclusions

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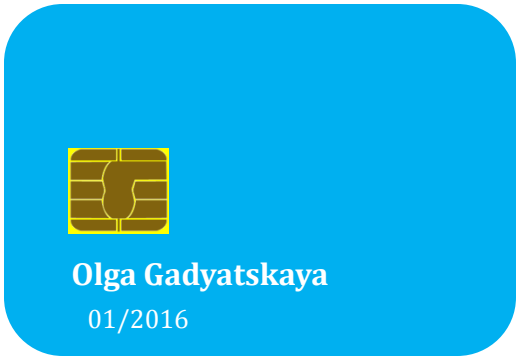
Open multi-application cards

picture from http://fingerprints-security.net



"One card to rule them all"

Open multi-application cards II

- One card can host multiple applications
- Applications are coming from different providers
- Applications can be installed or removed
- Applications can interact on the card to provide a given service

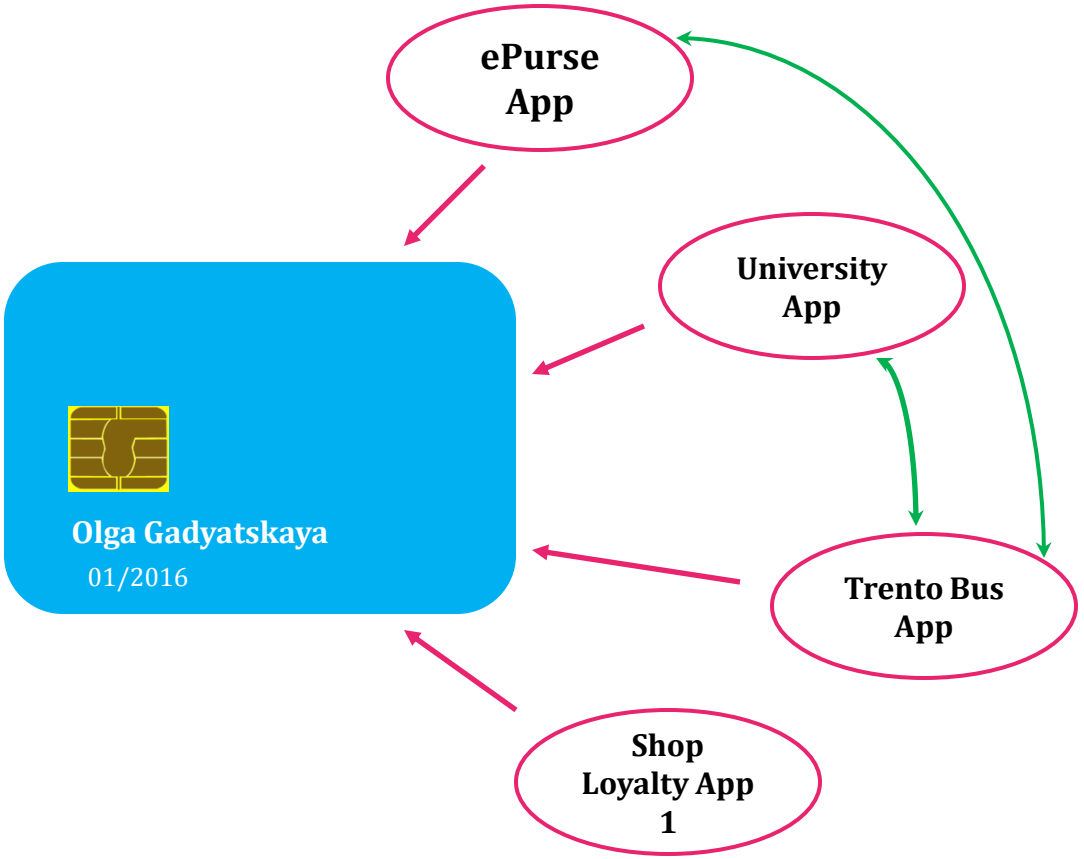
How to ensure their interactions are authorized?

