10th UCAAT User Conference on Advanced Automated Testing

ETSI The Standards People

Testability Tarpits: the Impact of Code Patterns on the Security Testing of Software Applications

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About me and others that contributed…

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Funded by EU project TESTABLE

https://www.testable.eu/

joint work with:

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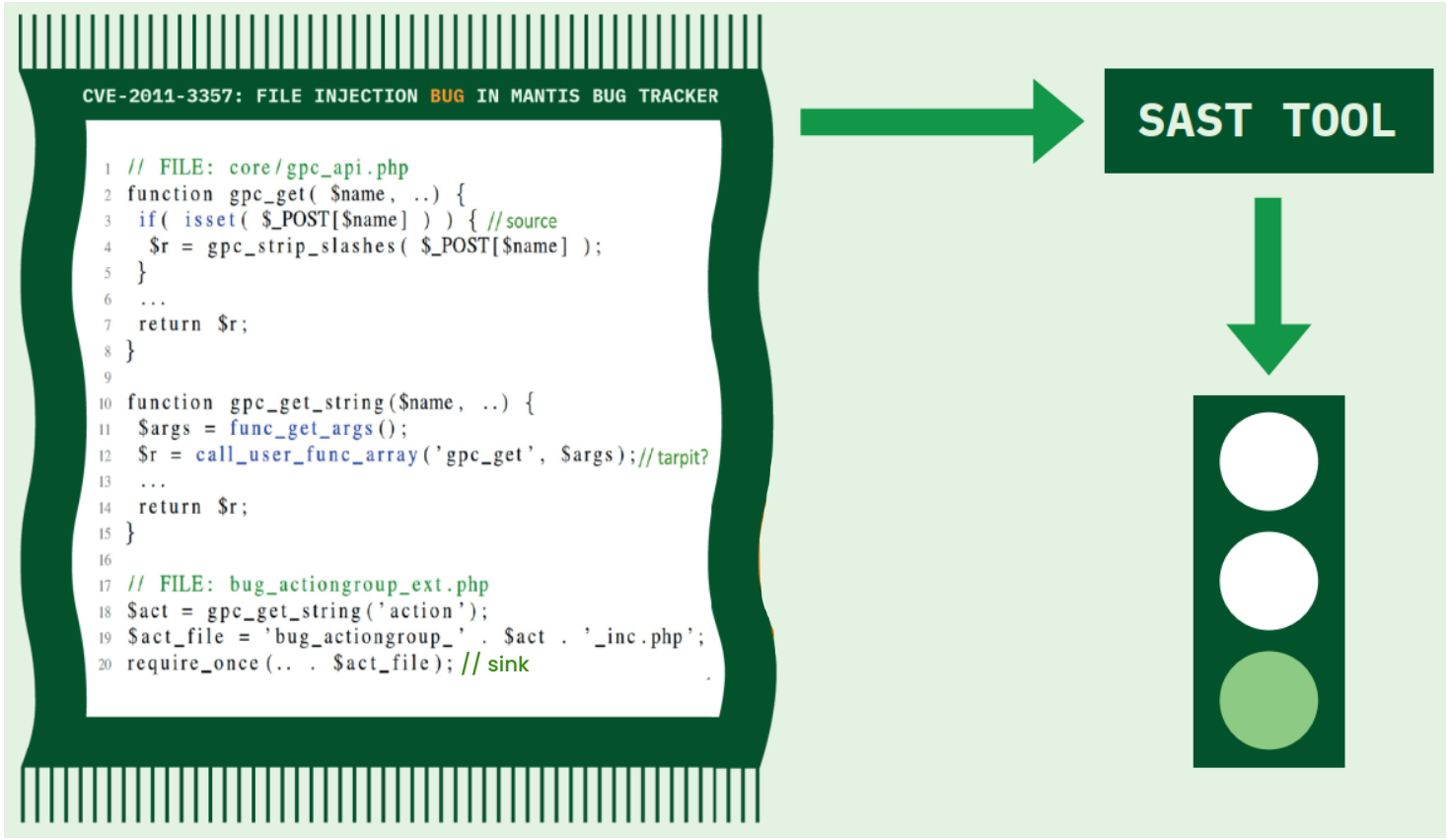
Context: SAST and testability

