SUBVERTING BYTE CODE LINKER SERVICE TO CHARACTERIZE JAVA CARD API

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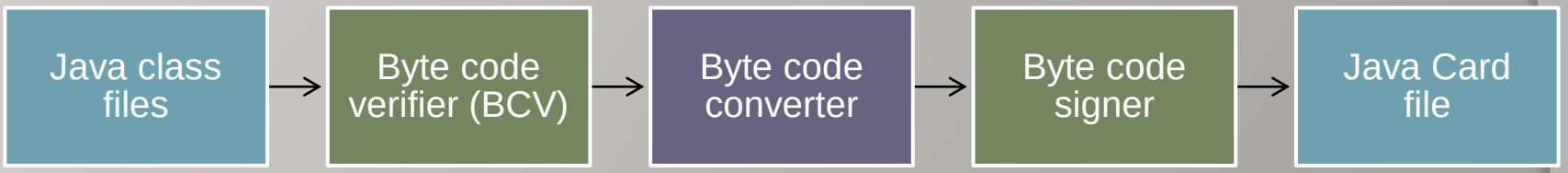
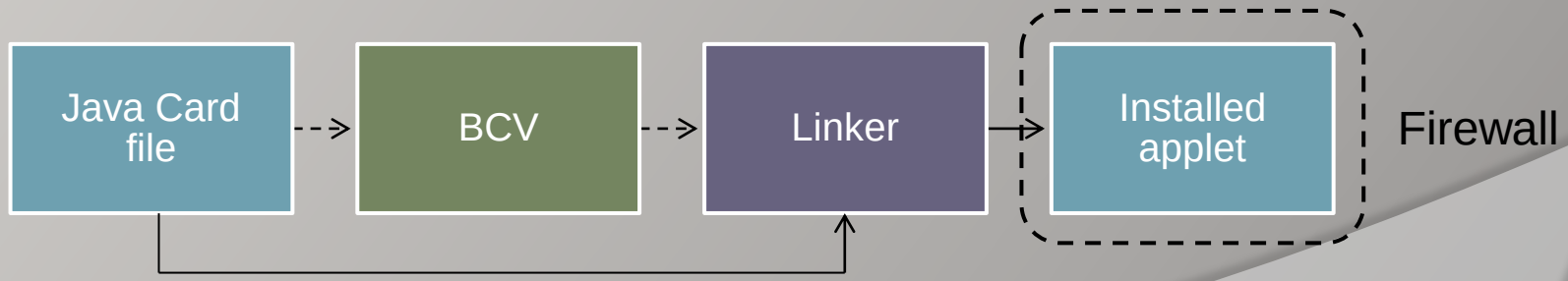
Introduction

Java Card security model

Off-card security model



On-card security model



Introduction

Our objectives

- Understand the security of Java Card better
- Improve it

Process

- Create ill typed files
- Load files on the card

Summary

Introduction

Overview

Dr4ccarD & the results

Counter measures

Conclusion

Overview

Goals

- Execute arbitrary & rich shell-codes

Problem

- The addresses of the methods are not access free

Process

How ?

- Modifying the CAP file

What ?

- Method Component
- Constant Pool Component
- Reference Location Component

When ?

- Linking step

Normal linking step : before

```
[ … ]
.ConstantPoolComponent {
        [ … ]
        0006 - ConstantStaticMethodRef : ExternalStaticMethoddRef : packageToken
        80 classToken 10 token 6
}
[ … ]
.MethodComponent {
[ … ]
        @008a    invokestatic 0006
[ … ]
}
[ … ]
.ReferenceLocationComponent {
[ … ]
offsets_to_byte2_indices = {
        [ … ]
        @008b
        [ … ]
}
[ … ]
}
[ … ]
```

Method referenced by the token 0006

Constant Pool reference (token)

Offset of a token

Normal linking step : after

```
[ … ]
.ConstantPoolComponent {
        [ … ]
        0006 - ConstantStaticMethodRef : ExternalStaticMethoddRef : packageToken
        80 classToken 10 token 6
}
[ … ]
.MethodComponent {
[ … ]
        #8553    invokestatic 0539
[ … ]
}
[ … ]
.ReferenceLocationComponent {
[ … ]
offsets_to_byte2_indices = {
        [ … ]
        @008b
        [ … ]
}
[ … ]
}
[ … ]
```

Real address to call the method

The attack

Original code

```
[ … ]
@008a   invokestatic 0006
@008d   bspush 2a
@008f   sreturn
[ … ]
```