The challenge

The card has to verify that the policies of all applets are satisfied

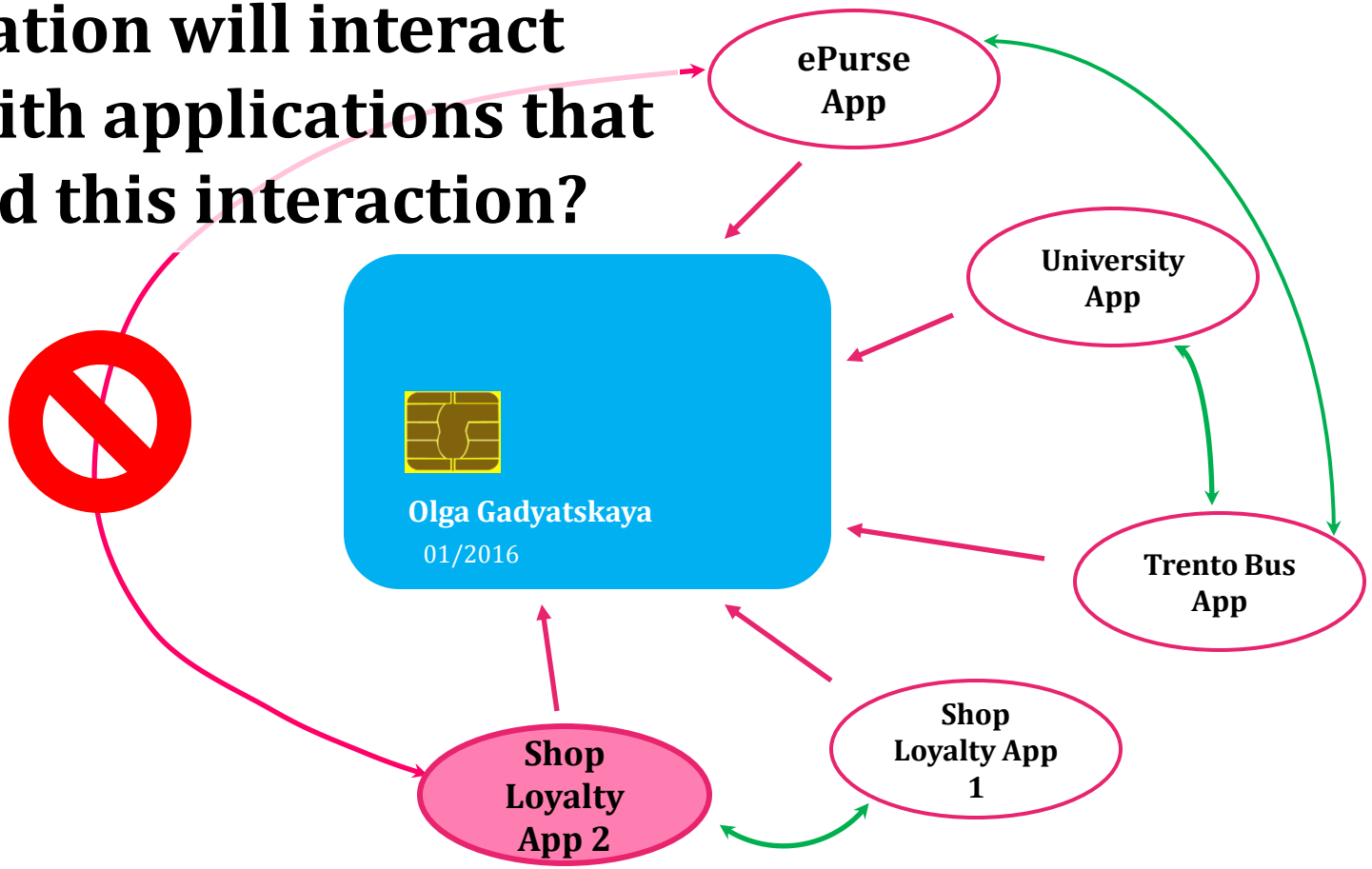
- set of applications to run on card is unknown initially
- evolution occurs unexpectedly
- each application has its own policy on interactions
- approach must work for a smart card:
  - run-time monitoring is not possible
  - algorithms have to be small and fast

An example


ePurse App
University App
Olga Gadyatskaya
01/2016
Trento Bus App
Shop Loyalty App 1

An example

How to ensure that new application will interact only with applications that allowed this interaction?



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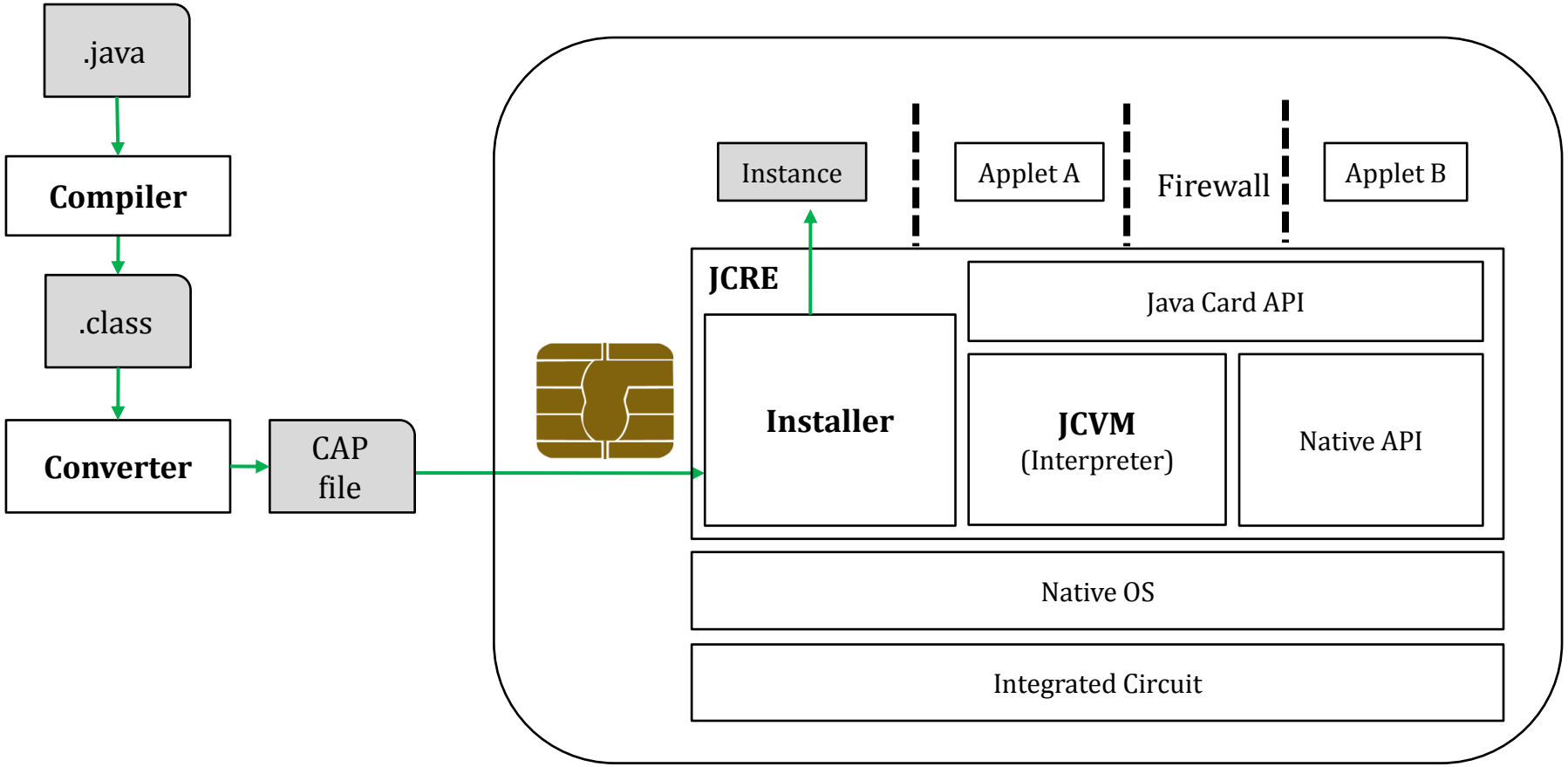
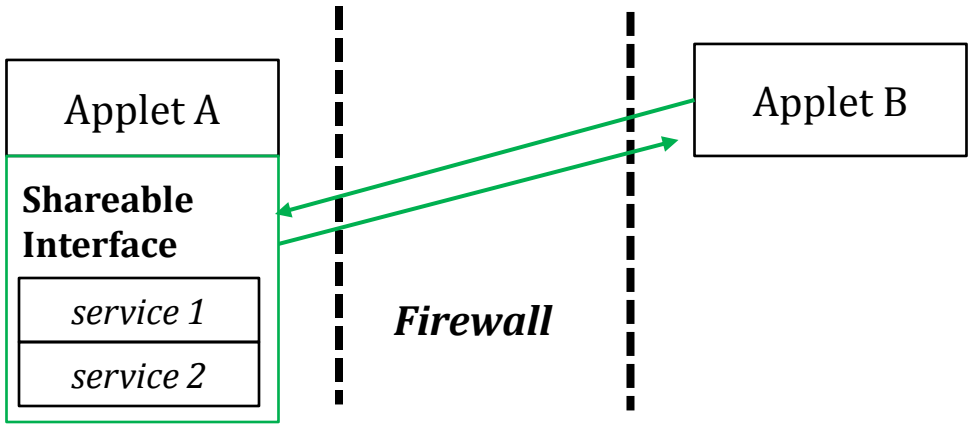
Loading process on Java Card 2.x.x



