SECURE INTEGRATION OF CRYPTOGRAPHIC SOFTWARE

Speaker: Stefan Krüger

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When a Developer Uses a Crypto API

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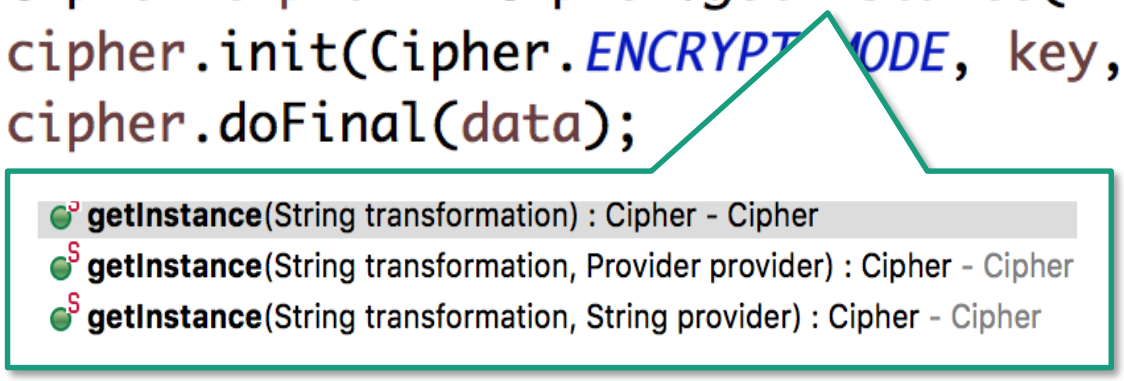

Uses Electronic Codebook (ECB)

The Average Developer is no Crypto Expert

of Android apps contain
at least one misuse

Popular vendors misuse
TLS libraries

of crypto-related vulnerabilites
result from API misuse

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What shall we do about it?

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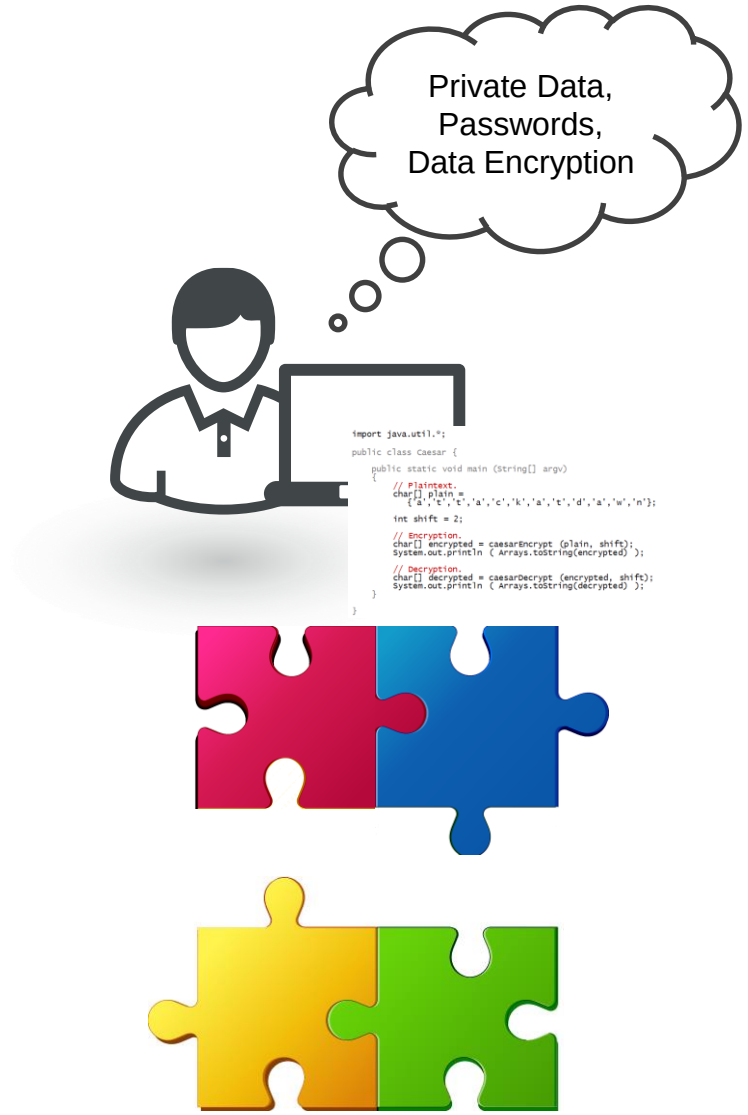