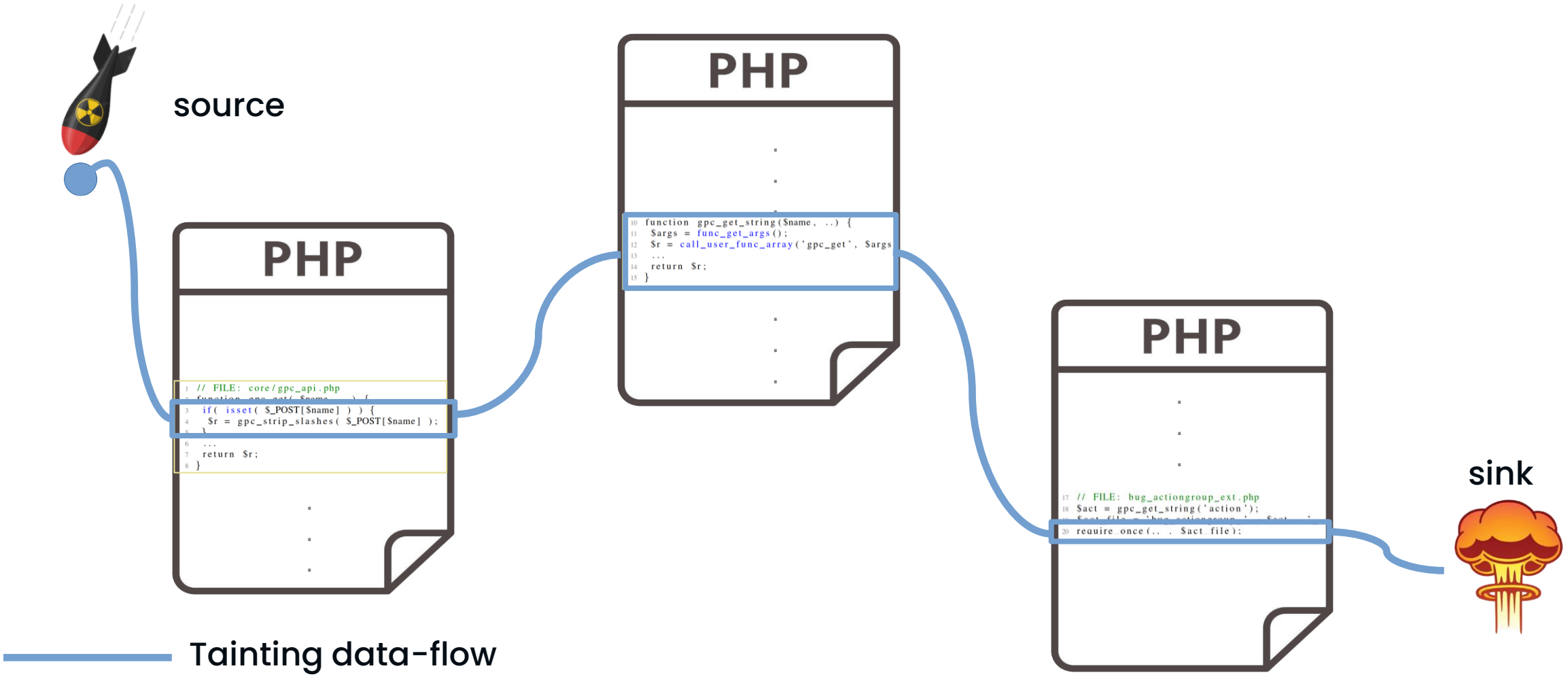
Static application security testing (SAST) is widely used in industry to detect vulnerabilities [1]



[1] OWASP Code Review Guide v2.0, cf. Figure 1 and Figure 2

Context: Injection vulnerabilities

Any attacker-controlled data (source) flowing in a dangerous operation (sink) without sanitization?



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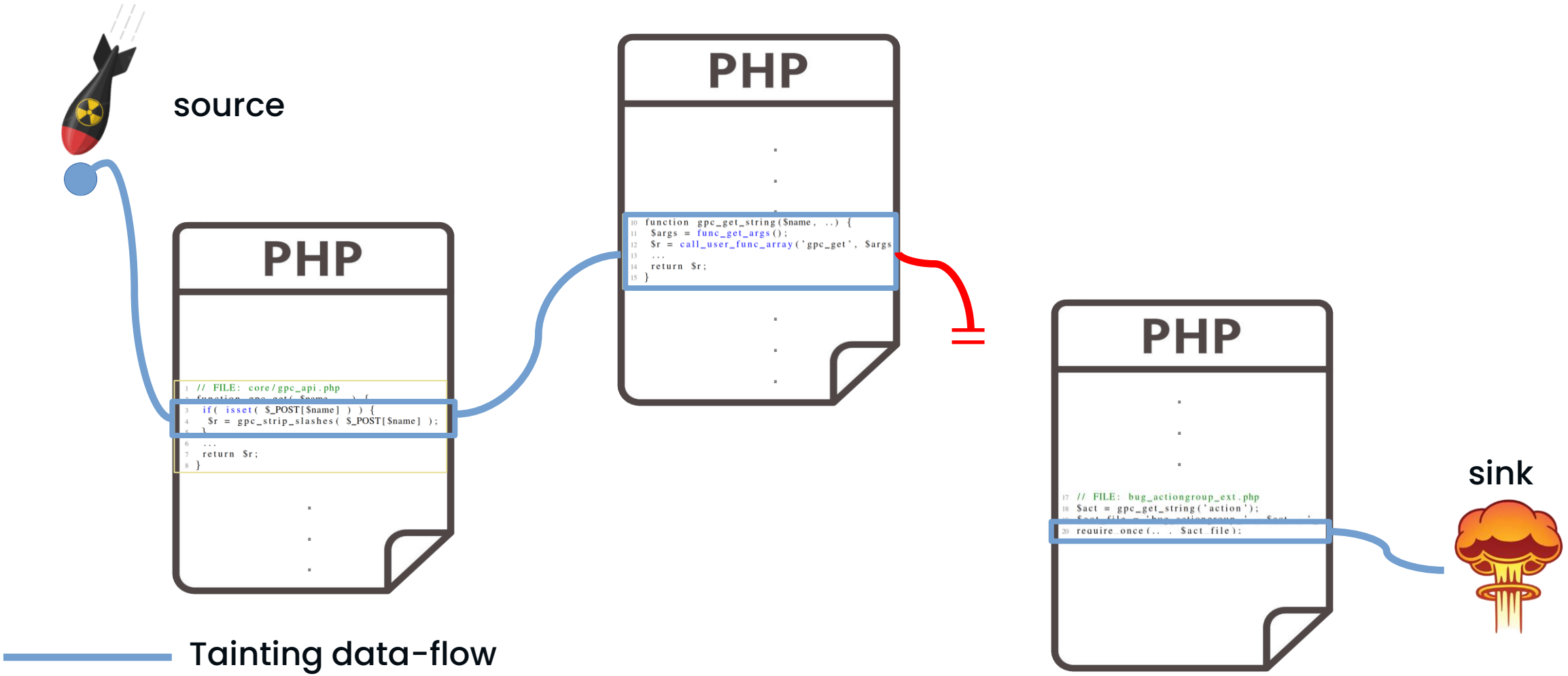

