Industrial Challenges of Secure Software Development

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Agenda

1 Introduction & Motivation
2 Secure Software Development at SAP
3 Challenges in Industrial Software Development
4 Discussion About Future Research Directions
Fact Sheet: 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
- More than 67,000 employees worldwide
- Headquartered in Walldorf, Germany (close to Heidelberg)
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: 11%
- SQL Injection: 8%
- Gain Information: 5%
- Bypass Something: 4%
- Other: 15%

Causes for most vulnerabilities are:
- programming errors
- configuration errors

Patching:
- is expensive
- may introduce new bugs

How can we ensure that no vulnerable code is shipped?
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Secure Software Development Lifecycle
Secure Software Development Lifecycle

Training

- Goals:
  - Create security awareness across all areas and roles
  - Role-specific education, e.g., in development (examples):
    - Threat modeling
    - Secure Programming: ABAP, Java, C/C++
    - Security testing (including static analysis)
  - Security expert curriculum
    - one year (part-time)
    - official job specialization
Secure Software Development Lifecycle
Requirements: SAP Product Standard Security

Security and data protection requirements for all products

1. Regulatory Compliance
   • SAP software shall be able to log security relevant events

2. Data Protection and Privacy
   • SAP software shall support erasure of personal data

3. Vulnerability Prevention
   • SAP software shall be free of SQL Injection vulnerabilities

4. Strategy and Attack Surface Reduction
   • SAP products shall support to be deployed and run securely in segmented networks
Secure Software Development Lifecycle
Requirements and Design: Threat Modeling

Workshops with

• Threat modeling experts
• Security experts
• Product owner
• Architect
• ...

Systematic analysis, e.g.,

• What data is stored on device?
• How is the user authenticated?
Secure Software Development Lifecycle

Implementation: Security Testing

- **Goal**: ensure that security controls are effective
- Static analysis since 2010 mandatory for all products

<table>
<thead>
<tr>
<th>Language</th>
<th>Tool</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABAP</td>
<td>Netweaver CVA</td>
<td>SAP</td>
</tr>
<tr>
<td>C/C++</td>
<td>Coverity</td>
<td>Coverity</td>
</tr>
<tr>
<td>JavaScript, Ruby</td>
<td>Checkmarx</td>
<td>Checkmarx</td>
</tr>
<tr>
<td>Others</td>
<td>Fortify</td>
<td>HP</td>
</tr>
</tbody>
</table>

- Additional security testing activities based on requirements and design (IBM AppScan, HP WebInspect, Burp Suite, Fuzzers, own tooling, ...)

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Before shipment:

• Check that products comply to SAP standards
• Important part: penetration testing
• Executed by independent group within SAP
• Validates quality of previous steps in SSDL
Secure Software Development Lifecycle

Response

After shipment:

- Handle security related bug reports
- Monitor external security community
- Organize roll-out of security patches
Secure Software Development Lifecycle

Training  -  Requirements  -  Design  -  Outsourcing  -  Implementation  -  Validation  -  Shipment  -  Response  -  Acquisition
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):
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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:

```
static int thinkpad_ec_request_row(const struct thinkpad_ec_row *args)
{
    u8 str3;
    int i;
```
So Everything is Secure Now, Right?

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

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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:
- Note:
  - There are sound or complete tools, but only for specific domains
  - In practice,
    - requirements are not formal enough to be sound and complete
    - scalability is very important
    - modularity is very important
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The Scalability Challenge

Code Metrics Overview
(ABAP Code Metrics only)
The Software Maintenance Challenge (Modularity)
### Example

<table>
<thead>
<tr>
<th>Product</th>
<th>Release</th>
<th>EOL</th>
<th>ext. EOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows XP</td>
<td>2001</td>
<td>2009</td>
<td>2014</td>
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<tr>
<td>Windows 8</td>
<td>2012</td>
<td>2018</td>
<td>2023</td>
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<tr>
<td>Red Hat Ent. Linux</td>
<td>2012</td>
<td>2020</td>
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Security is not a Binary Property

Systems are either secure or insecure.