Application interactions on Java Card

Run-time



Why the current architecture does not work?

- Once an application is installed, it can do whatever (try to call anybody)
- So the callee must check who is calling
- The execution logic of an applet is currently interleaved with the access control logic
- **This is**
  - **not flexible**
  - **error-prone**

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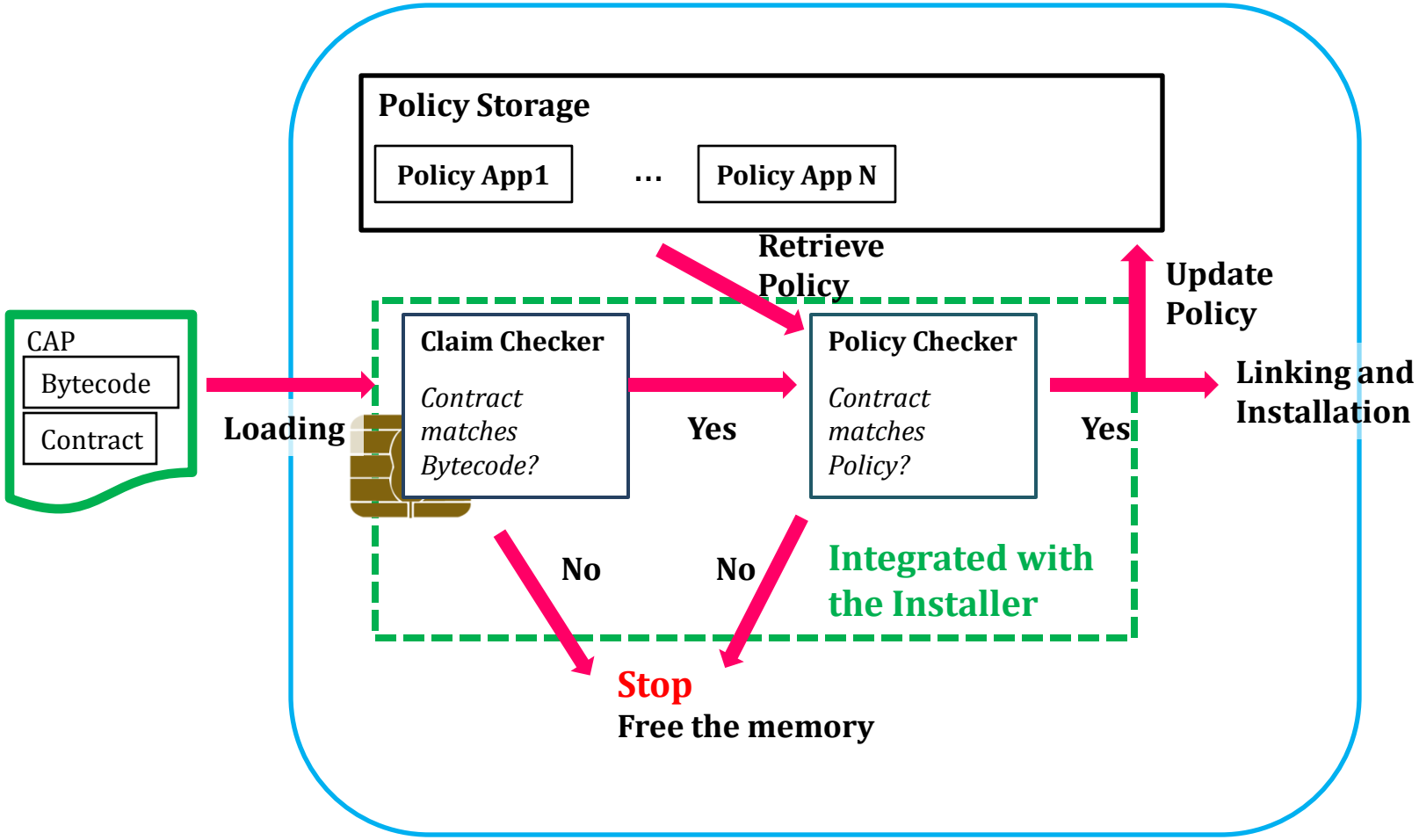
The SxC Workflow