Context: SAST and testability

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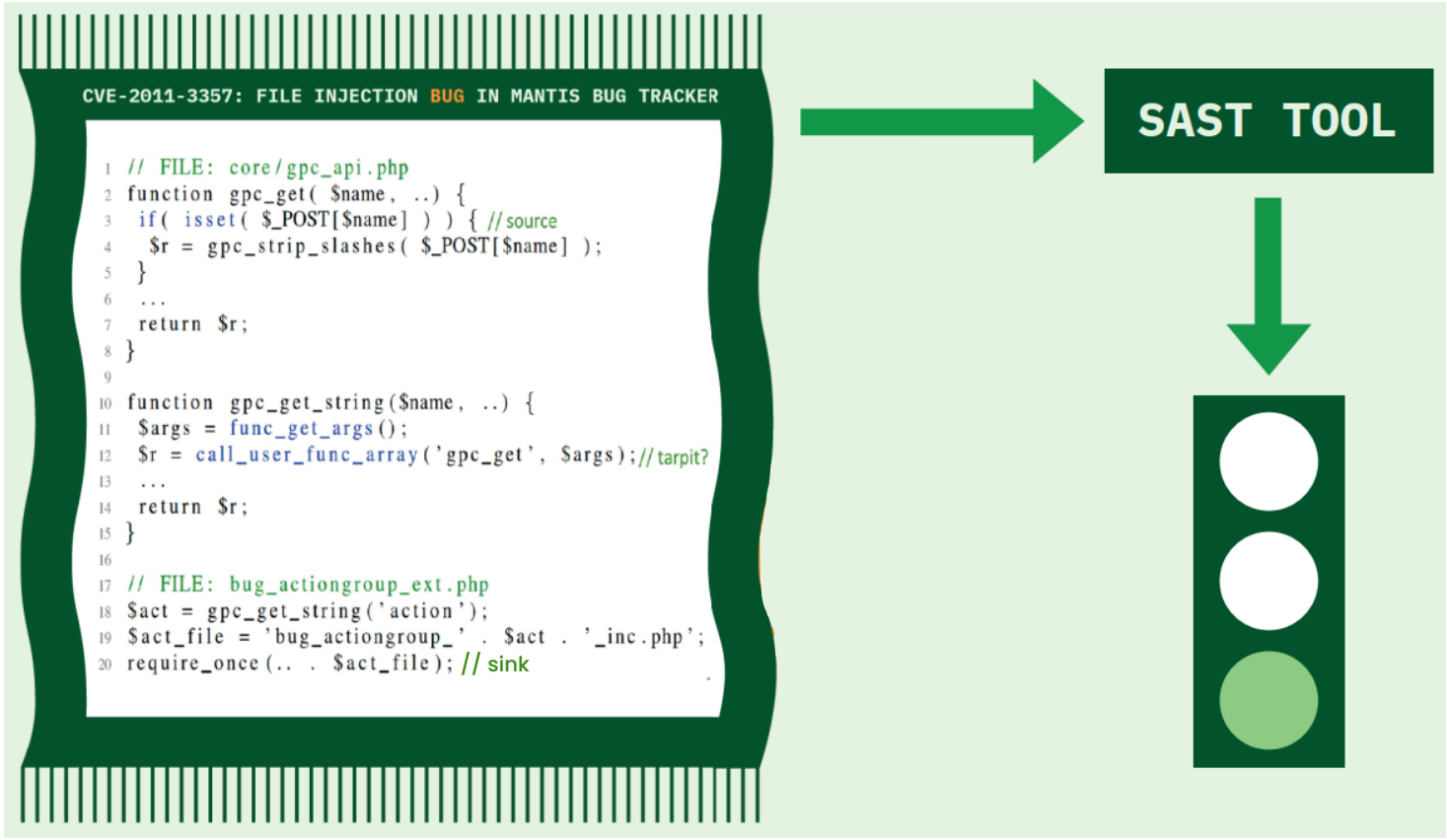

