# SECURITY BOOT CAMP FOR .NET DEVELOPERS

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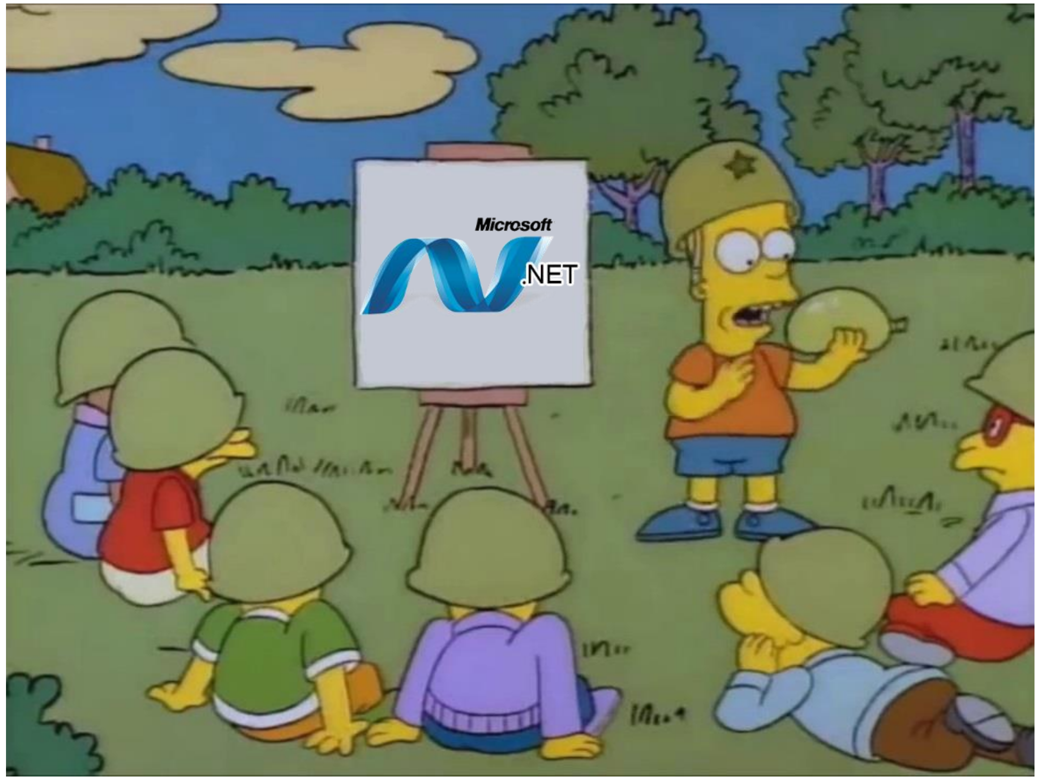
## WHO AM I ?

- Philippe Arteau
- Security Researcher at GoSecure
- Open-source developer
  - ~~.NET Security Guard~~ Security Code Scan (Roslyn – Static Analysis for .NET)
  - Find Security Bugs (SpotBugs - Static Analysis for Java)
  - Burp and ZAP Plugins (Retire.js, CSP Auditor)

- Volunteer for the nsec conference and former trainer

# AGENDA

- Introduction
- Vulnerabilities in .NET Context
  - Path Traversal
  - XSS
  - Cryptography
  - Hardcoded secret
- Automating Checks
  - Visual Studio / MsBuild
- Recent Trends
  - Deserialization
  - Double Parsing
- Methodology for Code Review
- Conclusion



# INTRODUCTION

## SECURITY CODE REVIEW

- Code review is the systematic examination of source code[1] with the specific goal of findings security bugs.

- Security Bugs?
  - Injections
  - XSS
  - Cryptographic weakness
  - Logic flaw
  - And many more...

[1] Wikipedia: Code review

## WHY SECURITY CODE REVIEW?

- Complementary to dynamic techniques (penetration testing, fuzzing, etc.)
- Every technique has its advantages

- Code review advantages:
  - Coverage
  - Finding all instances of a vulnerability
  - Accessible activity for developer
  - Excellent for doing defense in depth

## VULNERABILITIES IN .NET CONTEXT

# PATH TRAVERSAL

- SQL injection are *easy* to manage with **prepare statement**
- **Path traversal** is a source of injection that is often overlooked

- When does it matter?
  - File upload (writing to filesystem)
  - Document loading (reading from filesystem)
  - Can be applied in rare cases to URL [1]

[1] Example: https://sakurity.com/blog/2015/03/15/authy_bypass.html

# CROSS-SITE SCRIPTING (XSS)

- Encoding with Razor template is usually secure
  - HTML entities are escaped by default

Special cases

- Use of `@Html.Raw()`
- Placing values in JavaScript **/!\**
- JavaScript client-side template