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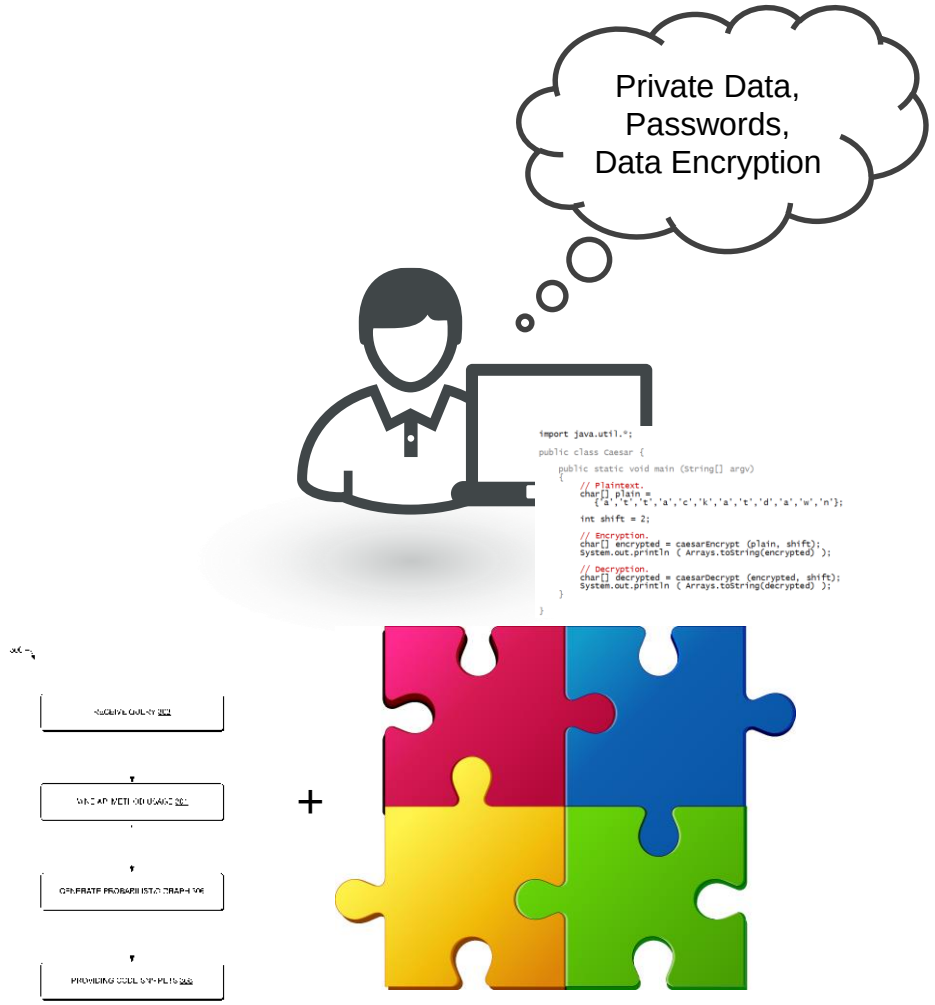

FIG. 3

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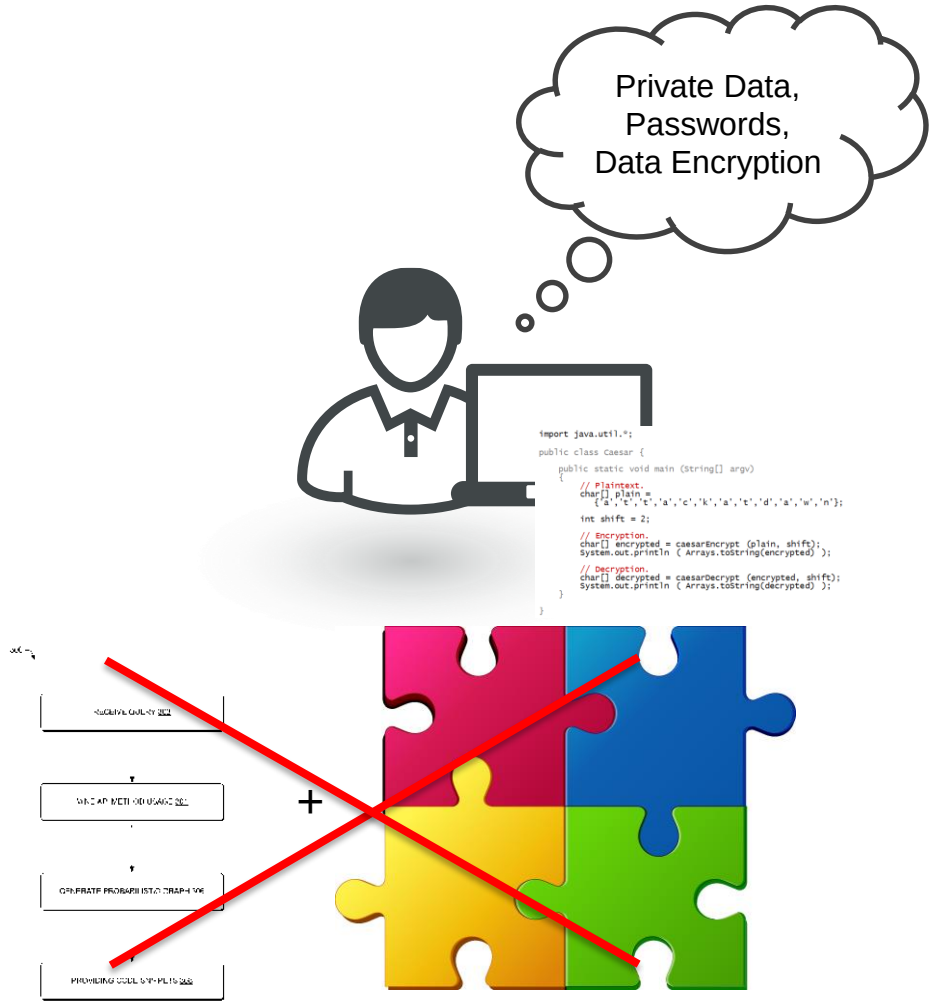

