Testing Web Application Scanner Tools

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NIST

Verify Conference

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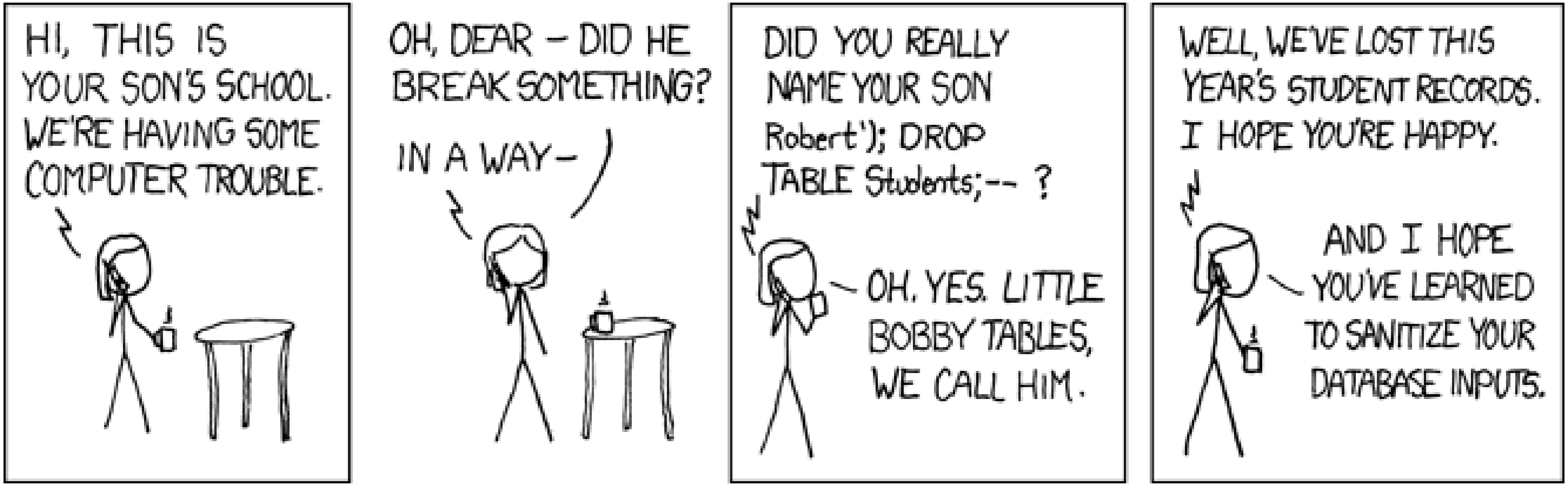

HI, THIS IS YOUR SON'S SCHOOL. WE'RE HAVING SOME COMPUTER TROUBLE.
OH, DEAR – DID HE BREAK SOMETHING?
IN A WAY–
DID YOU REALLY NAME YOUR SON Robert'); DROP TABLE Students;-- ?
OH. YES. LITTLE BOBBY TABLES, WE CALL HIM.
WELL, WE'VE LOST THIS YEAR'S STUDENT RECORDS. I HOPE YOU'RE HAPPY.
AND I HOPE YOU'VE LEARNED TO SANITIZE YOUR DATABASE INPUTS.

http://xkcd.com

Outline

- NIST SAMATE Project
- Which tools find what flaws?
- Web Application Scanner tools:
  specification and capabilities
- Testing Web Application Scanner Tools:
  Test methodologies and results

Software Assurance Metrics and Tool Evaluation (SAMATE) Project at NIST

- Project partially funded by DHS and NSA.
- Our focus
    - Examine software development and testing methods and tools to identify deficiencies in finding bugs, flaws, vulnerabilities, etc.
    - Create studies and experiments to measure the effectiveness of tools.