**DEMO**

## PADDING ORACLE AND INTEGRITY

- .NET Framework provided symetric encryption primitive
  - Namespace System.Security.Cryptography
  - Include the mode: CBC, ECB, OFB, …
  - Does not provided integrity

DEMO

# HARDCODED PASSWORD

- Password
- Service account
- API keys

- Store value in configuration
- Encrypt the value

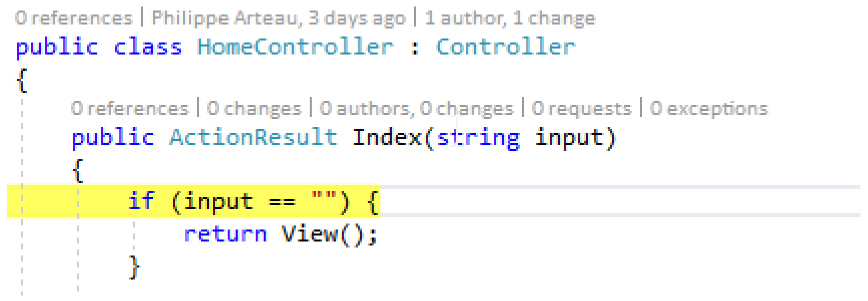
**Identity Server**

```
new Client
 {
       ClientId = "client",
       AllowedGrantTypes = GrantTypes.ClientCredentials,
       ClientSecrets =
       {
          new Secret("secret".Sha256())
       },
       AllowedScopes = { "api1" }
   }
```

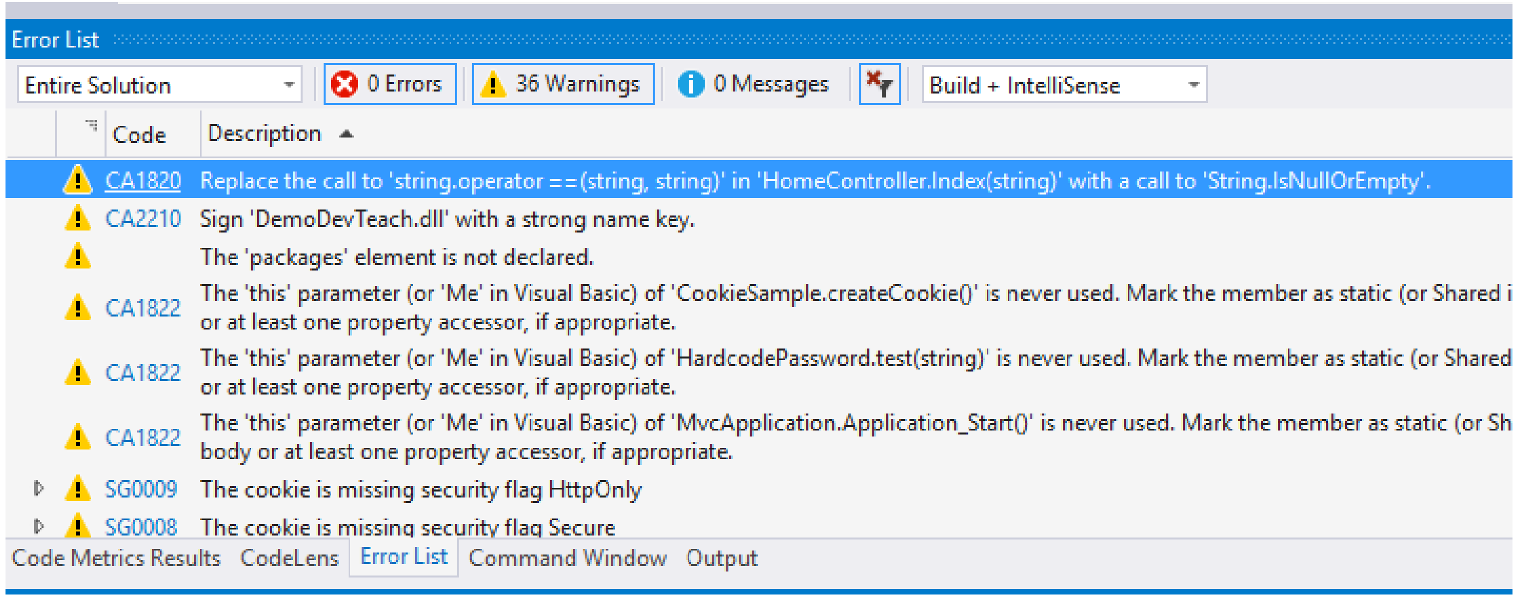
## AUTOMATING CHECKS

# AUTOMATE CODE ANALYSIS

- Identifying bugs and vulnerabilities is nice but…



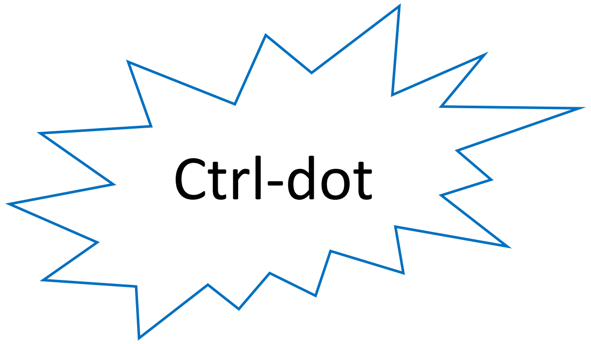
```
0 references | Philippe Arteau, 3 days ago | 1 author, 1 change
public class HomeController : Controller
{
    0 references | 0 changes | 0 authors, 0 changes | 0 requests | 0 exceptions
    public ActionResult Index(string input)
    {
        if (input == "") {
            return View();
        }
```