- Security is only one property out of many:
  - Usability
  - New features
  - Time-to-market

- We will never achieve 100% security

- **Question:** Where should I spent my (limited) budget? Or: What is the risk of not fixing an issue and how to balance it with other requirements?

- **Claim:** We need more research in
  - risk-based security
  - security economics (cost of fixing vs. costs of not fixing, etc.)
Soundness is not Binary Either

Security testing methods should be sound.

• Observations:
  • Proving soundness seems to be a prerequisite for getting an academic paper accepted.
  • (Nearly) no “real-world” tool is sound (the underlying method/theory might be sound)
  • Even worse: your sound tool will not report anything, on our frameworks
• What I need (from vendors/researchers) to provide the best “blend” to my developers:
  • A Clear specification what it “in-scope”
  • A Clear specification what it “out-scope”
  • Test cases that validate the expected behavior (e.g., similar to qualification kits for DO178C)
• Claim: We need more research in
  • “well-defined” unsound security testing methods
  • clear specifications of unsoundness
  • test sets for comparing security testing tools
  • extension/adaption points for security testing tools
• If you want to read more: http://www.soundiness.org
 Automation is Too important to Lie

My tool is fully automated

• No, it is (usually) not. And, btw, calling it interactive does not help either
• Again, clearly specify
  • what is automated
  • what needs to be configured “one-time”
  • what needs to be done manually/interactively “on each use”
• **Claim:** We need more research in
  • “automating” the knowledge of security experts
  • automation of “learning new frameworks and policies”
  • closing the gap between security (non-functional) and functional testing
  • need to be integrated into development and built environments
    • instant feedback (could be imprecise)
    • on each check-in
    • nightly/weekly (high quality, should generate compliance reports)
Software is Not Developed on The “Greenfield”

Security testing is done by the developer of a software component

• Observations:
  • Software evolves over time (both, on-premise and Cloud): small changes are the norm
  • Software is build using
    • Free and Open Source Software
    • third party libraries (closed source)
    • assets of acquired companies
  As vendor, you are responsible for all code you ship to customers

• Claim: We need more research in
  • composable security testing techniques, e.g.,
    • impact/change analysis for selecting (security) test cases
    • automated inference of security specifications of software components
  • in pushing security testing across the whole software supply chain
    • techniques that generate “security certificates”
    • formats and guidelines for exchanging “security test tool configurations”
Thank you!

http://xkcd.com/327/
Bibliography I

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Achim D. Brucker and Uwe Sodan.
Deploying static application security testing on a large scale.
Assume an SQL Statement for

```
selecting all users with "userName" from table "user"
```
A Bluffers Guide to SQL Injection (1/2)

• Assume an SQL Statement for

```sql
stmt = "SELECT * FROM 'users' WHERE 'name' = '" + userName + "';"
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Assume an SQL Statement for

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What happens if we choose the following `userName`:

```
userName = "' or '1'='1"
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• Resulting in the following statement:

```
stmt = "SELECT * FROM 'users' WHERE 'name' = '' or '1'='1';"
```

• Which is equivalent to

```
stmt = "SELECT * FROM 'users';"
```

selecting the information of all users stored in the table ‘users’!
A Bluffer's Guide to SQL Injection (2/2)

```java
void selectUser(HttpServletRequest req, HttpServletResponse resp)
    throws IOException {
    String userName = req.getParameter("fName"); // source

    String stmt = "SELECT * FROM 'users' WHERE 'name' = '", userName, ";"
    SQL.exec(stmt); // sink
}
```

- Many vulnerabilities have similar causes:
  - cross-site-scripting (XSS), code-injection, buffer-overflows, ...
- Root cause of a wide range of vulnerabilities
  - "bad" programming
  - mis-configuration
- **Warning:**
  - for preventing SQL injections, consider the use of prepared statements
  - do whitelisting (specify what is allowed) and *do not* blacklisting

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void selectUser(HttpServletRequest req, HttpServletResponse resp) throws IOException {
    String userName = req.getParameter("fName"); // source
    userName = Security.whitelistOnlyLetter(userName); // sanitation
    String stmt = "SELECT * FROM 'users' WHERE 'name' = "" + userName + ";";
    SQL.exec(stmt); // sink
}

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