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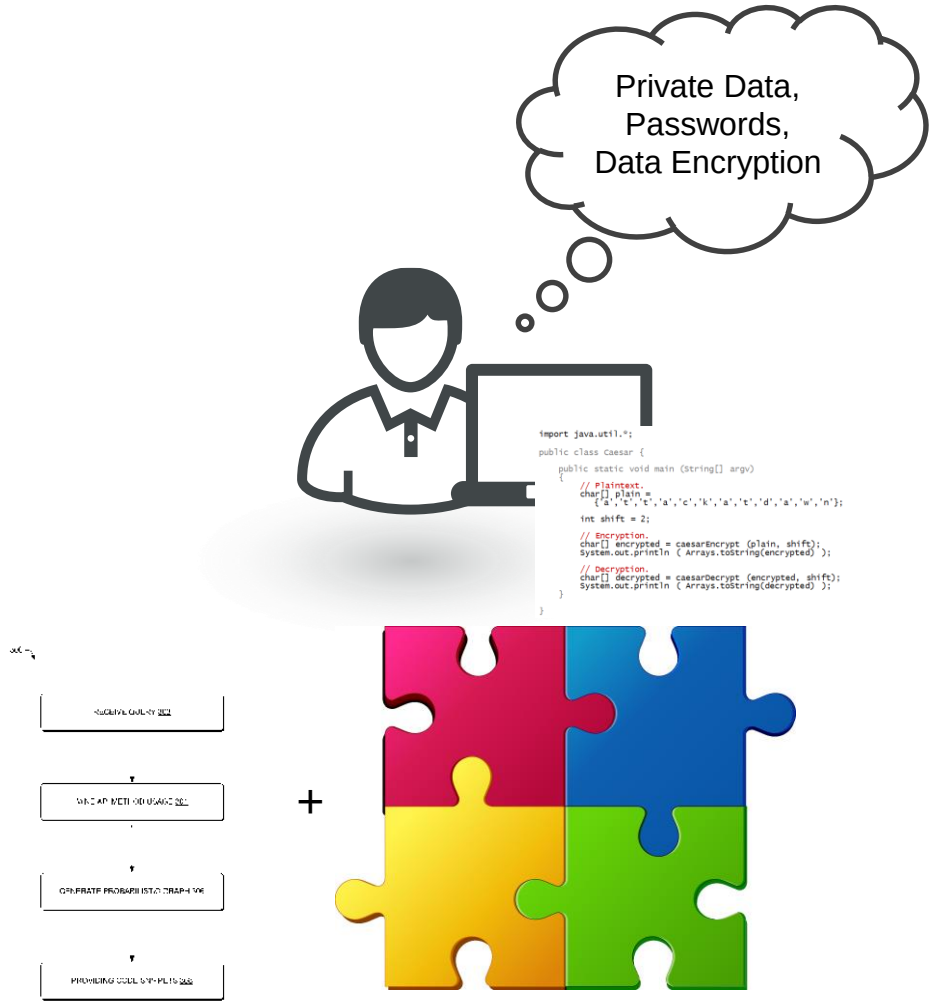

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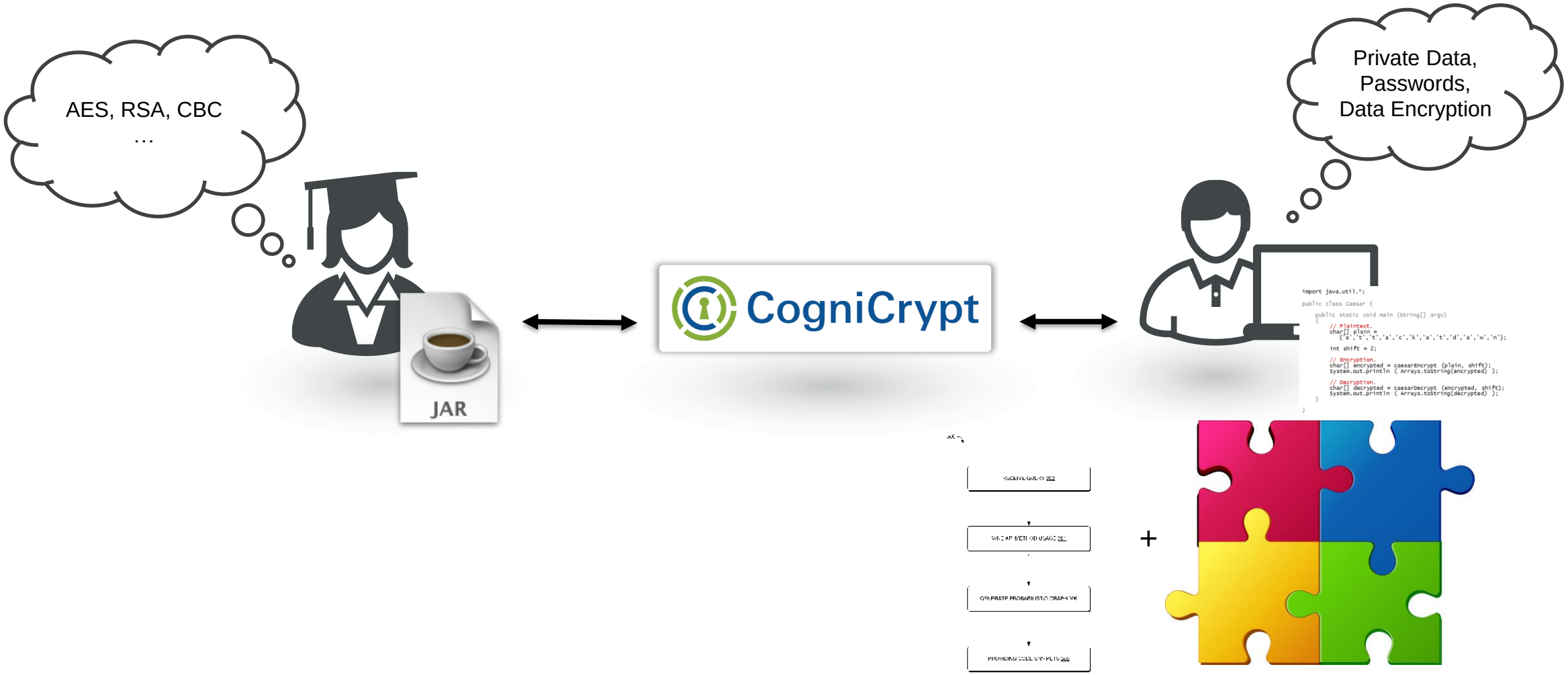

