Security Testing: Myths, Challenges, and Opportunities
Experiences in Integrating Security Testing “End-to-End” Into the Software Life-Cycle at SAP

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Abstract

Security testing is an important part of any security development lifecycle (SDL) and, thus, should be a part of any software (development) lifecycle. Still, security testing is often understood as an activity done by security testers in the time between “end of development” and “offering the product to customers.” On the one hand, learning from traditional testing that the fixing of bugs is the more costly the later it is done in development, security testing should be integrated into the daily development activities. On the other hand, developing software for the cloud and offering software in the cloud raises the need for security testing in a “close-to-production” or even production environment. Consequently, we need an end-to-end integration of security testing into the software lifecycle.

In this talk, we will report on our experiences on integrating security testing “end-to-end” into SAP’s software development lifecycle in general and, in particular, SAP’s Secure Software Development Lifecycle (S²DL). Moreover, we will discuss different myths, challenges, and opportunities in the area of security testing.

A Security Testing Taxonomy

In this talk, security testing refers to all kinds of methods that find security vulnerabilities in systems, including (but not limited) to:

- static approaches (e.g., SAST, code reviews)
- dynamic approaches (e.g., DAST, fuzzing)
- combined approaches (e.g., IAST, concolic testing)
Agenda

1. SAP in a Nutshell
2. Motivation
3. The Beginning: Large Scale Introduction of SAST
5. SAP’s Secure Software Development Lifecycle (S2DL)
6. Myths and Lesson’s Learned

Die SAP SE

• Leader in Business Software
  - Cloud
  - Mobile
  - On premise
• Many different technologies and platforms, e.g.,
  - In-memory database and application server (HANA)
  - Netweaver for ABAP and Java
• More than 25 industries
• 63% of the world’s transaction revenue touches an SAP system
• approx. 68,000 employees worldwide
• Headquarters: Walldorf
  (close to Heidelberg, Germany)

SAP’ Security Team
How SAP Organizes Software Security

De-centralized development model:
- **Central security expert team** (S2DL owner)
  - Organizes security trainings
  - Defines product standard “Security”
  - Defines risk and threat assessment methods
  - Defines security testing strategy
  - Selects and provides security testing tools
  - Validates products
  - Defines and executes response process
- **Local security experts**
  - Embedded into development teams
  - Organize local security activities
  - Support developers and architects
  - Support product owners (responsibles)

My Background

- I wear two hats:
  - Research Expert/Architect
  - **(Global) Security Testing Strategist**
- Background:
  - Security, Formal Methods, Software Engineering
- Current work areas:
  - Static code analysis
  - (Dynamic) Security Testing
  - Mobile Security
  - Security Development Lifecycle
  - Secure Software Development Lifecycle

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Costs of Vulnerabilities (Attacks on IT Systems)

- TJX Company, Inc. (2007) $ 250 million
- Sony (2011) $ 170 million
- Heartland Payment Systems (2009) $ 41 million

A hack not only costs a company money, but also its reputation and the trust of its customers. It can take years and millions of dollars to repair the damage that a single computer hack inflicts.

(http://financialedge.investopedia.com/financial-edge/0711/Most-Costly-Computer-Hacks-Of-All-Time.aspx)

Vulnerability Types of CVE Reports Since 1999

- Execute Code 28%
- Denial of Service 17%
- Overflow 12%
- XSS Injection 8%
- SSI 11%
- Other 15%
- Gain Information 5%
- Bypass something 4%

- Causes for most vulnerabilities are
  - programming errors
  - configuration errors
- Patching
  - is expensive
  - may introduce new bugs
- How can we help developers to avoid this mistakes?
How We Started: What We Wanted to Find
Programming Patterns That May Cause Security Vulnerabilities

Mainly two patterns
Local issues (no data-flow dependency), e.g.,
• Insecure functions
  1. var x = Math.random();
• Secrets stored in the source code
  1. var password = 'secret';

Data-flow related issues, e.g.,
• Cross-site Scripting (XSS)
  1. var docref = document.location.href;
  2. var input = docref.substring(docref.indexOf("default")+8);
  3. var fake = function (x) {return x;}
  4. var cleanse = function (x) {
     return 'hello world';
  }
  5. document.write(fake(input));
  6. document.write(cleanse(input));

• Secrets stored in the source code
  1. var foo = 'secret';
  2. var x = decrypt(foo,data);

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• Insecure functions
• Secrets stored in the source code

Data-flow related issues, e.g.,
• Cross-site Scripting (XSS)

SAST at SAP

• Since 2010, mandatory for all SAP products
• Multiple billions lines analyzed
• Constant improvement of tool configuration

SAST tools used at SAP:

<table>
<thead>
<tr>
<th>Language</th>
<th>Tool</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABAP</td>
<td>CVA (SLIN_SEC)</td>
<td>SAP</td>
</tr>
<tr>
<td>JavaScript</td>
<td>Checkmarx</td>
<td>Coverity</td>
</tr>
<tr>
<td>C/C++</td>
<td>CxSAST</td>
<td>Checkmarx</td>
</tr>
<tr>
<td>Others</td>
<td>Fortify</td>
<td>HP</td>
</tr>
</tbody>
</table>

So Everything is Secure Now, Right?

