Industrial Challenges of Secure Software Development

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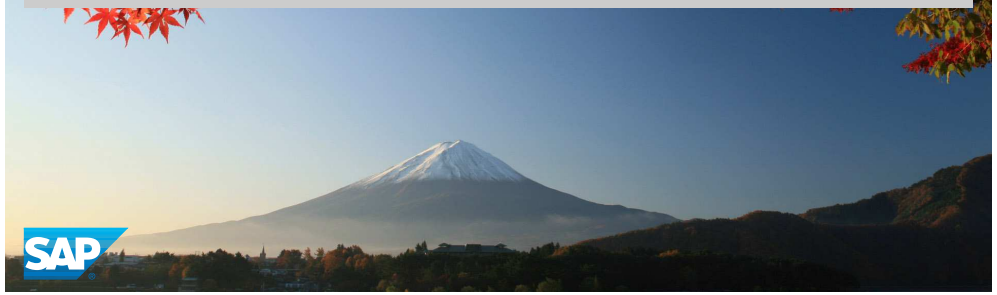
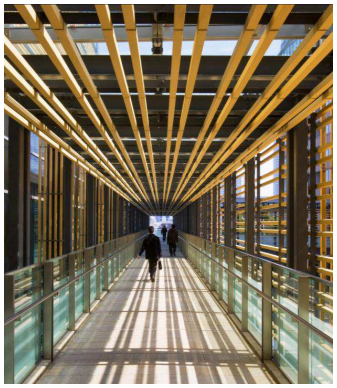


Agenda

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)



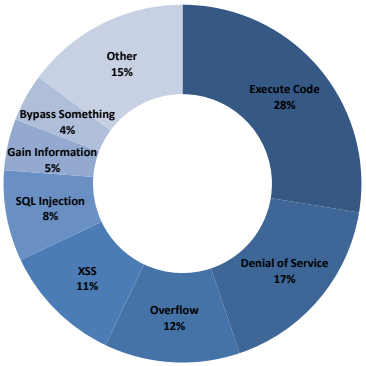
Costs of Vulnerabilities (Attacks on IT Systems)

• 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



- 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?

Agenda

Secure Software Development Lifecycle

Training | Requirements | Design | Implementation | Validation | Shipment | Response

Secure Software Development Lifecycle

Training

Training | Requirements | Design | Implementation | Validation | Shipment | Response

- 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

Training | Requirements | Design | Implementation | Validation | Shipment | Response

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

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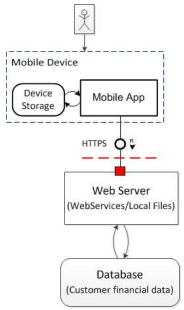

Workshops with

- 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

Training | Requirements | Design | Implementation | Validation | Shipment | Response

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

Language	Tool	Vendor
ABAP	Netweaver CVA	SAP
C/C++	Coverity	Coverity
JavaScript, Ruby	Checkmarx	Checkmarx
Others	Fortify	HP

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

Secure Software Development Lifecycle

Validation

Training | Requirements | Design | Implementation | Validation | Shipment | Response

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

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.

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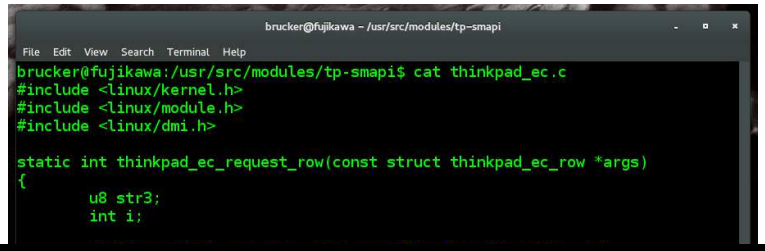

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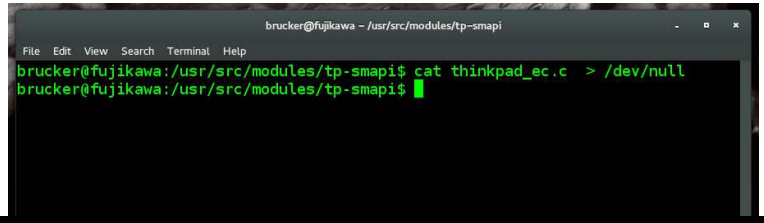