Purpose of Tool Evaluations

- Precisely document what a tool class does and does not do
- Inform users
  - Match the tool to a particular situation
  - Understand significance of tool results
- Provide feedback to tool developers

Details of Tool Evaluations

- Select class of tool
- Develop clear (testable) requirements
  - Tool functional specification aided by focus groups
  - Spec posted for public comment
- Develop a measurement methodology
  - Develop reference datasets (test cases)
  - Document interpretation criteria

Some Tools for specific application*

- Static Analysis Security Tools
- Web Application Vulnerability Tools
- Binary Analysis Tools
- Web Services Tools
- Network Scanner Tools

* Defense Information Systems Agency, "Application Security Assessment Tool Market Survey," Version 3.0 July 29, 2004

Other Types of Software Assurance Security Tools *

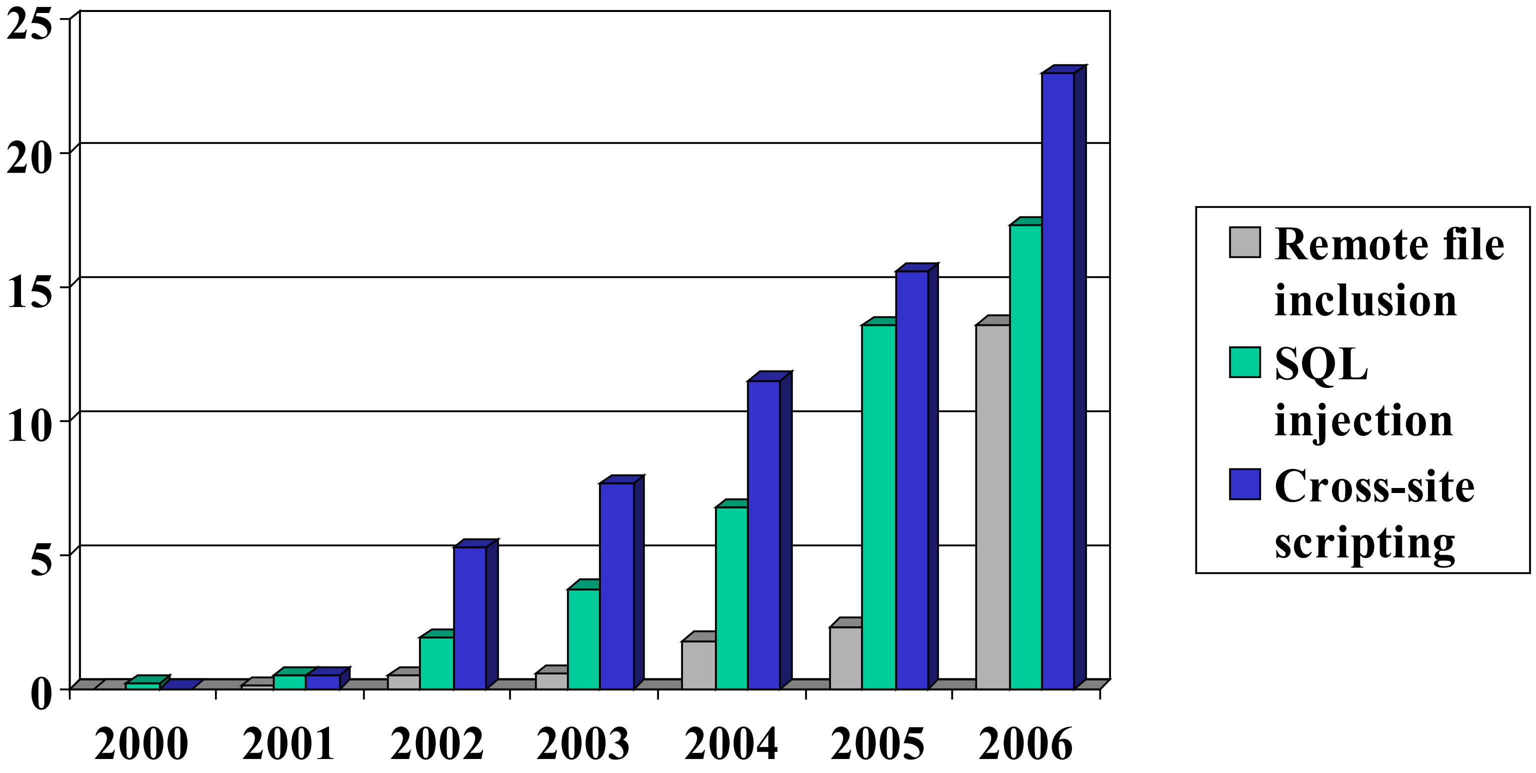
- Firewall
- Intrusion Detection/Prevention System
- Virus Detection
- Fuzzers
- Web Proxy Honeypots
- Blackbox Pen Tester