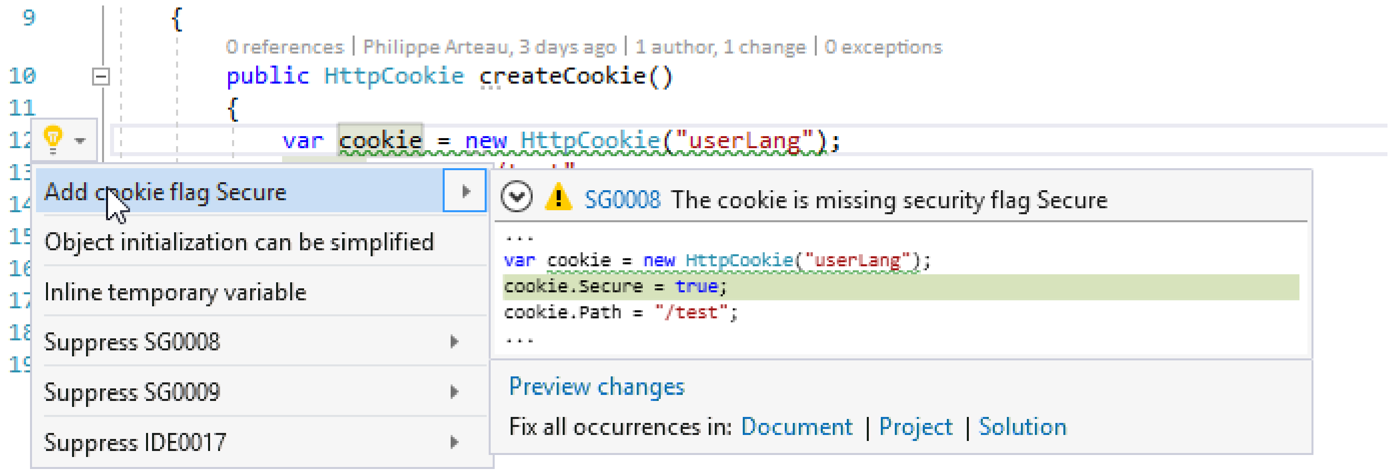


| Code | Description |
|---|---|
| CA1820 | Replace the call to 'string.operator ==(string, string)' in 'HomeController.Index(string)' with a call to 'String.IsNullOrEmpty'. |
| CA2210 | Sign 'DemoDevTeach.dll' with a strong name key. |
| | The 'packages' element is not declared. |
| CA1822 | The 'this' parameter (or 'Me' in Visual Basic) of 'CookieSample.createCookie()' is never used. Mark the member as static (or Shared i or at least one property accessor, if appropriate. |
| CA1822 | The 'this' parameter (or 'Me' in Visual Basic) of 'HardcodePassword.test(string)' is never used. Mark the member as static (or Shared or at least one property accessor, if appropriate. |
| CA1822 | The 'this' parameter (or 'Me' in Visual Basic) of 'MvcApplication.Application_Start()' is never used. Mark the member as static (or Sh body or at least one property accessor, if appropriate. |
| SG0009 | The cookie is missing security flag HttpOnly |
| SG0008 | The cookie is missing security flag Secure |

# AUTOMATE CODE REFACTORING

- Remediation is event better!





```
{
    0 references | Philippe Arteau, 3 days ago | 1 author, 1 change | 0 exceptions
    public HttpCookie createCookie()
    {
        var cookie = new HttpCookie("userLang");
```

Add cookie flag Secure
Object initialization can be simplified
Inline temporary variable
Suppress SG0008
Suppress SG0009
Suppress IDE0017

SG0008 The cookie is missing security flag Secure

```
...
var cookie = new HttpCookie("userLang");
cookie.Secure = true;
cookie.Path = "/test";
...
```

Preview changes
Fix all occurrences in: Document | Project | Solution

- Some vulnerabilities require high-level understanding of the application

## Security Code Scan
## Demo

roslyn + Visual Studio

DEMO

## RECENT TRENDS

# JSON DESERIALISATION

- History repeats itself
  - 2016: Numerous Java application were found vulnerable to native deserialization
  - 2017: Researchers [1] found issues in .NET JSON serializer
    - Some libraries have issued updates
    - The vulnerability was called: JSON Friday 13th