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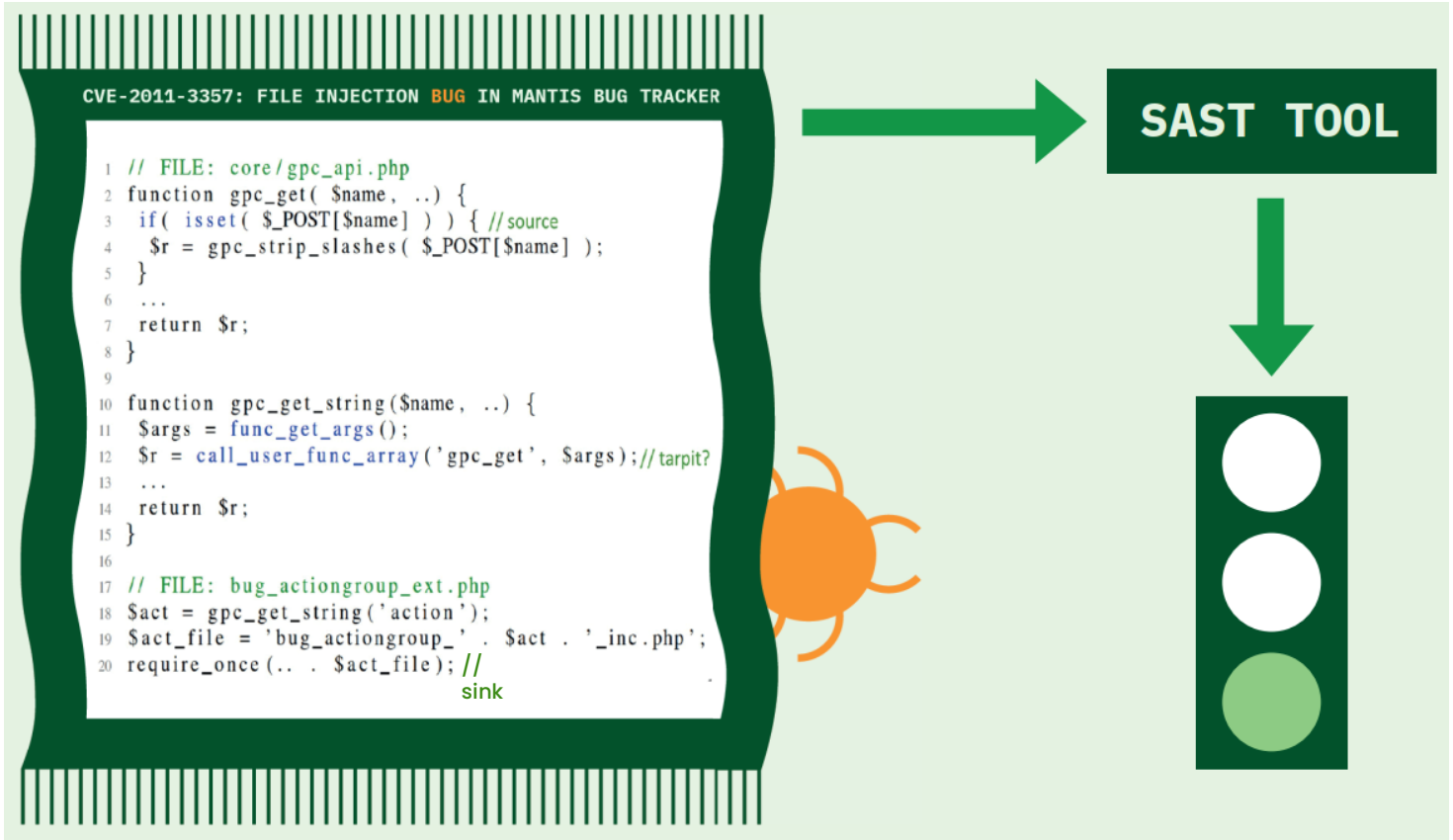

Was all the code analyzed?

No bugs under the carpet?

Research questions

Code obstacles impacting SAST?

Can we measure these obstacles?

Can we discover/remediate them?

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CVE-2011-3357: File inclusion in mantis bug tracker

```
20 require_once(.. . $act_file); // sink
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CVE-2011-3357: File inclusion in mantis bug tracker

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4    $r = gpc_strip_slashes( $_POST[$name] );
5   }
6   ...
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```

POST
https://mantisb.com/service

action=<ATTACKER_PAYLOAD>

Toward testability patterns for SAST

Many **SAST tools** (including commercial ones) do **not find** that **File inclusion**

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```

vulnerable app

pattern creation (1)

```
// replace with
// code companion for the obstacle
//
$a = $_GET[“p1”]; // source
$b = $a // replace with obstacle!
echo $b; // sink
```

testability pattern skeleton (baseline XSS)

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```

vulnerable app

pattern creation (1)

```
function F($var) {  // code companion
  return $var;      // for the obstacle
}                   //
$a = $_GET["p1"]; // source
$b = call_user_func_array("F", [$a]); // obstacle
echo $b; // sink
```

testability pattern instance

pattern transformation (3)