Contracts for applet interactions

Contract of a package

AppClaim

Provided services

<Interface token, method token>

Called services

<Provider package AID,
Interface token, method token>

AppPolicy

Authorizations for services access

<Interface token, method token,
Authorized package AID>

Functionally necessary services

<Provider package AID,
Interface token, method token>

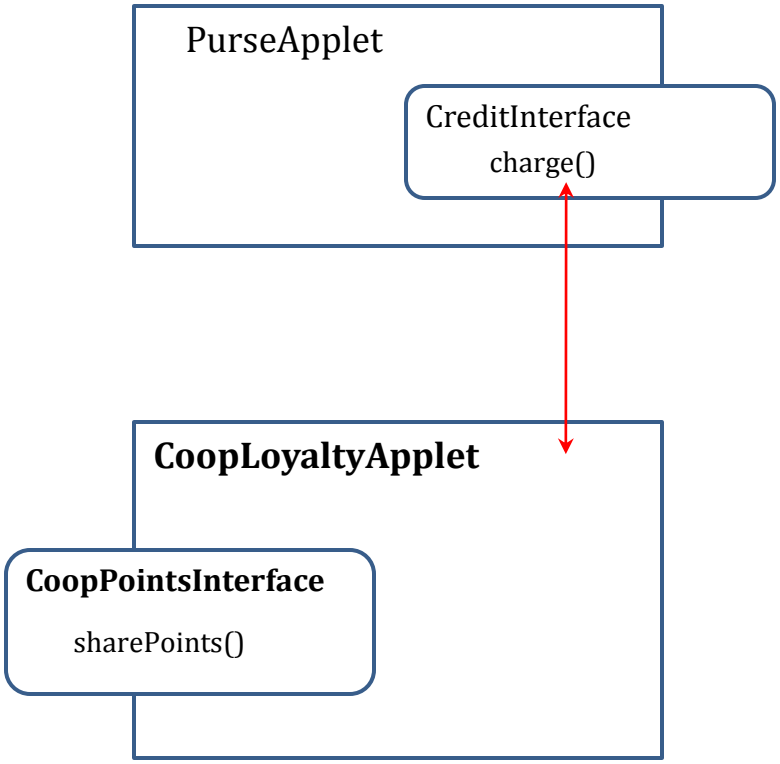
Example of a contract

A simple applet: 1 provided service, which can be used by 1 applet; 1 called service

Contract of **CoopLoyaltyApplet**:

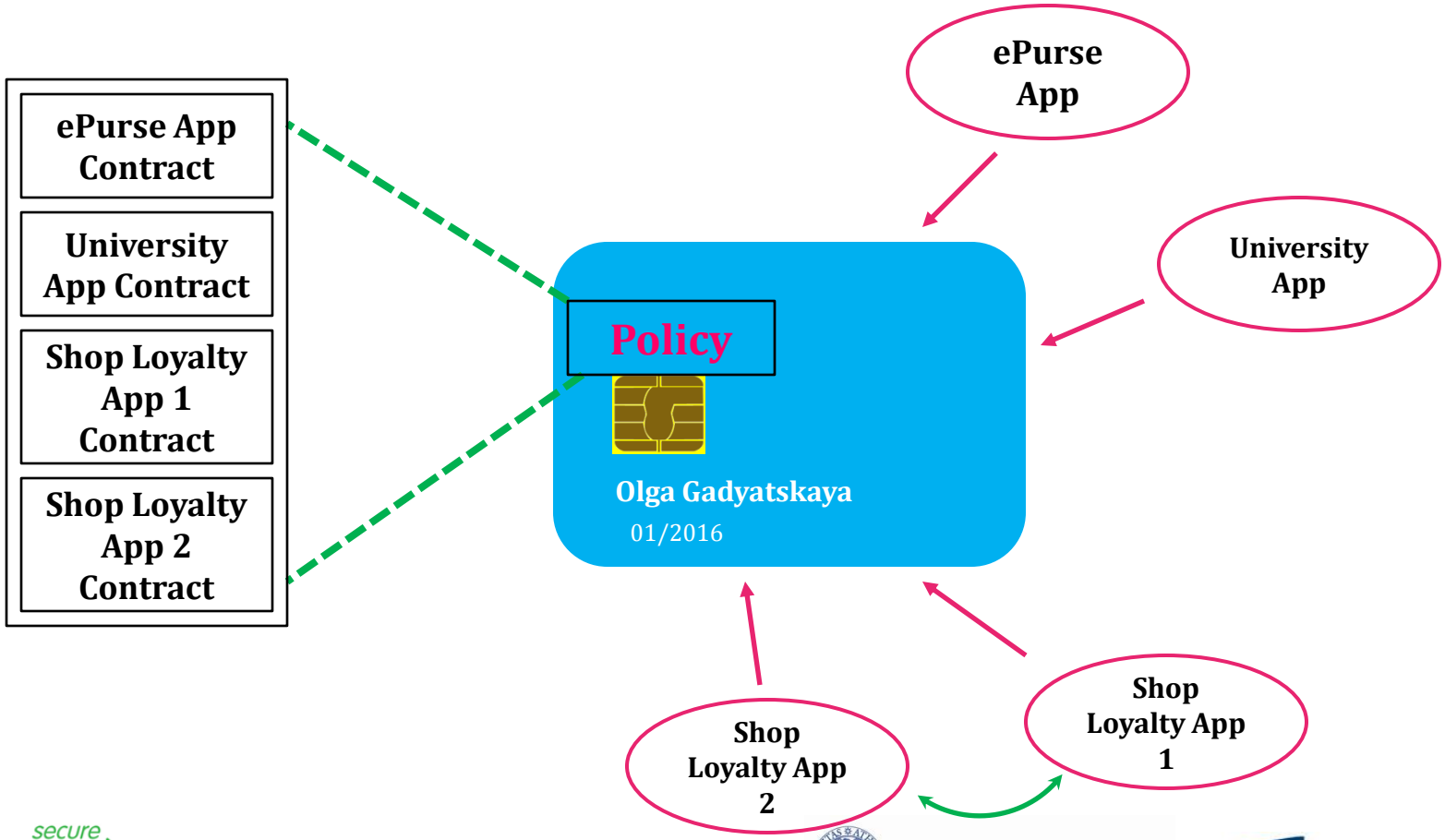
{ 0x0, 0x1, 0x0, 0x0, 0x0, 0x1,
0x0, 0x0, 0x6, 0x1, 0x2, 0x3, 0x4,
0x5, 0x0, 0x0, 0x0, 0x01, 0x8,
0x1, 0x2, 0x3, 0x4, 0x5, 0x6, 0x7,
0x0, 0x0, 0x1, 0x0, 0x0 }

Totally **31 byte**



Security policy of the card

Collection of all loaded applets' contracts



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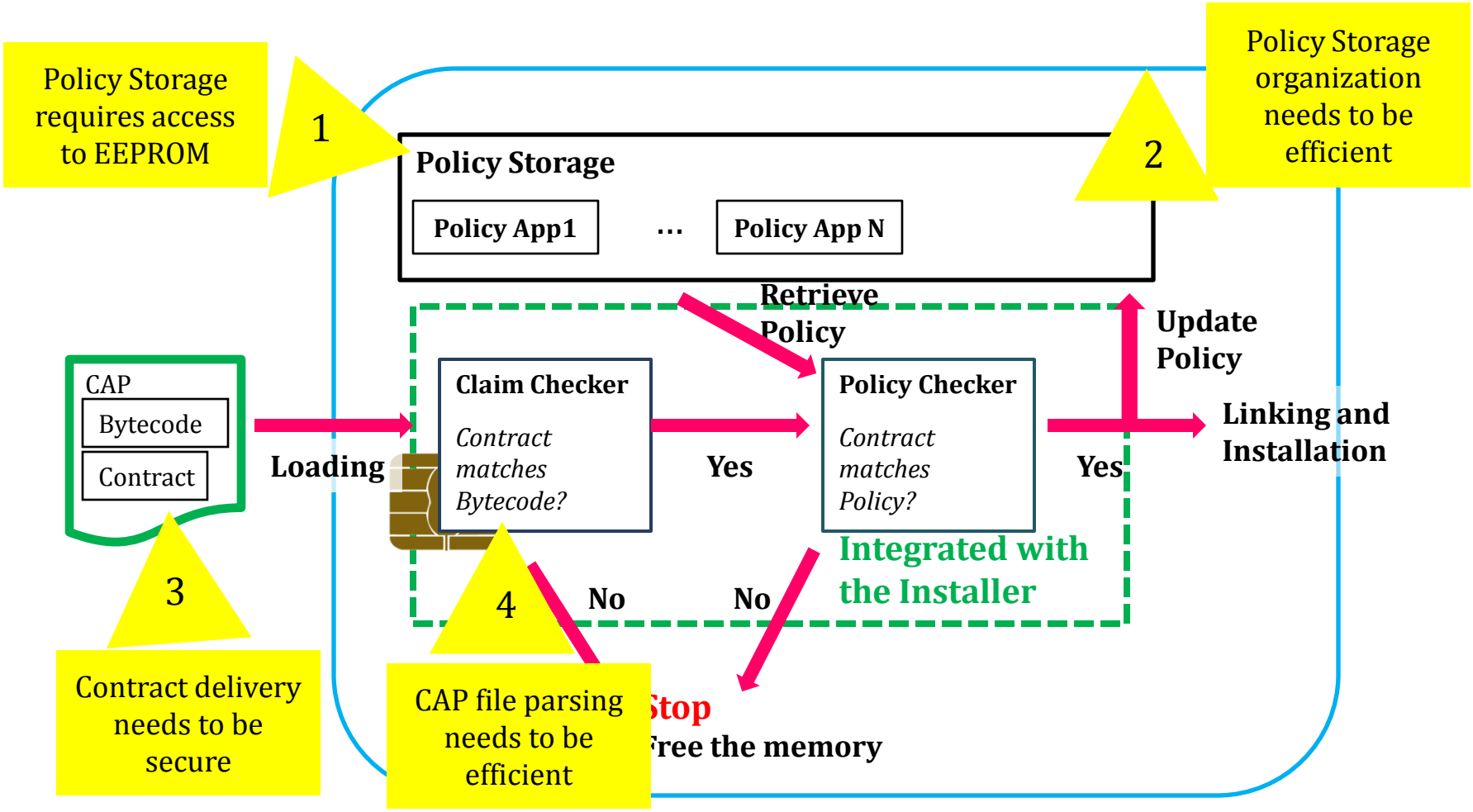
Implementation of the SxC framework