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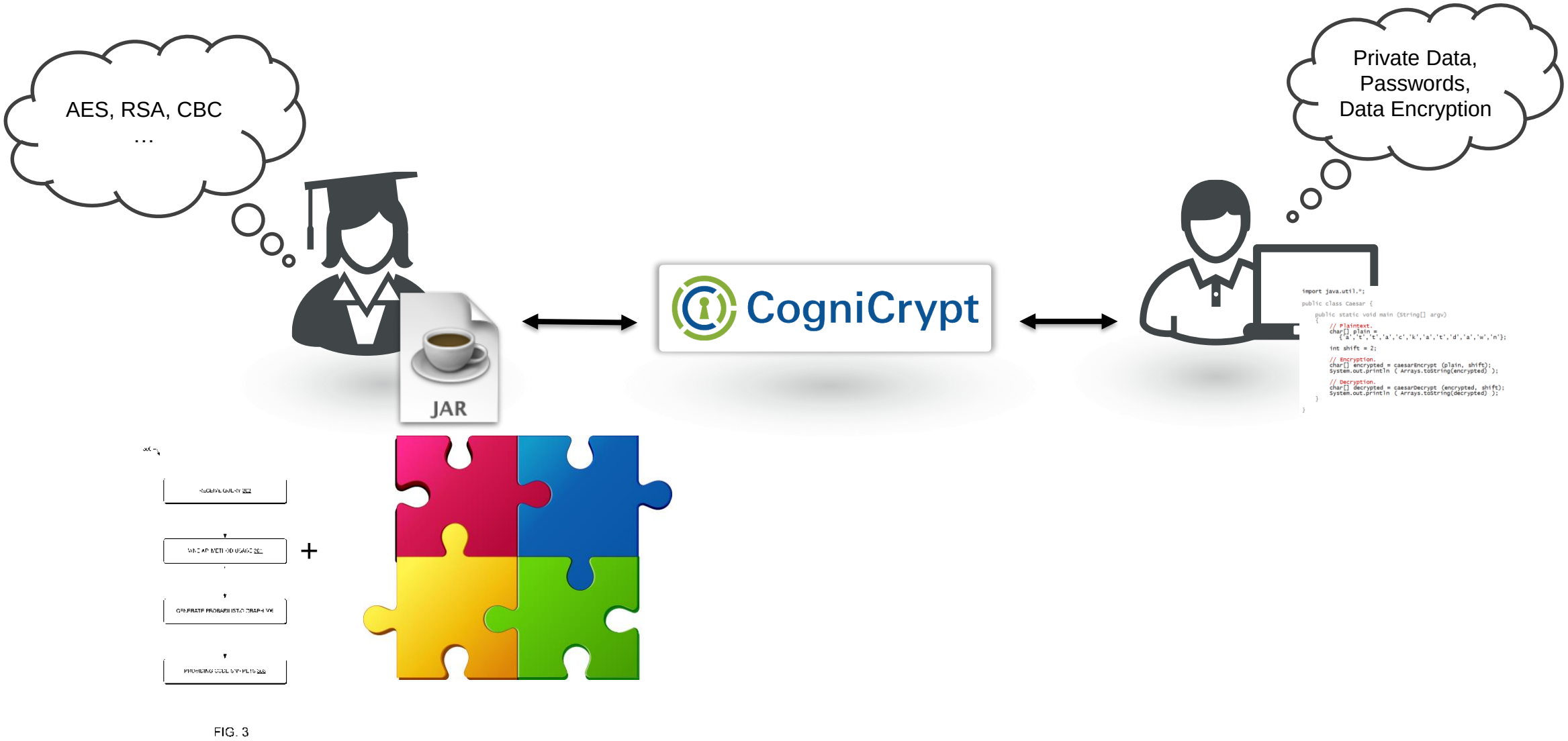
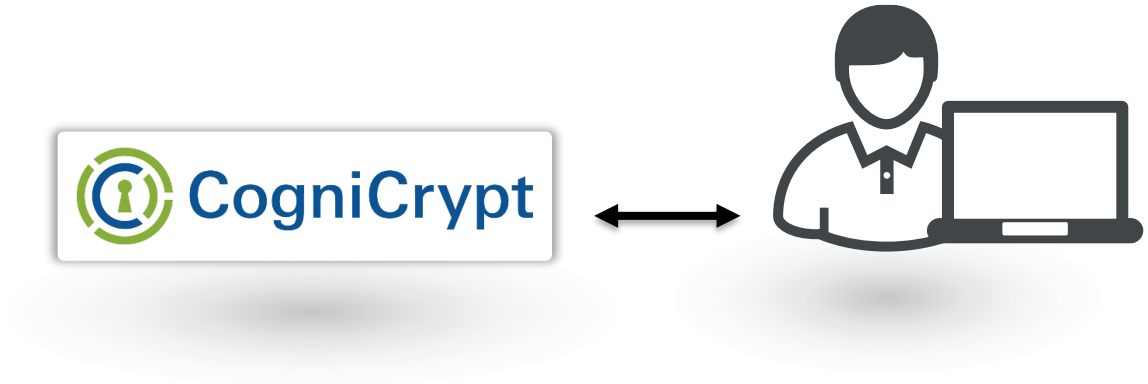