```
12  $r = gpc_get(...$args); // no obstacle anymore
```

SAST measurement (2)

SAST	Correct
RIPS	NO
phpSAFE	NO
WAP	NO
Progpilot	YES
Comm_2	NO
Comm_1	YES

After that **transformation**, commercial tool Comm_2 **finds** the **File inclusion!**

Many variants of that pattern can be created…

```
function F($var) {  // code companion
  return $var;      // for the obstacle
}                   //
$a = $_GET[“p1”]; // source
$b = call_user_func_array(“F”, [$a]); // obstacle
echo $b; // sink
```

instance 1

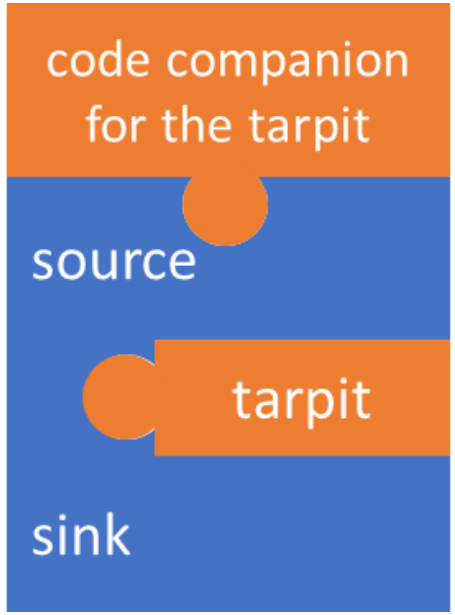
```
function F($var) {  // code companion
  return $var;      // for the obstacle
}                   //
$a = $_GET[“p1”]; // source
$f = “F”; // obstacle
$b = call_user_func_array($f, [$a]); // obstacle
echo $b; // sink
```

instance 2

```
function F_1($var) {  // code companion
  return $var;        // for the obstacle
}                     //
function F_2($var) {  //