- We experimented the SxC approach by implementing the framework as a proof-of-concept prototype that could be integrated with an industrial card
- The requirements for the prototype:
  - The framework needs to be written in C
  - Full memory footprint of the SxC prototype occupies up to 30 KB

Technical obstacles we have faced



Obstacle 1: EEPROM for the Policy storage

- Only modifiable persistent memory can be used to store the policy after each evolution
- Only applet instances are entitled an access to the EEPROM
- The Claim Checker and the Policy Checker are implemented in C

Solution:

- We implemented the Policy storage as the **Policy Applet**.
- The communication between the Policy Applet and the C components is implemented through the APDU buffer (a temporary solution)

Obstacle 2: Policy storage optimization

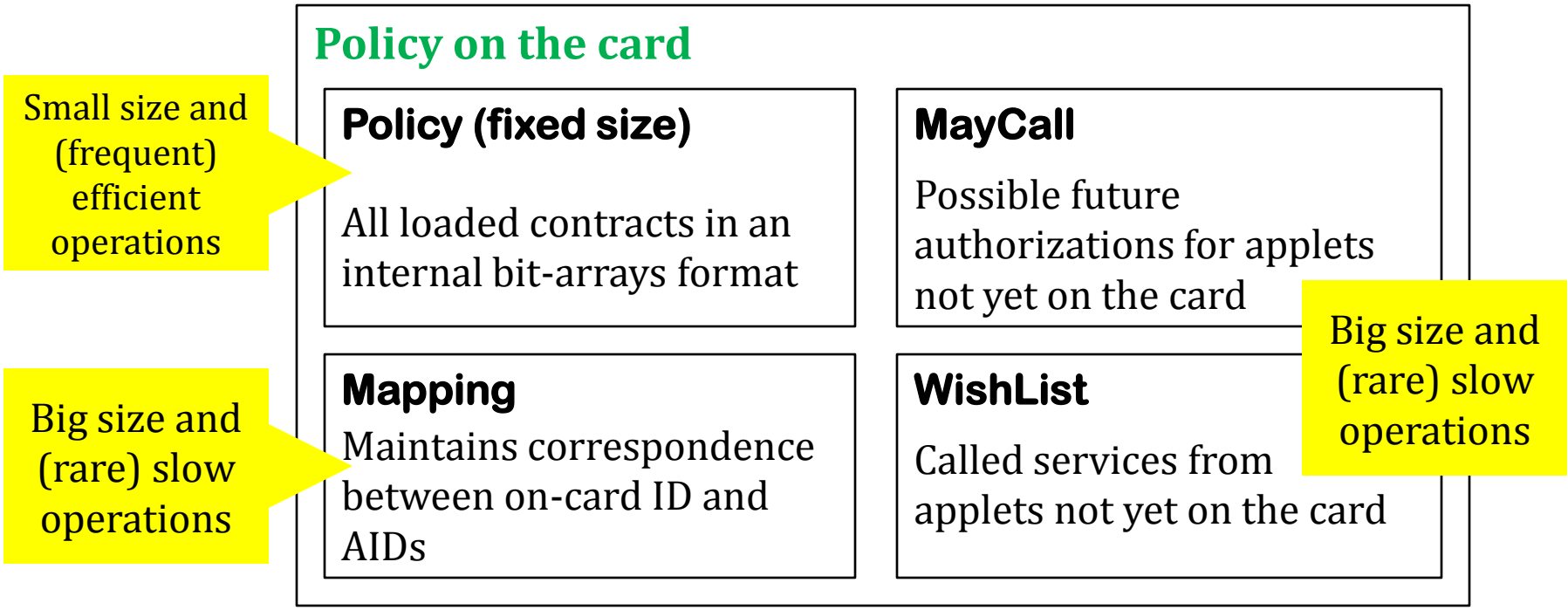
- AIDs are space-consuming objects
- The algorithms need to be fast

Solution:

- We organized the Policy storage efficiently using a fixed Policy structure and bit-vectors

Security Policy on the card

We assume 4 loaded applets, 8 services each



Obstacle 3: contract delivery

- Contracts need to be embedded in CAP files

Solution:

- We embed contracts into Custom components
- Alternative solution would be to use the Static Field component