FIG. 3

CogniCrypt supports Developers as an Eclipse Plugin



CogniCrypt supports Developers as an Eclipse Plugin

CogniCrypt‘s Components

CogniCrypt$_{GEN}$

CogniCrypt$_{SAST}$

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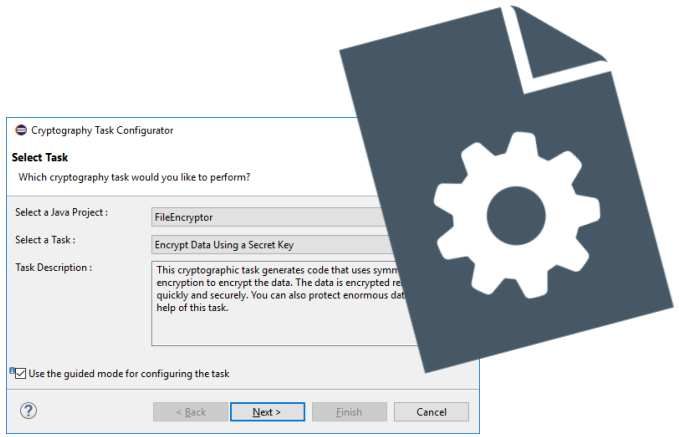
CogniCrypt$_{GEN}$ – Code Generation For Crypto APIs

CogniCrypt$_{GEN}$



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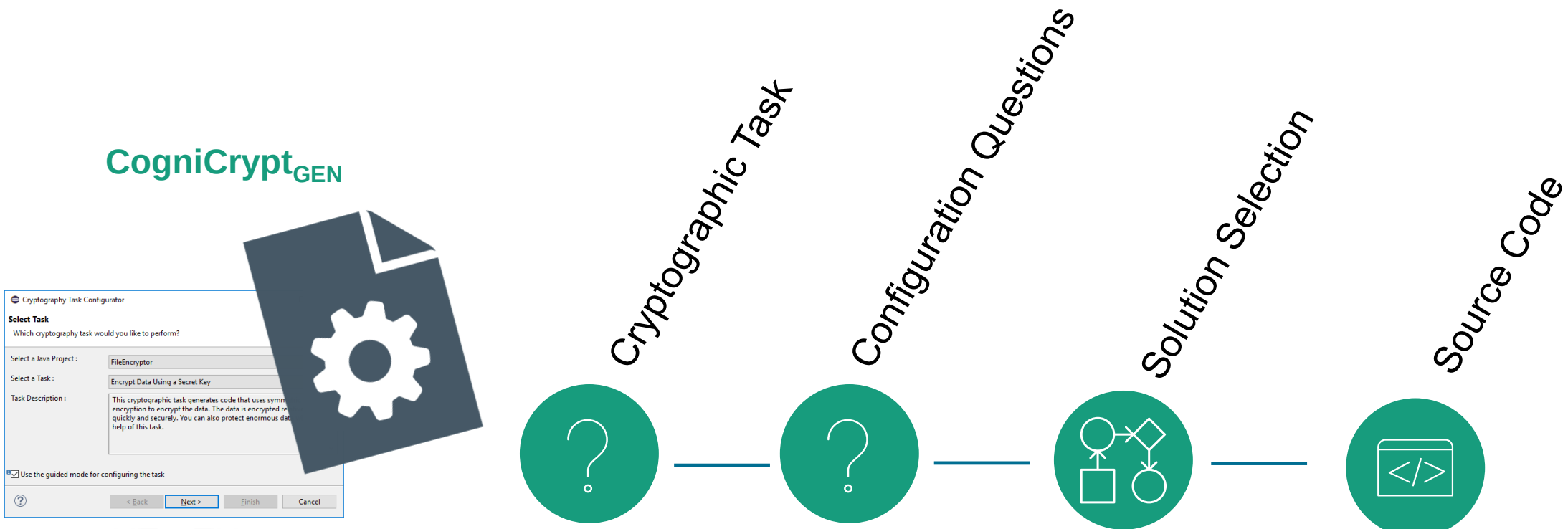

[CogniCrypt: Supporting Developers in using Cryptography. Stefan Krüger, Sarah Nadi, Michael Reif, Karim Ali, Eric Bodden, Mira Mezini, … . ASE Tool Track 2017.]

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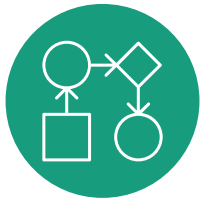
CogniCrypt$_{GEN}$ – Code Generation For Crypto APIs

