ENPM 809W
Introduction to Secure Software Engineering

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Lecture 14

Code Analysis

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD™

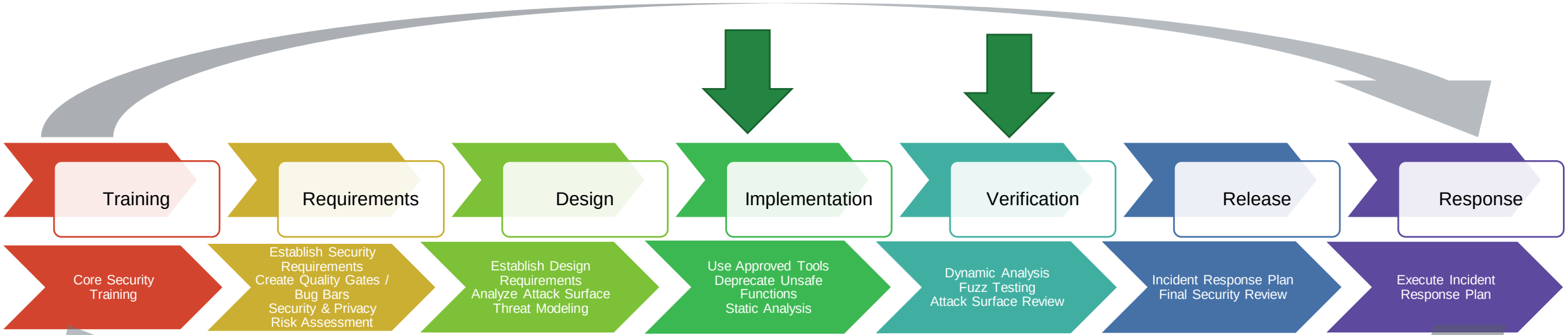
Outline

- Code Analysis
- Static Analysis
- Dynamic Analysis
- .NET C# Analyzers

Code Analysis

Code Analysis

- **This is usually performed during both the Implementation as well as the Verification stages of the Secure Development Lifecycle.**



Sources:
1. https://en.wikipedia.org/wiki/Npm_(software)#Notable_breakages

Phases Bugs injected versus Bugs detected

- **Typically, you don’t want bugs to be found when the product reaches the customer.**
- **That is when it becomes the most expensive to fix.**
- **Usually lose trust in the software and the brand.**
- **Want to detect issues early!**

Phase Discovered	Bug injected in this phase: Req's	Design	Devmnt	QA/Test	Cost*
Req's	0				$0
Design	3	0			$45
Devmnt	8	3	0		$275
QA/Test	21	2	142	0	$33,000
Customer	14	0	127	0	$141,000
Totals:	46	5	269	0	$174,320

Figure 25: Phase-Injection chart. The phase that caused the defect is plotted vertically; the phase where the defect was found is plotted horizontally.

**Cost-to-fix was estimated with data from IBM Israel. See later footnote text for details.*

Sources:
1. Jason A. Cohen. Best Kept Secrets of Peer Code Review: Modern Approach. Practical Advice. 2006. pp9-129.

Implementation Phase Checks

- **Usually it's cheapest to build checks during development processes that involve code check-in or integration of the code.**
  - Some may argue this slows down development, but really code that does not work or is shoddy should not exist in the source code repository in the first place.
  - A lot of code reuse can occur leading to propagation of such erroneous code or poor quality code.
- **Today this form of checking is referred to as "Secure DevOps" or "Security DevOps"**
- **Really nothing but automated mechanisms to check code before it is "committed" to a source code repository or version control system.**
- **Typically involves running automated tools that analyze the source code "statically" to ensure code is in working and high quality state before it is even submitted to the code version control system.**

Verification Phase Checks

- By now a lot of effort has been spent on development of a prototype or product and now the design has been “SOLIDified” somewhat …
- So now it technically becomes expensive to re-design or re-engineer parts or the whole of the software system if issues are discovered.
- Typically you run automated tools that run the compiled code and run tests etc. You typically run unit tests in the previous implementation phase.
- However, in this phase integration and runtime tests occur. The product is tested to ensure all requirements are being met.
- This includes performing any security testing and secure code review.
- What kinds of automated tools are used to aid with the secure code review?

Static Analysis Tools

- Scan the code without running the resulting binary to find security issues.
- Can range from lint checking (similar to a grep search of the code base) to checking data flows based on a graph of the code (control flow, data flow etc.)
- Typically is instrumented as part of compilation. This allows low level access to the code.
- A survey paper by Emanuelsson and Nilsson from Ericsson: https://www.sciencedirect.com/science/article/pii/S1571066108003824/pdf?md5=c5f321979e147ac2d83b160921a1f2aa&pid=1-s2.0-S1571066108003824-main.pdf

Dynamic Analysis Tools

- Scan the code and resources including memory for security issues as the code is run (dynamic).
- Typically involves memory and data flow analysis and keeping track of code as it runs.
- These tools can incorporate several different techniques.
- As an example, taint analysis could be used to check whether data provided from input is leaked to the output. It can also be used to check for memory leaks (data is propagated to a memory location, but that memory location is never freed) etc.
- Fuzzing is another dynamic analysis technique which runs the code using random inputs to detect crashes, exceptions etc.

Tool vendors

SYNOPSYS®

Coverity
Static Analysis

sonarqube

CyberRes

Fortify Static Code
Analyzer

JET
BRAINS

R# ReSharper

VERACODE

GRAMMATECH

CODESonar®

What about writing your own analyzer?

- See https://docs.microsoft.com/en-us/dotnet/csharp/roslyn-sdk/tutorials/how-to-write-csharp-analyzer-code-fix for using Roslyn compiler framework to write your own C# analyzer.
- This will be the focus of the last lab.
- Roslyn is Microsoft's compiler for C# as an API.
- You are able to analyze code nodes and check for "rules" that when met indicate an issue (could be code style, security or other general programming).
- You are also able to show "potential fixes that fix the issue" to the developer.
- Is this form of analysis considered static or dynamic analysis?

Security Code Scan (.NET)

- https://security-code-scan.github.io/
- Static code analysis tool that is also available as a Visual Studio plugin or a standalone runner (integration with Git hooks etc).
- Can configure with custom data sources and sinks, as well as custom sanitizers and validators.

Microsoft.CodeAnalysis.NetAnalyzers

- `PM> Install-Package Microsoft.CodeAnalysis.NetAnalyzers -Version 5.0.3`
- https://github.com/dotnet/roslyn-analyzers#microsoftcodeanalysisnetanalyzers
- **This supercedes FxCop .NET analyzer since all the rules have been ported to NetAnalyzers.**
- **Enabled automatically by default in .NET5.**
- **For older .NET versions:**

```
<PropertyGroup>
    <EnableNETAnalyzers>true</EnableNETAnalyzers>
    <AnalysisLevel>latest</AnalysisLevel>
</PropertyGroup>
```

- **The documentation on rules can be found: https://docs.microsoft.com/en-us/dotnet/fundamentals/code-analysis/quality-rules/?view=vs-2019**
- **Includes design, style and security rules.**

Next Week

- Review Week
- This week's lab on Code Analysis due
- Project Phase 3 due
- Remaining Quizzes