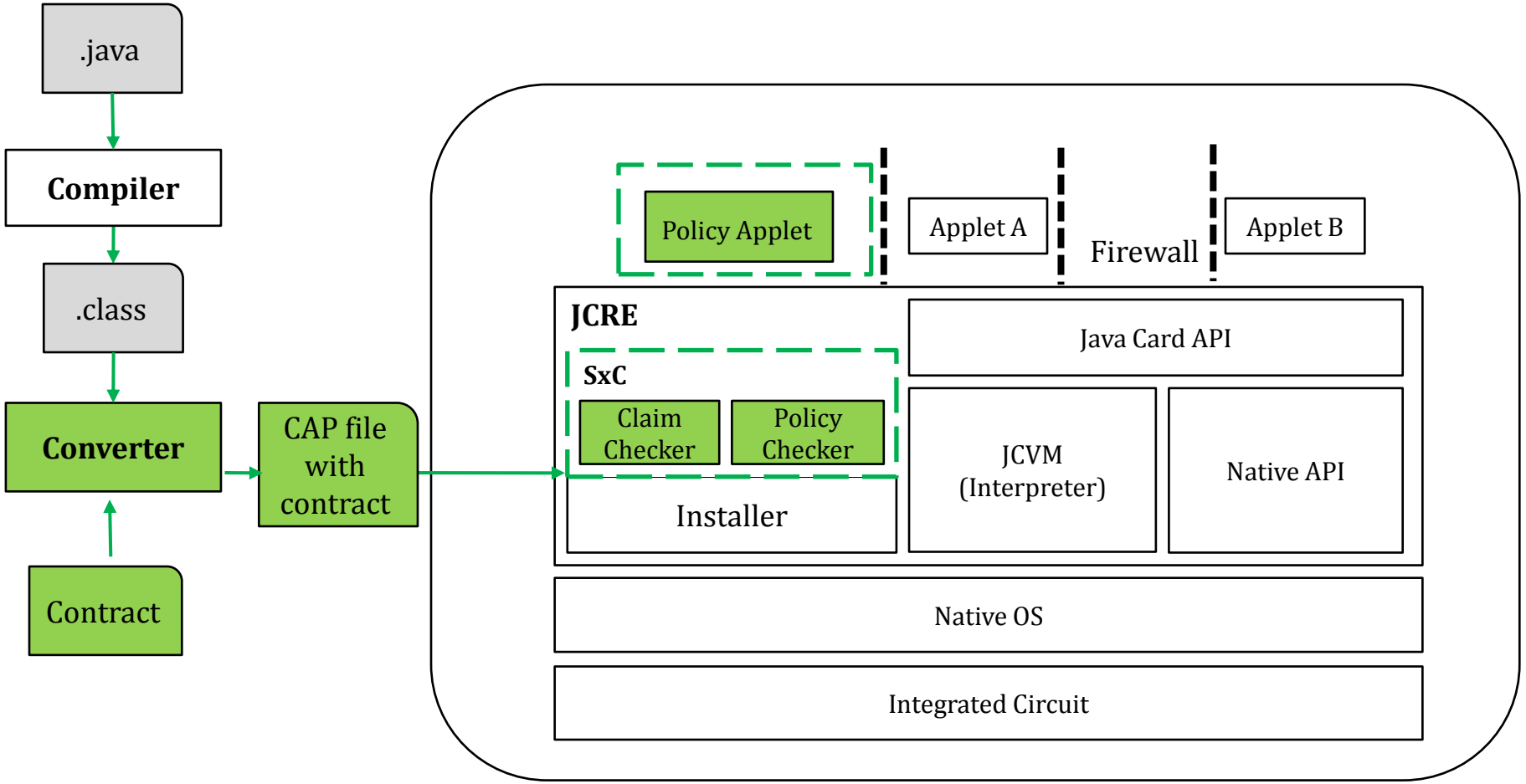
Obstacle 4: CAP file parsing efficiency

- Preferably each component should be parsed only once
- RAM usage optimization is necessary

Solution:

- We use specific 255 bytes temporary buffer for storing the computation data

The SxC architecture for loading



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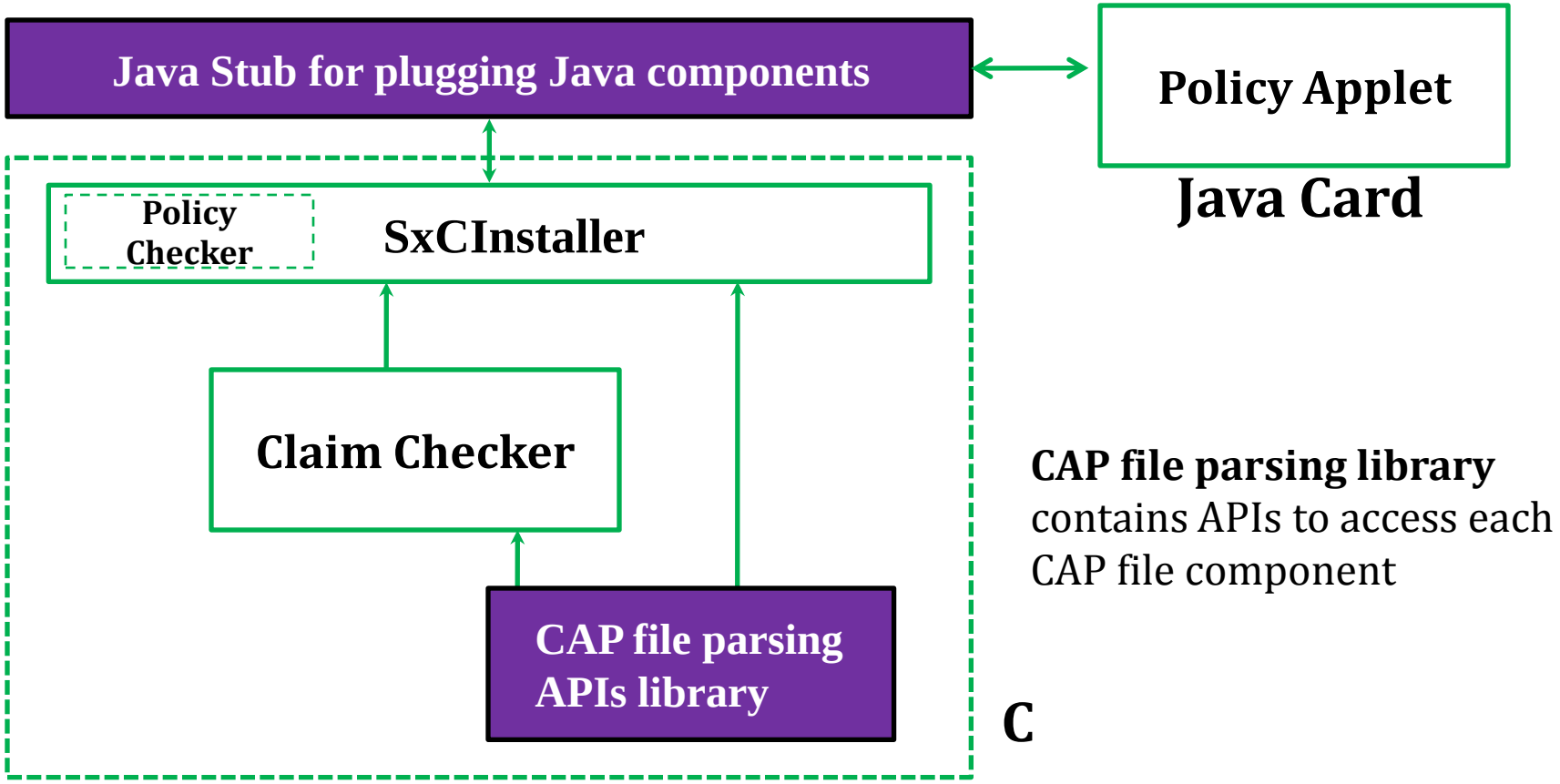
The SxC prototype architecture implemented on a PC simulator