Task Descriptions

Clafer

Algorithm Model

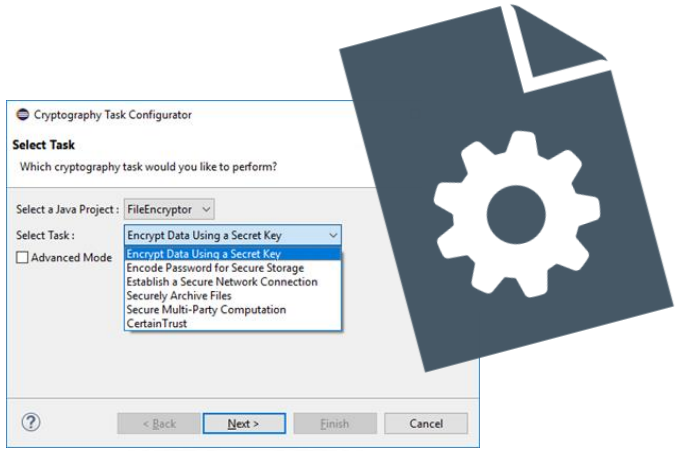
Code Template



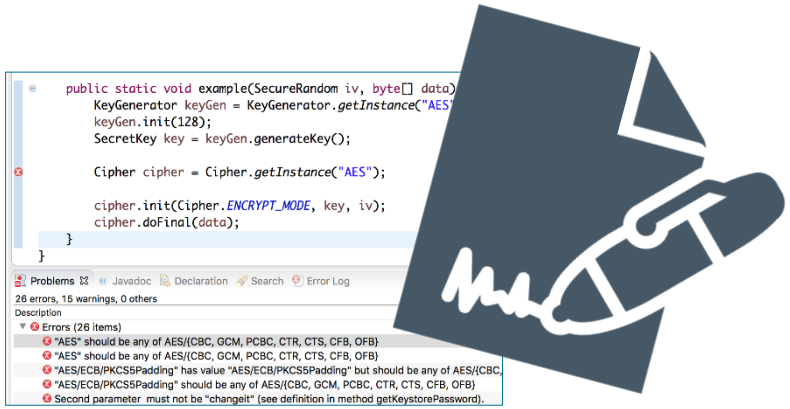
[CogniCrypt: Supporting Developers in using Cryptography. Stefan Krüger, Sarah Nadi, Michael Reif, Karim Ali, Eric Bodden, Mira Mezini, … . ASE Tool Track 2017.]

But… I have to Change My Code!

CogniCrypt$_{GEN}$

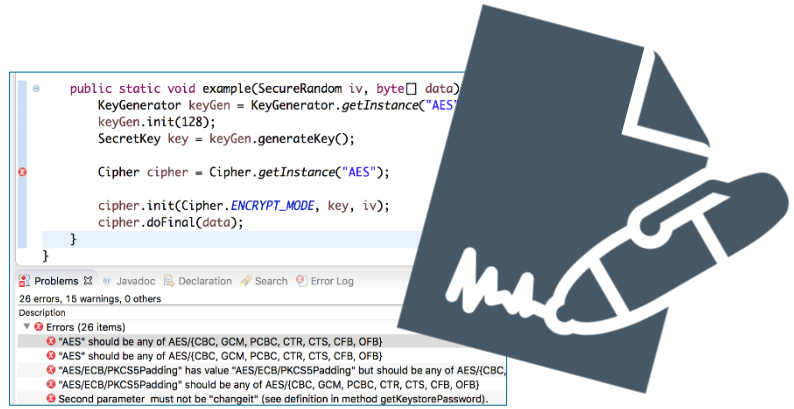


CogniCrypt$_{SAST}$



CogniCrypt$_{SAST}$ – Detection of Crypto-API Misuses

CogniCrypt$_{SAST}$



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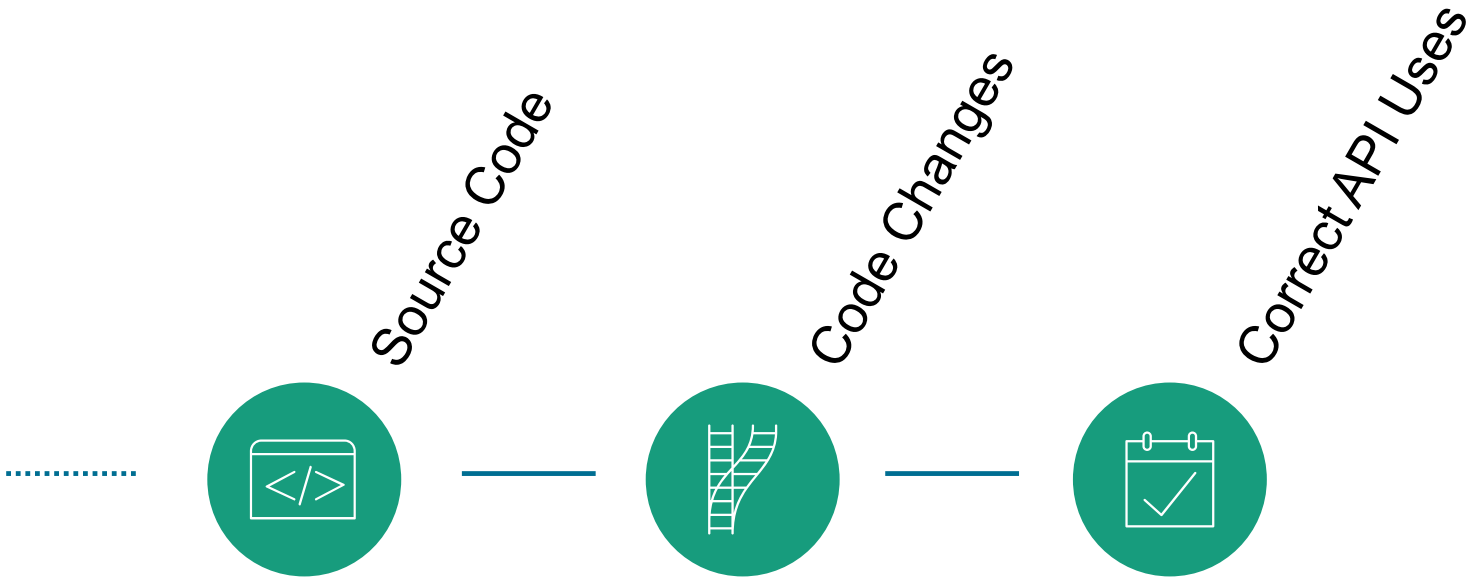