Call to the referenced method

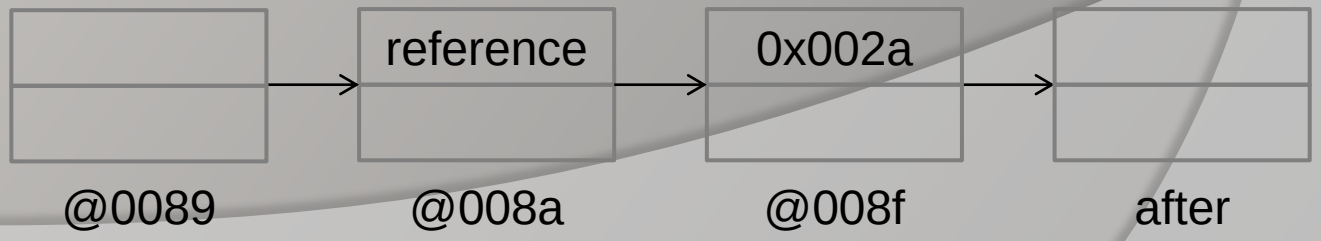
Token

Push the byte 0x2a as a signed short on the stack

Return the top of the stack

Output

0x002a



The attack

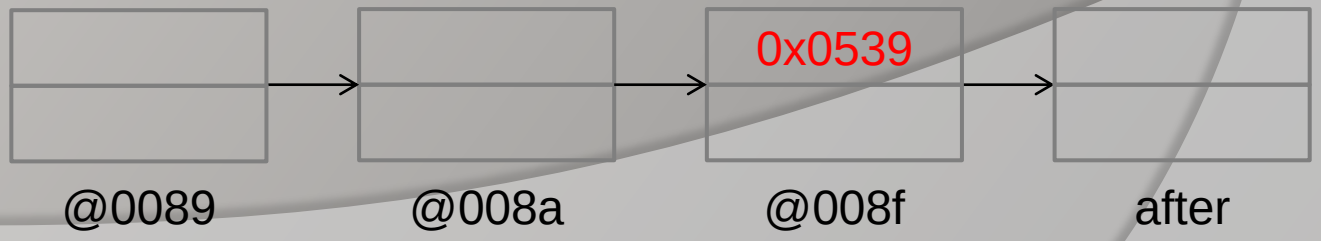
Modified code

```
[ … ]
@008a   sspush 0006
@008d   nop
@008e   nop
@008f   sreturn
[ … ]
```