- Two ingredients needed for a successful attack
  - Gadgets
  - Unsafe deserialization

[1] Alvaro Muñoz, Oleksandr Mirosh and James Forshaw

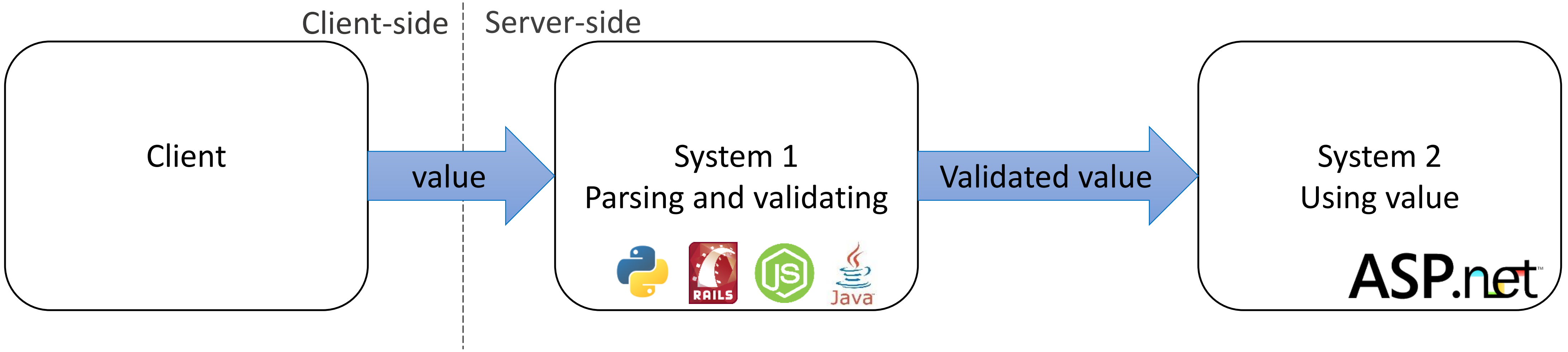
# JSON DESERIALIZATION

Affected librairies

- FastJSON
- Json.NET (use of TypeNameHandling.All)
- FSPickler
- Sweet.Jayson
- JavascriptSerializer
- DataContractJsonSerializer

Ref: https://www.blackhat.com/docs/us-17/thursday/us-17-Munoz-Friday-The-13th-JSON-Attacks-wp.pdf