  return “foo”;       //
}                     //
$a = $_GET[“p1”]; // source
$f = $_GET[“Func_id”]; // obstacle
$b = call_user_func_array(“F_”.$f, [$a]); // obstacle
echo $b; // sink
```

instance 3

…



Testability Patterns for SAST

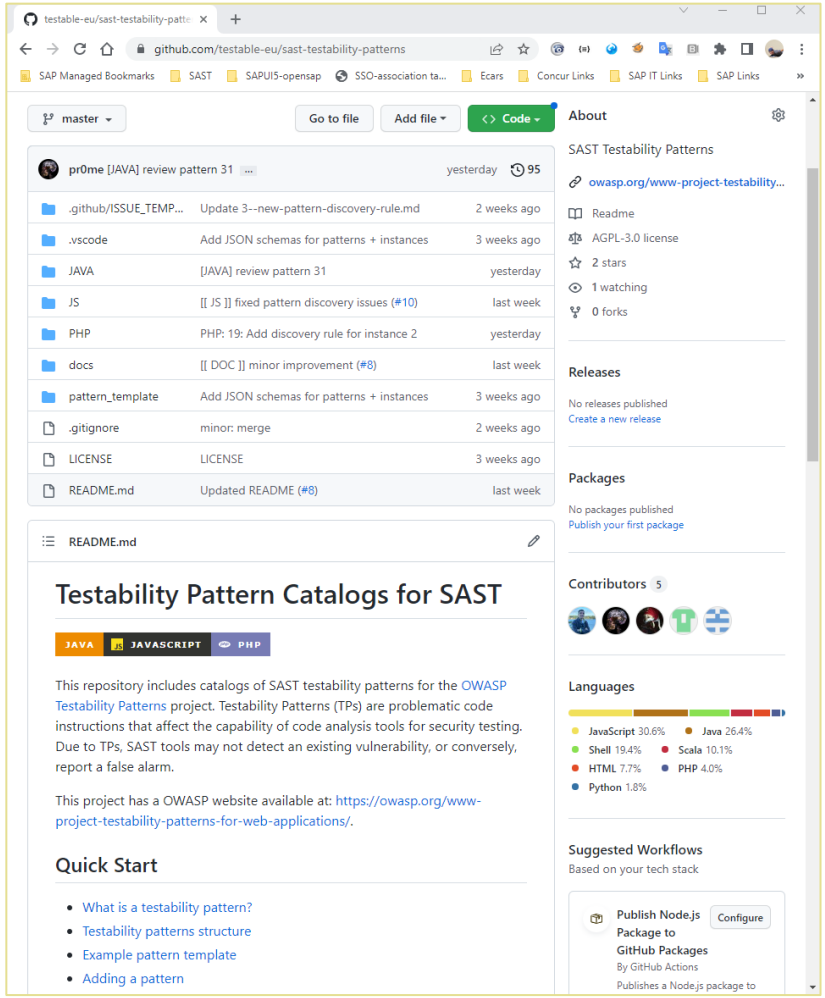
Targeted **3** popular **languages**

- **PHP**: ~120 pattern instances
- **JS**: ~150 pattern instances
- **Java**: ~200 pattern instances

We inspected the entire language manual

What do we want to do with them?

- SAST tools **measurement**
- **Discover** patterns into applications
- Remediate patterns to increase testability



https://github.com/testable-eu/sast-testability-patterns

Testability Patterns Framework for SAST

Framework provides operations for

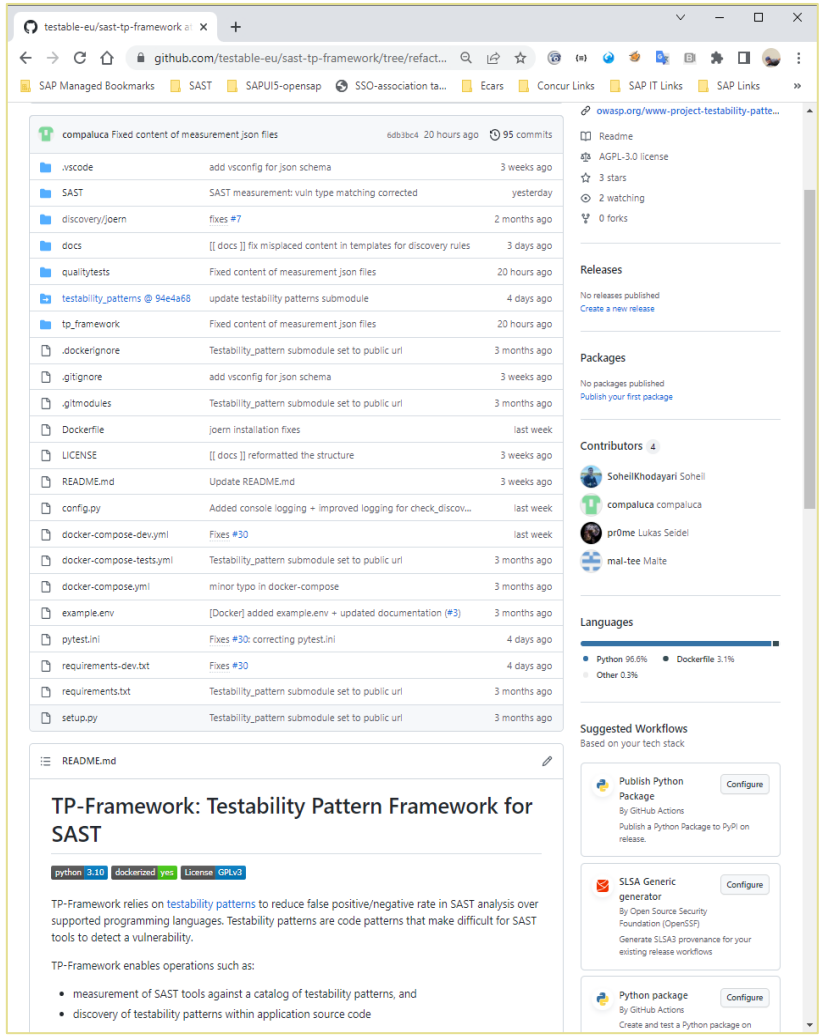
- SAST tools **measurement** (e.g., codeql integrated)
- **Discover** patterns into apps (via Joern and Scala queries)