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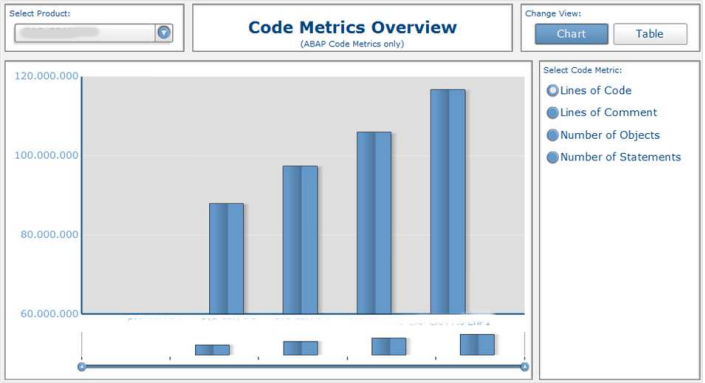
- The cat tool reports each line, that might contain a vulnerability:
- It supports also a mode that reports no false positives:
- Note:
  - There are sound or complete tools, but only for specific domains
  - In practice,
    - requirements are not formal enough to be sound and complete
    - scalability is very important
    - modularity is very important

Agenda

The Scalability Challenge



The Software Maintenance Challenge (Modularity)

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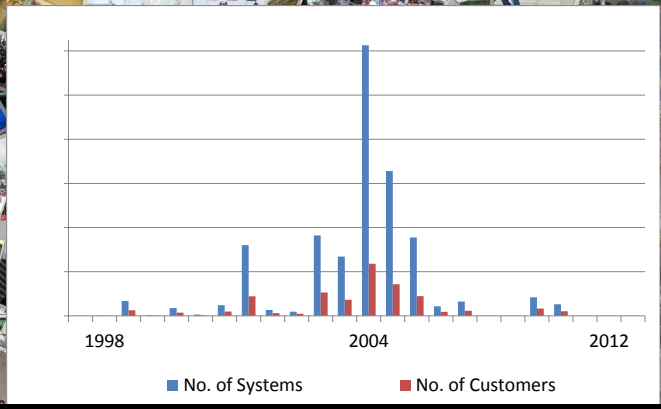

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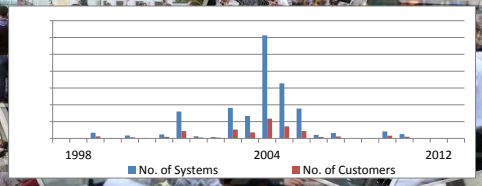

Example

Product	Release	EOL	ext. EOL
Windows XP	2001	2009	2014
Windows 8	2012	2018	2023
Red Hat Ent. Linux	2012	2020	2023

Agenda

1. Introduction & Motivation
2. Secure Software Development at SAP
3. Challenges in Industrial Software Development
4. Discussion About Future Research Directions

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”

Bibliography I

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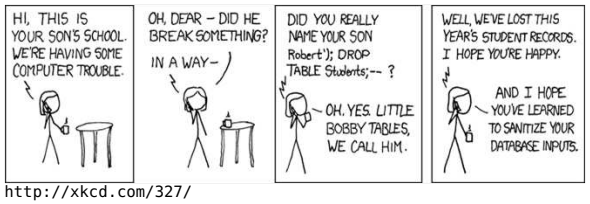
Deploying static application security testing on a large scale.
In Stefan Katzenbeisser, Volkmar Lotz, and Edgar Weippl, editors, *GI Sicherheit 2014*, volume 228 of *Lecture Notes in Informatics (LNI)*, pages 91–101. GI, March 2014.

Thank you!



http://xkcd.com/327/

Part II

Appendix

A Bluffers Guide to SQL Injection (1/2)

- **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**

```
stmt = "SELECT * FROM ‘users‘ WHERE ‘name‘ = ’" + userName + "’;"
```


A Bluffers Guide to SQL Injection (1/2)

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- **What happens if we choose the following *userName*:**

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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 Bluffers Guide to SQL Injection (2/2)

```
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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Page 30 of 30

A Bluffers Guide to SQL Injection (2/2)

```
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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Page 30 of 30