Push the token on the stack

Output

0x0539



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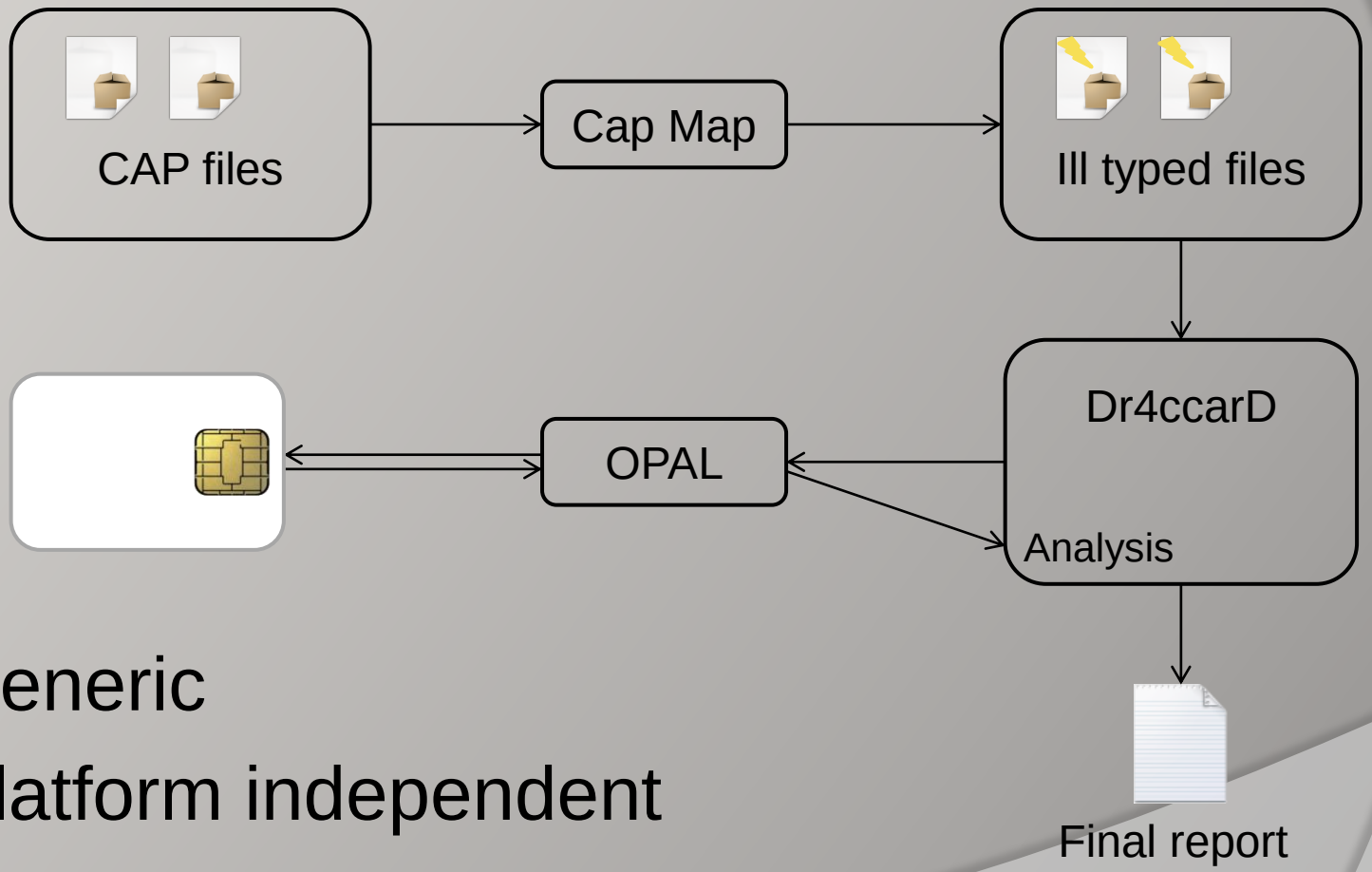
Dr4ccarD



- Generic
- Platform independent
- API version (in)dependent

The results

Reference	Java Card	GP	Characteristics	Address of *getKey*
a-21a	2.1.1.	2.0.1.		0x8C08
a-22a	2.2.	2.1.	64k EEPROM	0x080A
a-22c	2.1.1.	2.1.1.	36k EEPROM, RSA	0x020F
b-21a	2.1.1.	2.1.2.	16k EEPROM, RSA	0x3267
c-22a	2.1.1.	2.0.1.	RSA	0x810B
c-22c	2.2.	2.1.1.	72k EEPROM, dual interface, RSA	0x810B
d-21a	2.1.	2.0.1.	32K EEPROM, RSA	0x0003
d-22b	2.1.1.	2.1.1.	16k EEPROM	0x80BA
e-21a	2.2.	2.1.	72k EEPROM	0x142F

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Counter measures

Use an embedded BCV

- O(n * 43 + p)
- n : number of instructions
- p : number of tokens

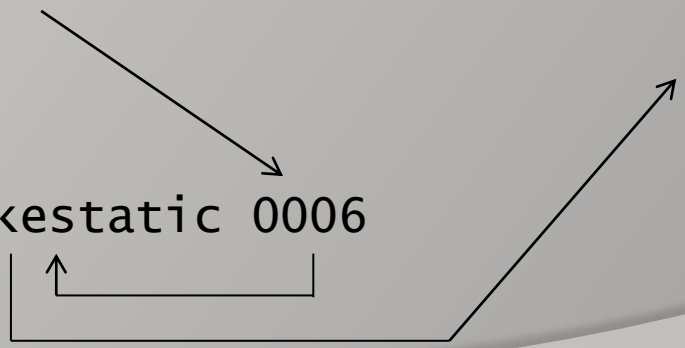
Counter measures

Only link real tokens

- O(p * log(log(43)))
- p : number of tokens

```
.ReferenceLocationComponent {
[ … ]
        @008b
[ … ]
}

@008a  invokestatic 0006
```



Belong to {new, invokestatic, invokevirtual, …} ?

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Conclusion

- Map of the Java Card API
- Reverse engineering is easier
- Affordable counter measure
- Ongoing work : Use a laser beam to bypass an embedded BCV

Thank you for your attention

Do you have any question ?

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