```
tpframework measure -l JS -p 1 2 --tools codeql:2.9.2

tpframework discovery -t MYAPP/ -l PHP –a --tools T1:V1 T2:V2
```

Results spoiler

1. Measurement: many SAST tools struggle on our patterns
2. Discovery: many apps in Github use these patterns
3. Testability for SAST can be improved!

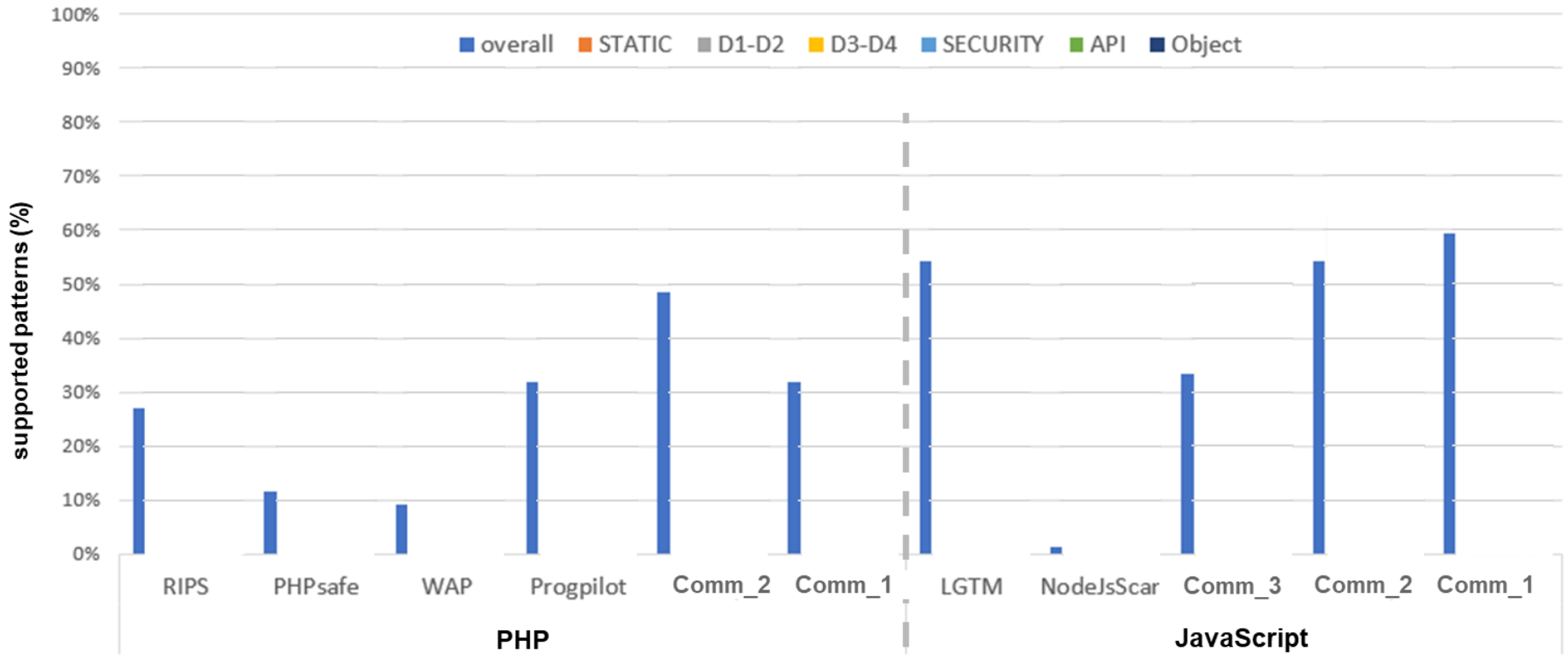


https://github.com/testable-eu/sast-tp-framework

1. Measurement: many SAST tools struggle on our patterns

Measured our pattern instances against **SAST**

- Overall: <50% support for PHP and <60% for JS
- Tools Combination: 66% PHP, 82% JS

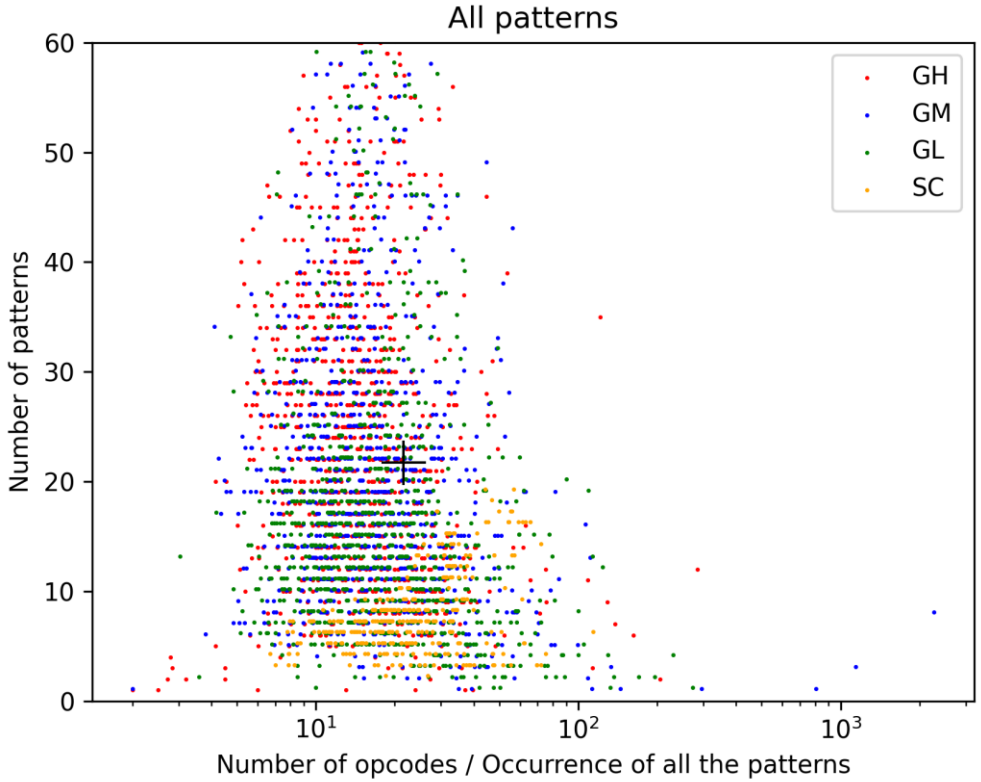


2. Discovery: many apps in Github use these patterns

PHP: created **discovery rules** for our patterns and run them over **>3000** open-source PHP **apps** (from Github and Sourcecodester)

Our patterns are very **prevalent** in the real world

	Unique obstacles per Project	obstacles per LoC
AVG	21	20



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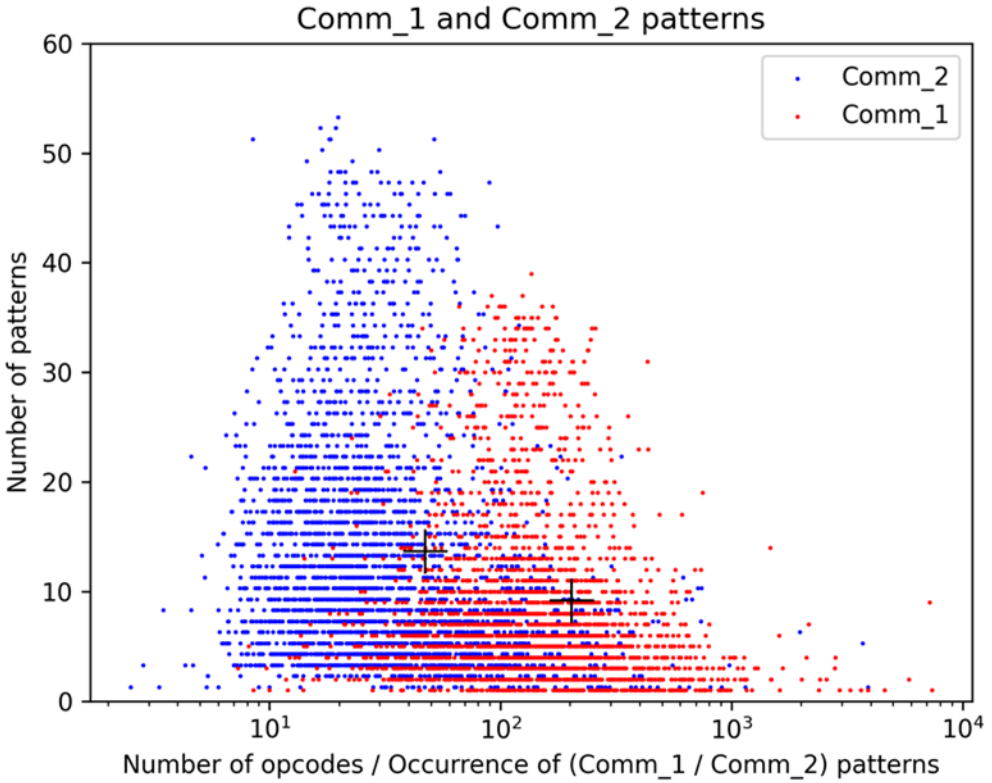
Comm_1	8	203
Comm_2	13	47