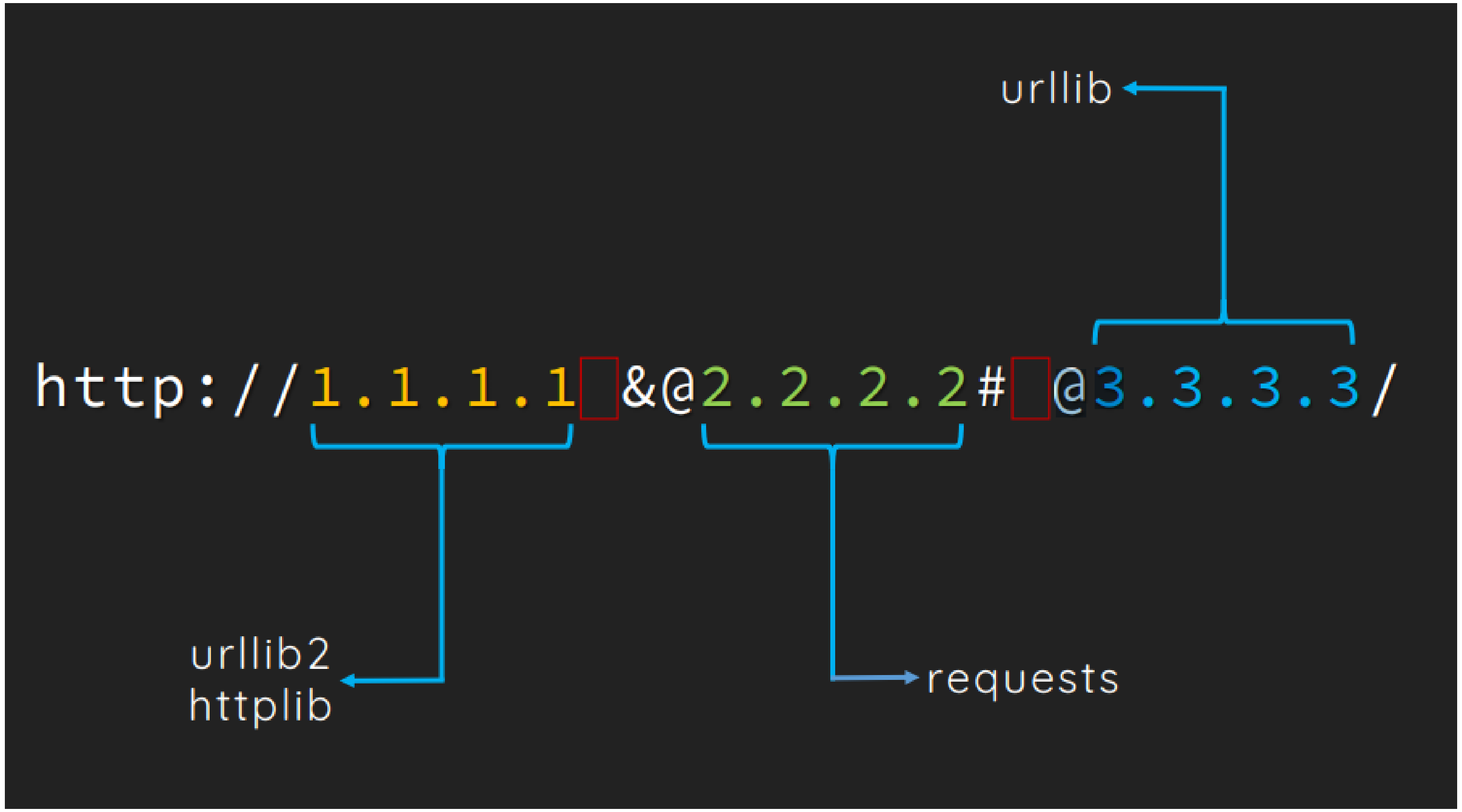
# DOUBLE PARSING



- What if the **system validating** and **using the value** was not the same

## DOUBLE PARSING: URLS

When parsing the following URL, what is the host?



Reference: A New Era of SSRF - Exploiting URL Parser in Trending Programming Languages!

## DOUBLE PARSING: URLS

- Less likely to happen in .NET
  - Small numbers of URI parser
- High probability when interacting **in other systems**
- DNS rebinding needed to be considered for host whitelisting

- Conclusion
  - Do not trust validated input that was parsed differently

# FIND THE BUGS

```
{
  "username": "philippe",
  "fullname": "Philippe A.",
  "newPassword": “C0nf00"
}
```

IdentityValidator.cs

```
boolean IsValidRequest(json) {
    var jsonReader = JsonReaderWriterFactory.CreateJsonReader(json,[…]);
    var root = XElement.Load(jsonReader);

    return root.XPathSelectElement("//username ").Value == HttpContext.Current.User.Identity.Name;
}
```

UpdateUser.cs

```
void ProcessUpdateUser(json) {
   if(IsValidRequest(json)) {
      JObject user = JObject.Parse(json);

      var usersToUpdate = context.User.Where(u => u.username == user.GetValue(“username")).ToList();
      usersToUpdate.ForEach(u => u.Password = user.GetValue("newPassword"));
      context.SaveChanges();
   }
}
```

*Pseudocode is highly simplified

# JSON PARSER IN .NET

```
{
  "username": "philippe",
  "username": "yannlarrivee",
  "fullname": "hihihi",
  "newPassword": “C0nf00"
}
```

using System.Runtime.Serialization.Json;

```
{
  "username": "philippe",
  "username": "yannlarrivee",
  "fullname": "hihihi",
  "newPassword": “C0nf00"
}
```

using Newtonsoft.Json;

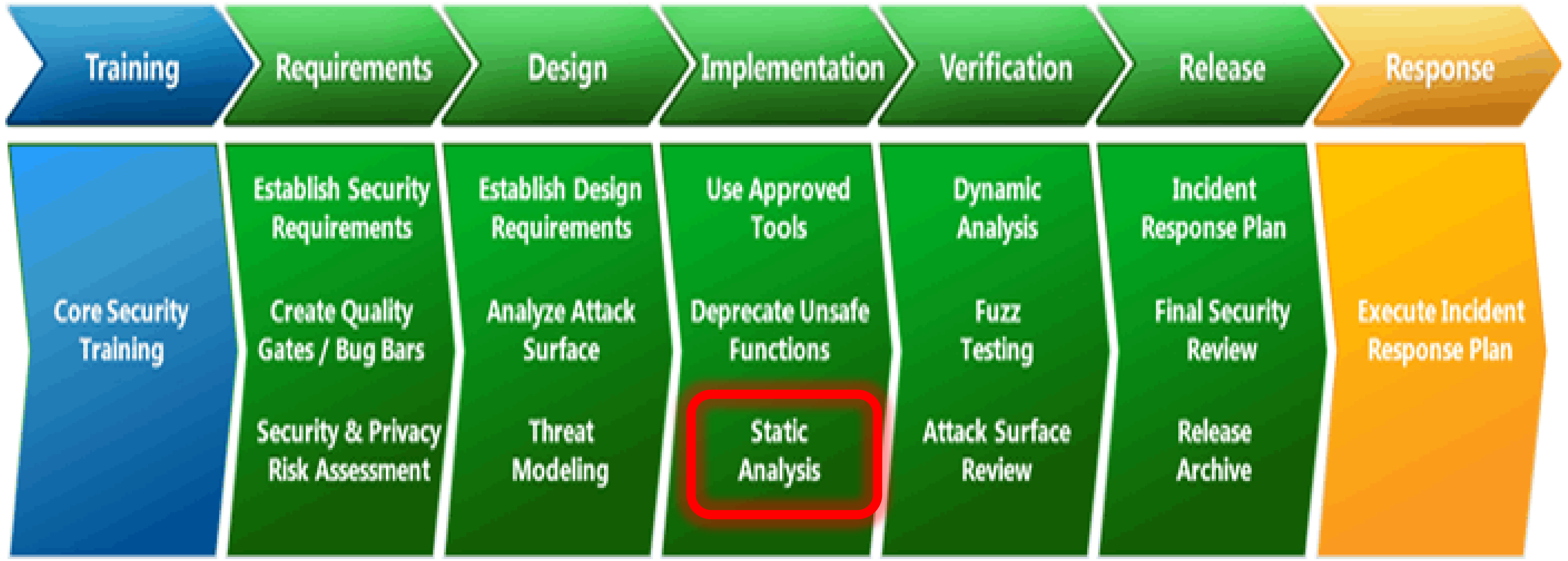
```
{
  "username": "philippe",
  "username": "yannlarrivee",
  "fullname": "hihihi",
  "newPassword": “C0nf00"
}
```

