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Foreword

This document explores three common OWASP Enterprise Security API (ESAPI) design patterns. OWASP ESAPI toolkits help software developers guard against security-related design and implementation flaws. Just as web applications and web services can be Public Key Infrastructure (PKI) enabled (PK-enabled) to perform for example certificate-based authentication, applications and services can be OWASP ESAPI-enabled (ES-enabled) to enable applications and services to protect themselves from attackers.

We’d Like to Hear from You

Further development of ESAPI occurs through mailing list discussions and occasional workshops, and suggestions for improvement are welcome. Please address comments and questions concerning the API and this document to the ESAPI mail list, owasp-esapi@lists.owasp.org

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1 About ESAPI

OWASP ESAPI Toolkits are designed to ensure that strong simple security controls are available to every developer in every environment. All OWASP ESAPI versions work in the same basic way, as depicted in the figure below.

Figure 1: How ESAPI works out of the box from a programmer’s perspective

Allowing for language-specific differences, all OWASP ESAPI versions have the same basic design:

- There is a set of security control interfaces. There is no application logic contained in these interfaces. They define for example types of parameters that are passed to types of security controls. There is no proprietary information or logic contained in these interfaces.

- There is a reference implementation for each security control. There is application logic contained in these classes, i.e. contained in these interface implementations. However, the logic is not organization-specific and the logic is not application-specific. There is no proprietary information or logic contained in these reference implementation classes. An example: string-based input validation.

- There are optionally your own implementations for each security control. There may be application logic contained in these classes which may be developed by or for your organization. The logic may be organization-specific and/or application-specific. There may be proprietary information or logic contained in these classes which may be developed by or for your organization. An example: enterprise authentication.

There are three common ways to write your own implementations for each security control: using a “built-in” singleton pattern, using an “extended” singleton pattern, or using an “extended” factory pattern. The remainder of this document explores these three design patterns, including situations where taking more than one approach may be appropriate.
2 The Built-In Singleton Pattern

The ESAPI security control interfaces include an “ESAPI” class that is commonly referred to as a “locator” class. The ESAPI locator class is called in order to retrieve singleton instances of individual security controls, which are then called in order to perform security checks (such as performing an access control check) or that result in security effects (such as generating an audit record).

The “built-in” singleton pattern refers to the replacement of security control reference implementations with your own implementations. ESAPI interfaces are otherwise left intact.

For example:

```php
... require_once dirname(__FILE__) . '/../Authenticator.php'; ...

class MyAuthenticator implements Authenticator { //your implementation ...

Developers would call ESAPI in this example as follows:

```php
...
$ESAPI = new ESAPI();
$myauthenticator = new MyAuthenticator();
$ESAPI::setAuthenticator($myauthenticator); //register with locator class
$authenticator = $ESAPI::getAuthenticator();
$authenticator->login(...); //use your implementation ...
```

The UML for the above example is in the figure below.

![UML Diagram](image-url)

**Figure 2: Built-In Singleton Pattern Example**
Pros of taking this approach include loose coupling between ESAPI and your own implementations.

Cons include the need for developers to understand how to call ESAPI functions with the parameters required by your organization and/or application.
3 The Extended Singleton Pattern

While ESAPI security control reference implementations may perform the security checks and result in the security effects required by your organization and/or application, there may be a need to minimize the need for developers to understand how to call ESAPI functions with the parameters required by your organization and/or application. Availability of training may be an issue, for example. Another example would be to facilitate enforcing a coding standard.

The “extended” singleton pattern refers to the replacement of security control reference implementations with your own implementations and the addition/modification/subtraction of corresponding security control interfaces.

For example:

```php
require_once dirname(__FILE__) . '/../Validator.php';

class DefaultValidator implements Validator { //reference implementation
    function isValidEmployeeID($eid) { //not defined in Validator interface
        ...
    }
}
```

Developers would call ESAPI in this example as follows:

```php
$ESAPI = new ESAPI();
$validator = ESAPI::getValidator();
$validator->isValidEmployeeID(1234);
```

The UML for the above example is in the figure below.

![UML Diagram](image-url)

Figure 3: Extended Singleton Pattern Example
Pros of taking this approach are the lessening of the need for developers to understand how to call ESAPI functions with the specific parameters required by your organization and/or application. Pros also include minimizing or eliminating the ability for developers to call ESAPI functions that deviate from your organization’s and/or application’s policies.

Cons result from the tight coupling between ESAPI and your own implementations: you will need to maintain both the modified security control reference implementations and the modified security control interfaces (as new versions of ESAPI are released over time).
4 The Extended Factory Pattern

While ESAPI security control reference implementations may perform the security checks and result in the security effects required by your organization and/or application, there may be a need to eliminate the ability of developers to deviate from your organization’s and/or application’s policies. High developer turnover may be an issue, for example. Another example would be to strongly enforce a coding standard.

The “extended” factory patterns refers to the addition of a new security control interface and corresponding implementation, which in turn calls ESAPI security control reference implementations and/or security control reference implementations that were replaced with your own implementations. The ESAPI locator class would be called in order to retrieve a singleton instance of your new security control, which in turn would call ESAPI security control reference implementations and/or security control reference implementations that were replaced with your own implementations.

For example:

In the ESAPI locator class:

```php
... class ESAPI {
    ... private static $adapter = null; // not defined in ESAPI locator class
    ...
    public static function getAdapter() { // new function
        if ( is_null(self::$adapter) ) {
            require_once dirname(__FILE__).'/adapters/MyAdapter.php';
            self::$adapter = new MyAdapter();
        }
        return self::$adapter;
    }
    ...
    public static function setAdapter($adapter) { // new function
        self::$adapter = $adapter;
    }
}
```

In the new security control class’ interface:

```php
interface Adapter { // new interface
    function getValidEmployeeID($eid);
    function isValidEmployeeID($eid);
}
```

In the new security control class:
require_once dirname ( __FILE__ ) . '/../Adapter.php';

class MyAdapter implements Adapter { //new class with your implementation

function getValidEmployeeID($eid) { //for your new interface
    $val = ESAPI::getValidator(); //calls reference implementation
    $val->getValidInput( //calls using hardcoded parameters
        "My Organization's Employee ID",
        $eid,
        "EmployeeID", //regex defined in ESAPI configuration file
        4,
        false
    );
}

function isValidEmployeeID($eid) { //for your new interface
    try {
        $this->getValidEmployeeID($eid);
        return true;
    } catch (Exception $e) {
        return false;
    }
}

Developers would call ESAPI in this example as follows:

$ESAPI = new ESAPI();
$adapter = ESAPI::getAdapter();
$adapter->isValidEmployeeID(1234); //no other ESAPI controls called directly

The UML for the above example is in the figure below.

![UML Diagram for Extended Factory Pattern Example]

**Figure 4: Extended Factory Pattern Example**

Pros of taking this approach are the same as for the extended singleton pattern, and additionally include loose coupling between ESAPI and your own implementations, compared to the extended singleton pattern.

Cons include the need to maintain the modified ESAPI locator class (as new versions of ESAPI are released over time).
5 Where to Go From Here

OWASP is the premier site for Web application security. The OWASP site hosts many projects, forums, blogs, presentations, tools, and papers. Additionally, OWASP hosts two major Web application security conferences per year, and has over 80 local chapters. The OWASP ESAPI project page can be found here http://www.owasp.org/index.php/ESAPI

The following OWASP projects are most likely to be useful to users/adopters of ESAPI:

- OWASP Top Ten Project - http://www.owasp.org/index.php/Top_10

Similarly, the following Web sites are most likely to be useful to users/adopters of ESAPI:

- OWASP - http://www.owasp.org
- PCI Security Standards Council - publishers of the PCI standards, relevant to all organizations processing or holding credit card data, https://www.pcisecuritystandards.org
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