* OWASP Tools Project

How to Classify Tools and Techniques

- Life Cycle Process (requirements, design, …)
- Automation (manual, semi, automatic)
- Approach (preclude, detect, mitigate, react, appraise)
- Viewpoint (blackbox, whitebox (static, dynamic))
- Other (price, platform, languages, …)

The Rise of Web App Vulnerability



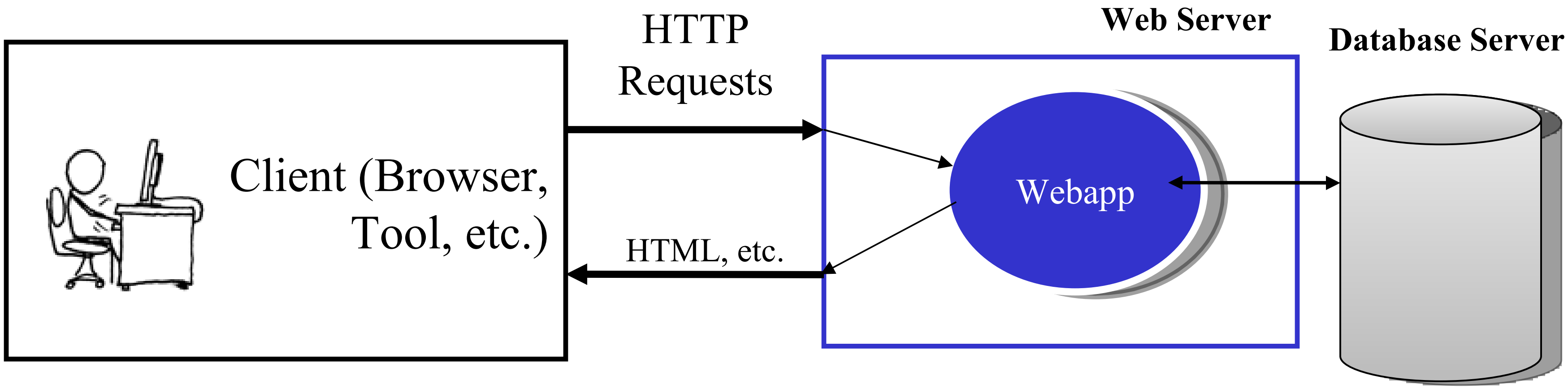
Top web app vulnerabilities as % of total vulnerabilities in NVD

Web Application Security Scanner

*is software which communicates with a web application through the web front-end and identifies potential security weaknesses in the web application.**

* Web Application Security Consortium evaluation criteria technical draft, August 24. 2007.

Web Application Architecture



Characteristics of Web Application

- Client and Server Interaction
- Distributed n-tiered architecture
- Remote access
- Heterogeneity
- Content delivery via HTTP
- Concurrency
- Session management
- Authentication and authorization

Scope – What types of tools does this spec **NOT** address?

- Limited to tools that examine software applications on the web.
- Does not apply to tools that scan other artifacts, like requirements, byte-code, or binary code
- Does not apply to database scanners
- Does not apply to other system security tools, e.g., firewalls, anti-virus, gateways, routers, switches, intrusion detection system

Some Vulnerabilities that Web Application Scanners Check

- Cross-Site Scripting (XSS)
- Injection flaws
- Authentication and access control weaknesses
- Path manipulation
- Improper Error Handling

Some Web Application Security Scanning Tools

- AppScan DE by Watchfire, Inc. (IBM)
- WebInpect by SPI-Dynamics (HP)
- Acunetix WVS by Acunetix
- Hailstorm by Cenzic, Inc.
- W3AF, Grabber, Paros, etc.
- others…

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Establishing a Framework to Compare

- What is a common set of functions?
- Can they be tested?
- How can one measure the effectiveness?

NIST is "neutral", not consumer reports, and does not endorse products.

Purpose of a Specification

- Precisely document what a tool class does and does not do
- Provide feedback to tool developers
- Inform users
  - Match the tool to a particular situation
  - Understand significance of tool results

How should this spec be viewed?