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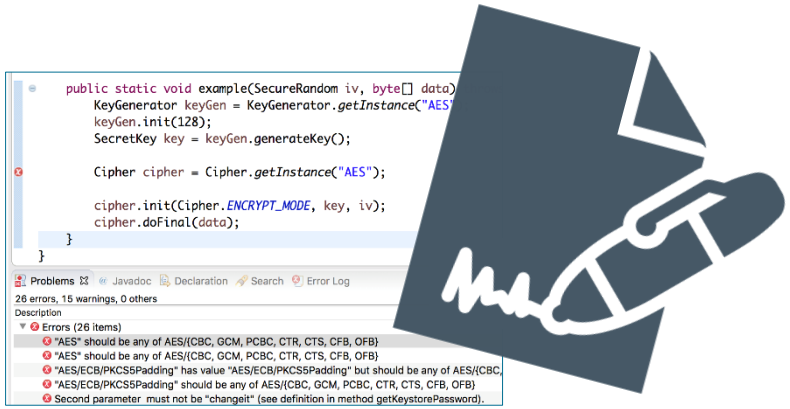

[CrySL: An Extensible Approach to Validating the Correct Usage of Cryptographic APIs. Stefan Krüger, Johannes Spaeth, Karim Ali, Eric Bodden, Mira Mezini. ECOOP 2018.]

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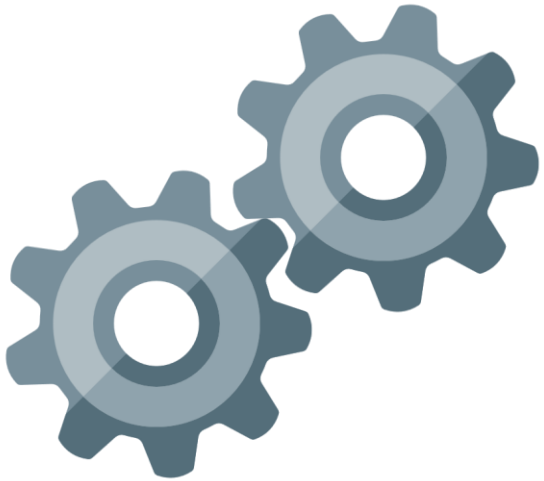
…within Eclipse…!

Save

Static Analysis



Error Markers

Main Error Types of CogniCrypt$_{SAST}$

Incorrect Usage Pattern

Insecure Parameters

Insecure Class Composition

I.E. Error Type: Insecure Parameters

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KeyGenerator keyGen = KeyGenerator.getInstance("AES");
keyGen.init(128);
SecretKey key = keyGen.generateKey();

Cipher cipher = Cipher.getInstance("AES");
cipher.init(Cipher.ENCRYPT_MODE, key, iv);
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```

„AES“ should rather be „AES/{CBC/GCM}“

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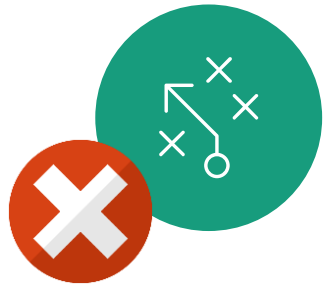
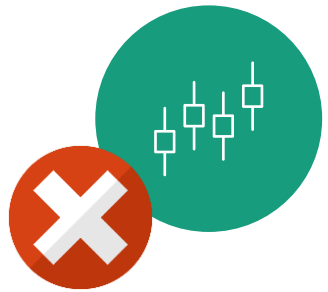
CrySL – Specifiying The Use of Crypto APIs (1/2)

```
SPEC javax.crypto.KeyGenerator
OBJECTS
    int keySize;
    javax.crypto.SecretKey key;
    java.lang.String alg;
EVENTS
    g1: getInstance(alg);
    g2: getInstance(alg, _);
    Gets := g1 | g2;
    i1: init(keySize);
    i2: init(keySize, _);
    i3: init(_);
    i4: init(_, _);
    Inits := i1  | i2 | i3 | i4;
    gk: key = generateKey();
```

```
ORDER
    Gets, Inits?, gk
```



```
CONSTRAINTS
 alg in {"AES"} => keySize in {128, 192, 256};
 alg in {"DES"} => keySize in {56};
 alg in {"Blowfish"} => keySize in {40, 44, 48,
52, 56, ..., 436, 440};
```



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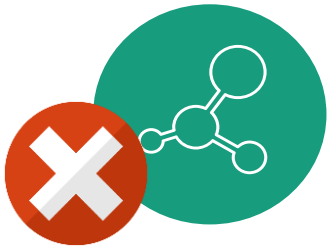
CrySL – Specifiying The Use of Crypto APIs (2/2)

```
ENSURES
    generatedKey(key,alg);
```



```
SPEC javax.crypto.Cipher
…
REQUIRES
  generatedKey(key, alg(transformation));
ENSURES
    encrypted(plainText, cipherText);
```

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CrySL Rules for the Java Cryptographic Architecture (JCA)

Encryption & Decryption

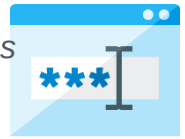
Signing & Verification

Key Generation

23 Classes & Interfaces

Randomness

Hashing and MACs



Persisting of Key Material

[CrySL: An Extensible Approach to Validating the Correct Usage of Cryptographic APIs. Stefan Krüger, Johannes Spaeth, Karim Ali, Eric Bodden, Mira Mezini. ECOOP 2018.]