Inspired by: https://justi.cz/security/2017/11/14/couchdb-rce-npm.html

## METHODOLOGY FOR CODE REVIEW

# CODE REVIEW IN SDLC

- First thing first, code review is ONE of the security activities thad need to be integrated in the development lifecycle.



## CODE REVIEW STEPS

1. Threat modeling [1]
2. Analysis
3. Reporting (Document or Opening ticket) *
4. Bug fixing *

[1] OWASP Code Review Guide v2 p.32
* Not covered in this presentation

## THREAT MODELING : DECOMPOSING THE APPLICATION

- Identify assets to protect
  - Personal information
  - Documents
  - Passwords
- Identify entry points
  - MVC Controller
  - Web Services
  - Forms
- Identify external dependencies
- Imagine possible threats (STRIDE : **S**poofing, **T**ampering, **I**nformation **D**isclosure, **D**enial of Service, **E**levation of privilege)

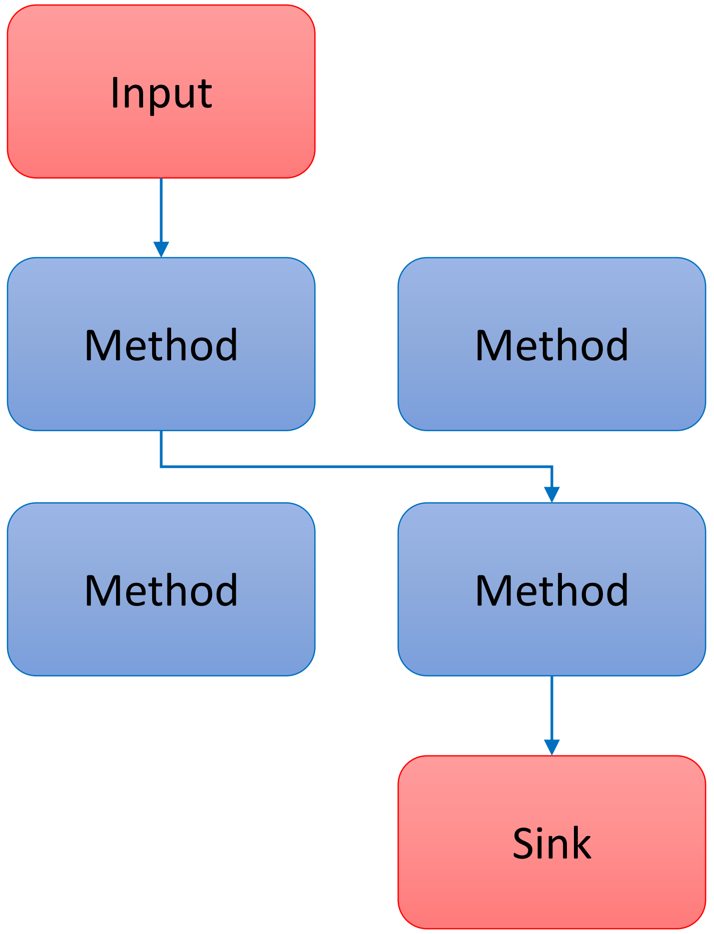
# ANALYSIS

1. Tools configuration
2. Automate scan
   - Review potential issues
3. Manual review

Static analysis tools can also be run in parallel with the manual review.