CAP file parsing library contains APIs to access each CAP file component

Memory footprint of the prototype

Component	Memory (bytes)		LOCs
SxCInstaller	6754 B	Object files	152
Claim Checker	6522 B		162
Policy Applet	2282 B	Occupied EEPROM	101

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Industry-Academia validation

Or *How to validate the framework while protecting the smart card platform APIs*

- The prototype relies on the CAP file parsing library
- Thorough industrial testing with actual CAP file parsing APIs is being done

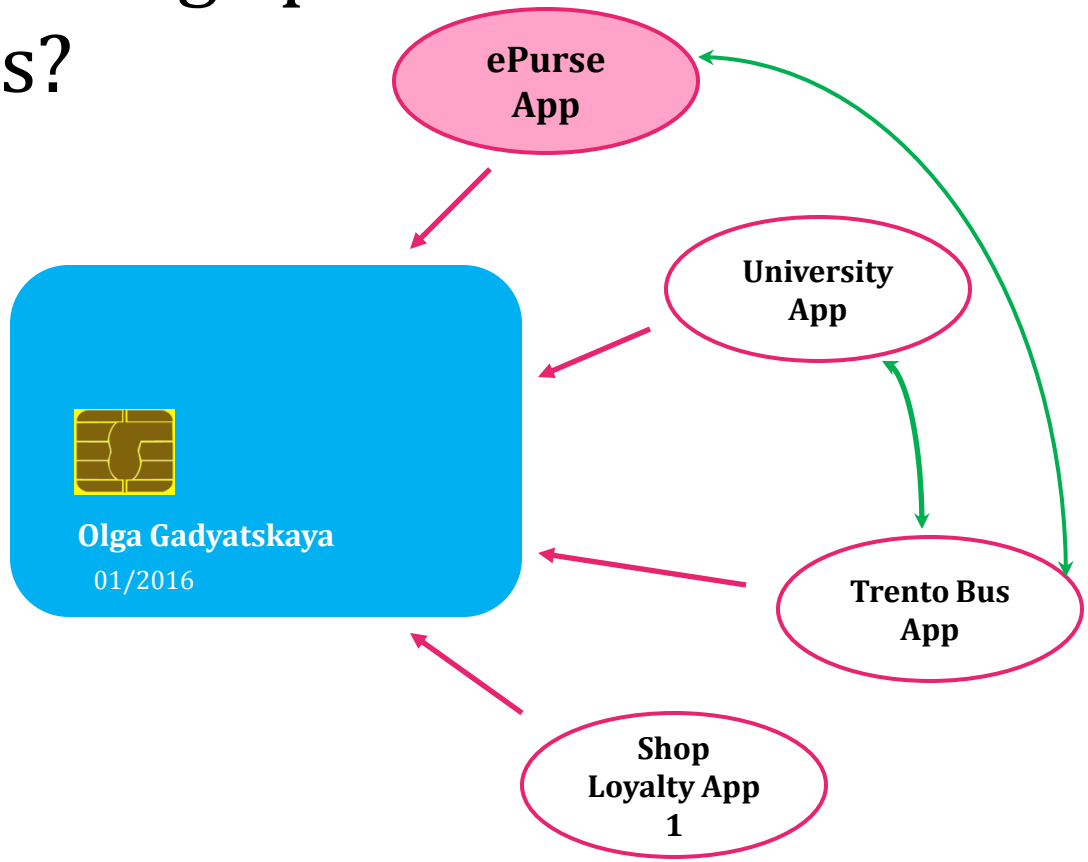
Future work

How the card can manage possible conflicts among applications?

What if ePurse App wants to be removed and Trento Bus App relies on it?

Alternatives:

- ePurse is forced to stay
- Trento Bus is disabled



Thank You!

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or visit http://disi.unitn.it/~gadyatskaya/

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