Our tool reports all vulnerabilities in your software – you only need to fix them and you are secure.

Undisclosed sales engineer from a SAST tool vendor.
So Everything is Secure Now, Right?

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Yes, this tools exists! It is called Code Assurance Tool (cat):

- The cat tool reports each line, that might contain a vulnerability:
- It supports also a mode that reports no false positives:
### Combining Multiple Security Testing Methods and Tools

<table>
<thead>
<tr>
<th>Client Application</th>
<th>Web Browser</th>
<th>Server Application</th>
<th>Runtime Container</th>
<th>Backend Systems</th>
</tr>
</thead>
</table>

- Risks of only using only SAST
  - Wasting effort that could be used more wisely elsewhere
  - Shipping insecure software
- Examples of SAST limitations
  - Not all programming languages supported
  - Covers not all layers of the software stack

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### Tools

- Checkmarx (JavaScript)
- Fortify (Java)
- DOMinator
- Coverity (C/C++)
- HP WebInspect / IBM AppScan
A Risk-based Test Plan

- Combines multiple security testing methods, e.g., code scans, dynamic analysis, manual penetration testing or fuzzing
- Selects the most efficient test tools and test cases based on the risks and the technologies used in the project
- Re-adjusts priorities of test cases based on identified risks for the project
- Monitors false negative findings in the results of risk assessment

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SAP’ Secure Software Development Lifecycle (S²DL)


Start of development

- Security Measure Plan
  - Based on Security Risk Identification and Mitigation Report (Threat Modelling, SECURIM)
  - Describes planned security testing activities, including test cases and test coverage
  - Input for validation and operation (cloud)

- Security Measure Report
  - Result of executed security testing activities
  - Input for validation and operation (cloud)
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Continuously Measure Your Work and Improve Your Setup

But How to Measure and What to Expect?

What we do:
- Externally reported vulnerabilities/found by validation: check why we missed it earlier
- Potential reasons for missing a vulnerability (and actions)
  - Vulnerability not detected by our tools (strategy)
    - could be detected in principle by our tools
    ⇒ analyze necessary changes (with tool vendor) and decide if risk justifies effort for enhancing tool
    - cannot be detected in principle by our tools
    ⇒ research for suitable tools and decide if risk justifies effort for introducing new tool
  - Vulnerability can be detected by our tools
    - With recent configuration but not configuration at release date
      ⇒ no immediate actions necessary
    - With configuration at release date
      ⇒ analyze why it was not detected and take further actions

What we expect
- Issues not covered by current tool configuration should increase (ideally to 100%)

What we observe
- Increase of logic-based flaws

Penetration Tests at the End of Development

...test/ensure the security of the developed product, right?

Main purpose of penetration tests at end of development is:
- to check for “flaws” in the the S²DL (and not the product)
- Ideally, they only find:
  - no issues that can be fixed/detected earlier (e.g., configuration)

Note, penetration tests in productive environments are different:
- They test the actual configuration
- They test the productive environment (e.g., cloud/hosting)

False Positives are not Your Biggest Concern

A Pragmatic Solution for Too Many Findings: Prioritize Them

- What needs to be audited
- What needs to be fixed
  - as security issue
  - quality issue
- Different rules for
  - old code
  - new code
False Positives are not Your Biggest Concern
A Pragmatic Solution for Too Many Findings: Prioritize Them

- What needs to be audited
- What needs to be fixed
  - as security issue (response effort)
  - quality issue
- Different rules for
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Different rules for
- old code
- new code

Listen to Your Developers: Development Awareness
Developers Should be the Best Friends of Security Experts (not Their Enemies)

We are often talking about a lack of security awareness and, by that, forget the problem of lacking development awareness.

Always keep in mind:
Building a a secure system more difficult than finding a successful attack.

We need:
- Easier to use security APIs
- More tools that make it easy to implement system securely
- Frameworks that make it hard to implement insecure systems
- ...

And, btw, this also holds for DevOps (Cloud)