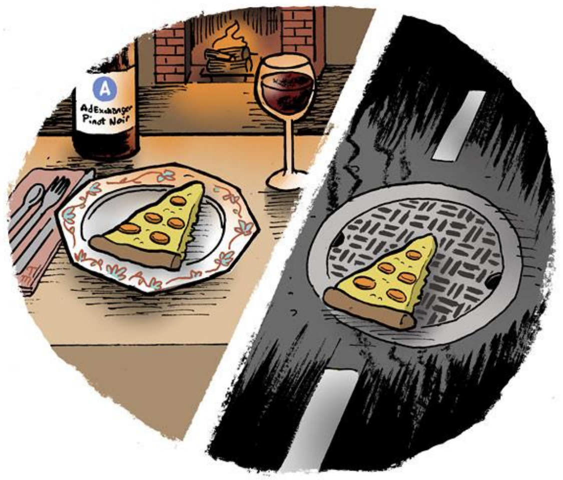
# DATAFLOW

- Mapping between inputs and APIs
- Categories of bugs
  - Injection
  - Path traversal
  - Static IV (Cryptography)
  - Deserialization



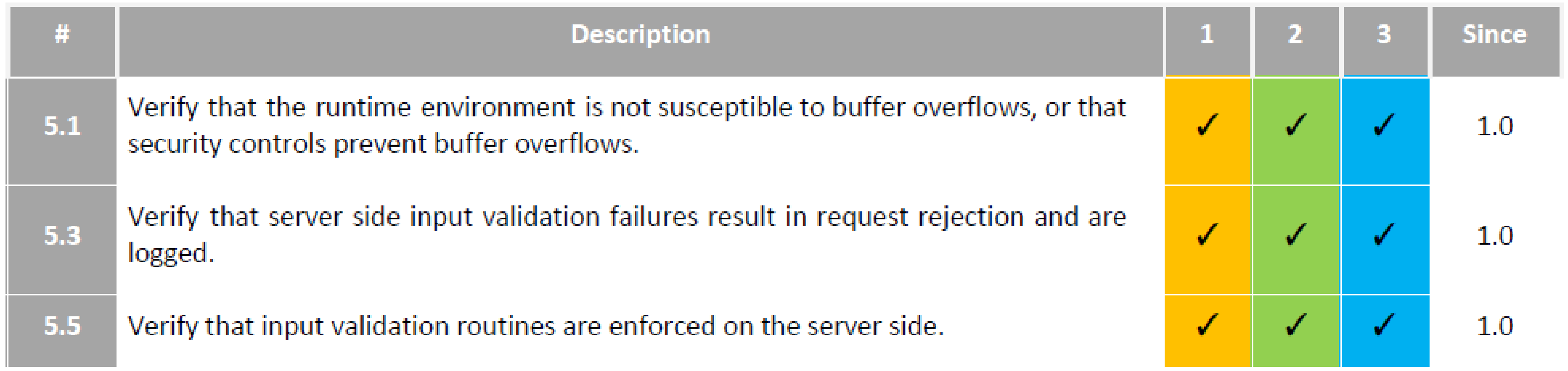
# CONTEXT

- APIs are not vulnerable by default
- APIs are designed to be used in a certain context
- Categories of bugs
  - Random number generation
  - Oracle Padding Attack or any other active attack
  - Control based on Host header
  - Insecure communication (internal communication vs network communication)
  - Configuration files vs Upload files


Context Matters

# CHECKLIST

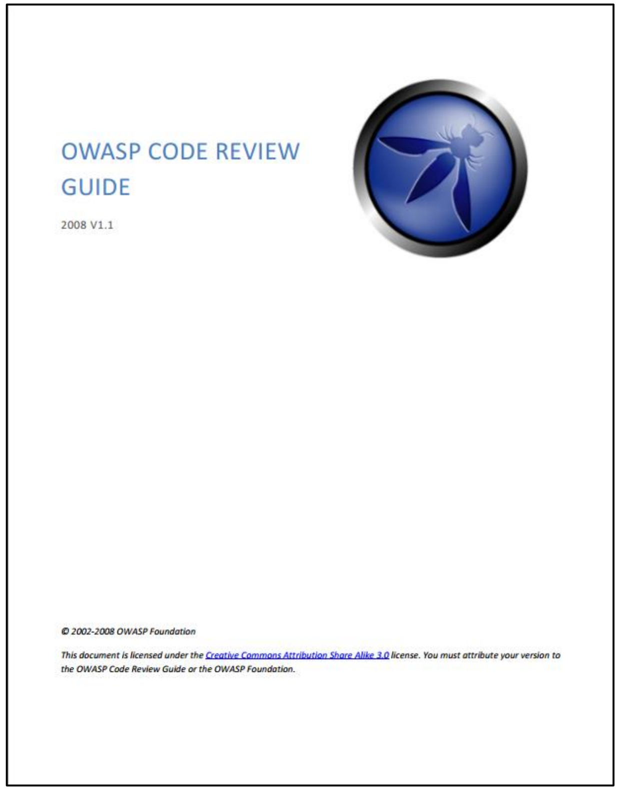
- Intended for baseline verifications
- Guidelines
- Reproducibility