Evaluation - Android

10k Android Apps

96% of these Apps are insecure

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Evaluation - Maven

2.7+ Million Software Artefacts

73% of these Artefacts are insecure

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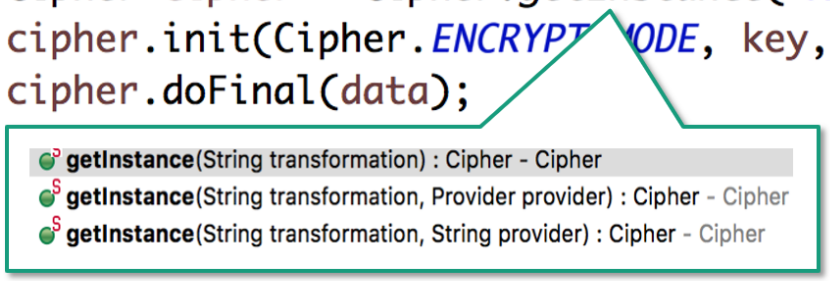

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When a De

KeyGenera
keyGen.in
SecretKey

Cipher ci
cipher.in
cipher.do

getInstance(
getInstance(
getInstance(

What shall we do about it?

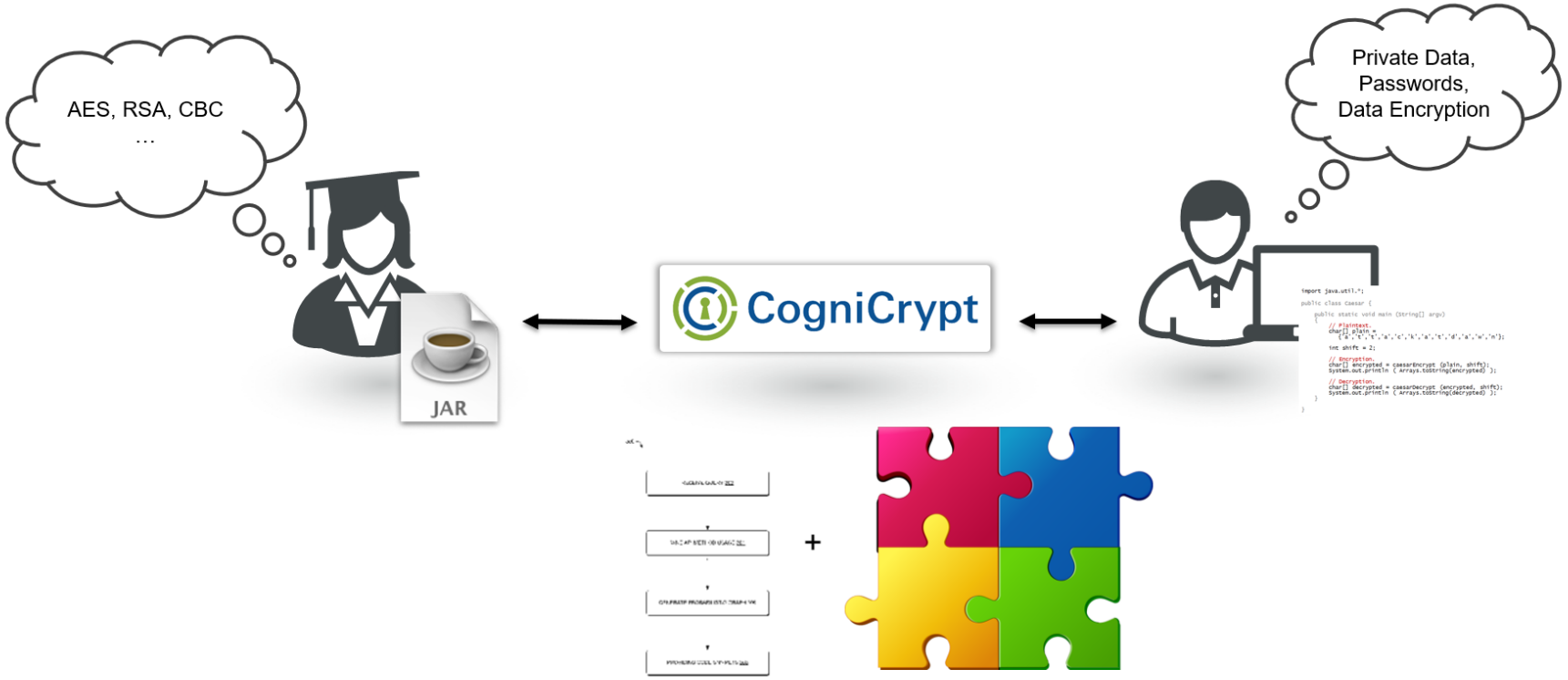

FIG. 3

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CogniCrypt‘s Components

KeyGener
keyGen.i
SecretKe

Cipher c
cipher.i
cipher.d

getInstan
getInstan
getInstan

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words,
cryption

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```

getInstance(String transformation) : Cipher - Cipher
getInstance(String transformation, Provider provider) : Cipher - Cipher
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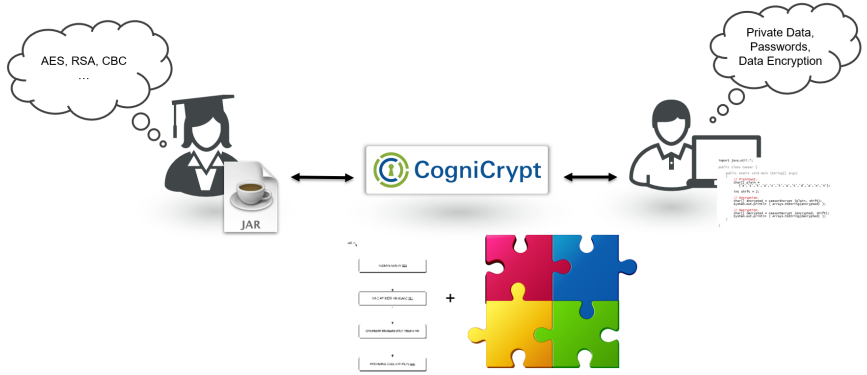
What shall we do about it?



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