3. Testability for SAST can be improved!

Remediation 1: Two **transformation experiments** targeting PHP and JS

- transformations intended as code rewriting for obstacles
- **>9000 new alerts**: **370 true positives** in 48 apps (over ~2700 alerts inspected)
- **182** true positives **already confirmed** from 31 projects: 38 impacting popular Github projects

Remediation 2: improve SAST tools *(e.g., our paper at USENIX 2023)*

Remediation 3: provide **custom rules** to make SAST tools overcoming obstacles *(on-going work)*

A new OWASP project: journey started

Targeting the **Testability** dimension

First concrete result: **Testability Patterns for SAST**

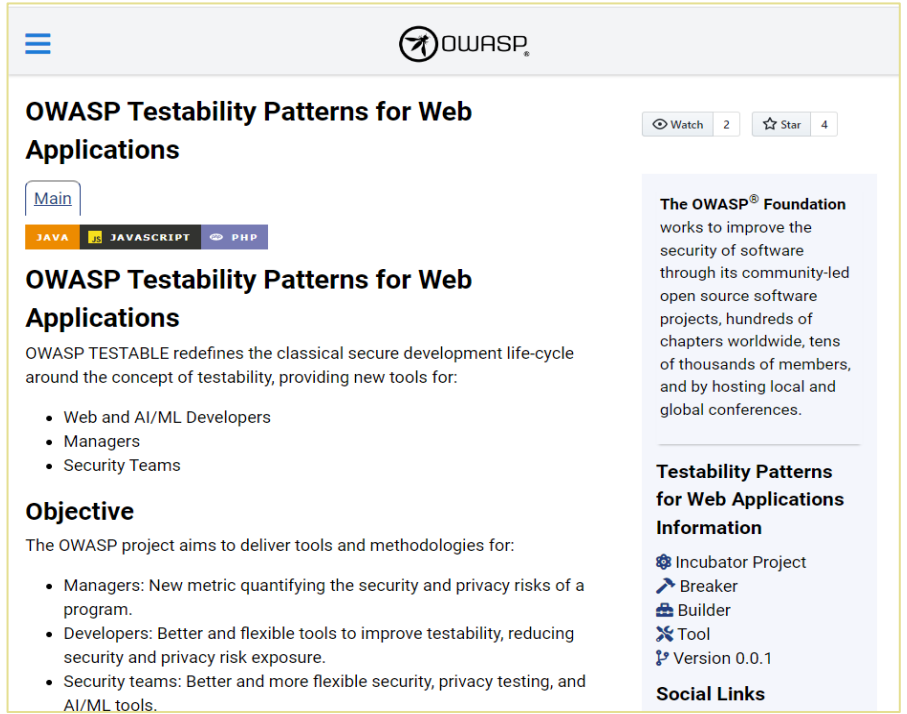
- https://github.com/testable-eu/sast-testability-patterns
- https://github.com/testable-eu/sast-tp-framework

Interested to contribute with your valuable expertise?

https://owasp.org/www-project-testability-patterns-for-web-applications/

Let us devise OWASP top 10 testability patterns for SAST!

Can we do the same for DAST, Privacy, ML?



Any further questions?