| # | Description | 1 | 2 | 3 | Since |
|---|---|---|---|---|---|
| 5.1 | Verify that the runtime environment is not susceptible to buffer overflows, or that security controls prevent buffer overflows. | ✓ | ✓ | ✓ | 1.0 |
| 5.3 | Verify that server side input validation failures result in request rejection and are logged. | ✓ | ✓ | ✓ | 1.0 |
| 5.5 | Verify that input validation routines are enforced on the server side. | ✓ | ✓ | ✓ | 1.0 |

Listing taken from: [OWASP Application Security Verification Standard Project]

## GOOD RESOURCES


OWASP CODE REVIEW GUIDE

2008 V1.1

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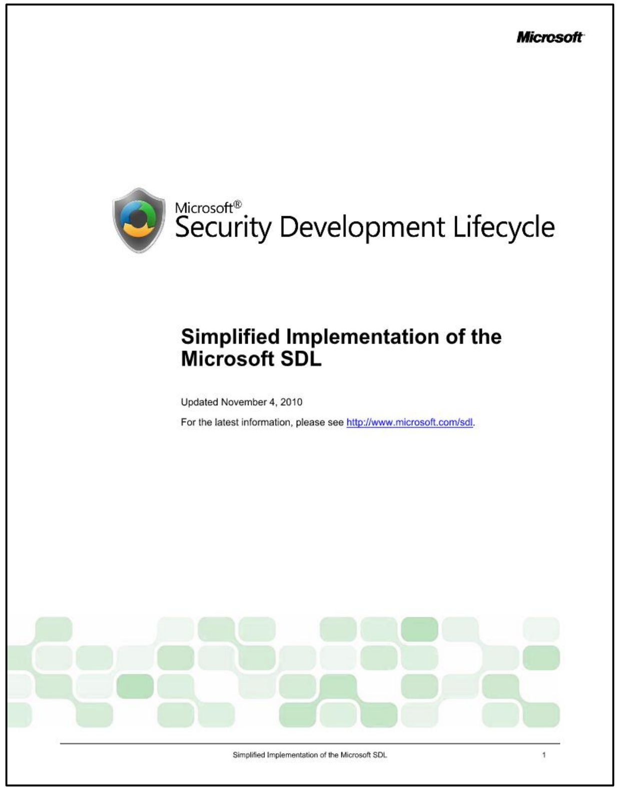
Microsoft

Microsoft® Security Development Lifecycle

Simplified Implementation of the Microsoft SDL

Updated November 4, 2010

For the latest information, please see http://www.microsoft.com/sdl.

Simplified Implementation of the Microsoft SDL 1

OWASP Open Web Application Security Project

Application Security Verification Standard 3.0

October 2015

Code Review Guide

Development Lifecycle

Verification List

## CONCLUSION

## CONCLUSION

- Code review is a powerful technique to find security bugs
  - But don’t forget to do dynamic tests as well
- Use tools when possible
  - Build or extends tools when needed
- Recent trends affecting .NET
  - Angular XSS (Client-side template injection)
  - Deserialization vulnerabilities
  - Double parsing

## REFERENCES

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- OWASP .NET Project

[https://www.owasp.org/index.php/Category:OWASP_.NET_Project](https://www.owasp.org/index.php/Category:OWASP_.NET_Project)

- .NET Security Cheat Sheet

[https://www.owasp.org/index.php/.NET_Security_Cheat_Sheet](https://www.owasp.org/index.php/.NET_Security_Cheat_Sheet)

- Security Code Scan

[https://security-code-scan.github.io/](https://security-code-scan.github.io/)

## ROSLYN REFERENCES

- .NET Compiler Platform ("Roslyn"): Analyzers and the Rise of Code-Aware Libraries

https://www.youtube.com/watch?v=Ip6wrpYFHhE

- Roslyn Wiki

https://github.com/dotnet/roslyn/wiki

- Learn Roslyn Now: Part 10 Introduction to Analyzers by Josh Varty

https://joshvarty.wordpress.com/2015/04/30/learn-roslyn-now-part-10-introduction-to-analyzers/

- .NET Compiler Platform SDK

https://marketplace.visualstudio.com/items?itemName=VisualStudioProductTeam.NETCompilerPlatformSDK

## .NET JSON DESERIALIZATION

- Ysoserial.net : Payload generator

https://github.com/pwntester/ysoserial.net

- Friday The 13th JSON Attack - White Paper

https://www.blackhat.com/docs/us-17/thursday/us-17-Munoz-Friday-The-13th-JSON-Attacks-wp.pdf

# QUESTIONS ?

**Contact**

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