- Specifies basic (minimum) functionality
- Defines features unambiguously
- Represents a consensus on tool functions and requirements
- Serves as a guide to measure the capability of tools

How should this spec be used?

- Not to prescribe the features and functions that all web application scanner tools must have.
- Use of a tool that complies with this specification does not guarantee the application is free of vulnerabilities.
- Production tools should have capabilities far beyond those indicated.
- Used as the basis for developing test suites to measure how a tool meets these requirements.

Criteria for selection of Web Application Vulnerabilities

- Found in existing applications today
- Recognized by tools today
- Likelihood of exploit or attack is medium to high

Web Application Vulnerabilities

- OWASP Top Ten 2007
- WASC Threat Classification
- CWE – 600+ weaknesses definition dictionary
- CAPEC- 100+ attack patterns for known exploits

Test Suites

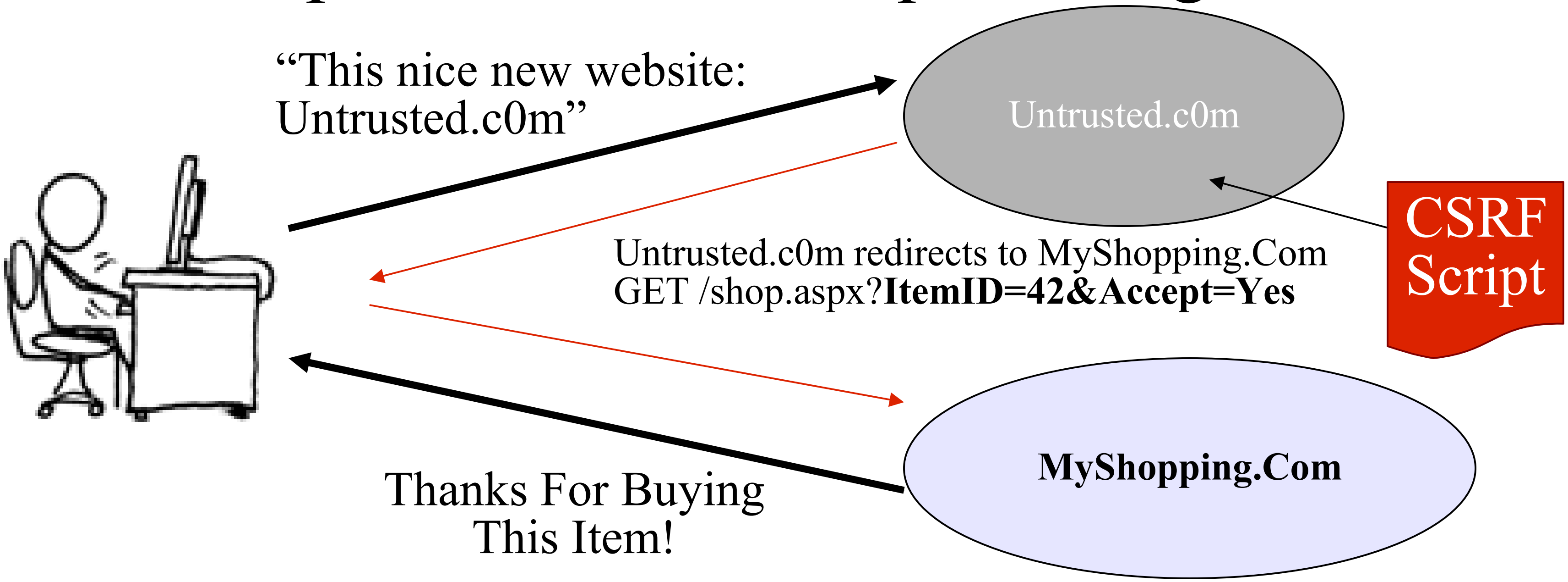
- Test applications that model real security features and vulnerabilities
- Configurable to be vulnerable to one or many types of attack
- Ability to provide increasing level of defense for a vulnerability

Defense Mechanisms

- Different programmers use different defenses
- Defenses/Filters are not all equivalent
- We have different instances of vulnerabilities: levels of defense

Levels of Defense

- Example: Cross-Site Request Forgeries



“This nice new website: Untrusted.c0m”

Untrusted.c0m

CSRF Script

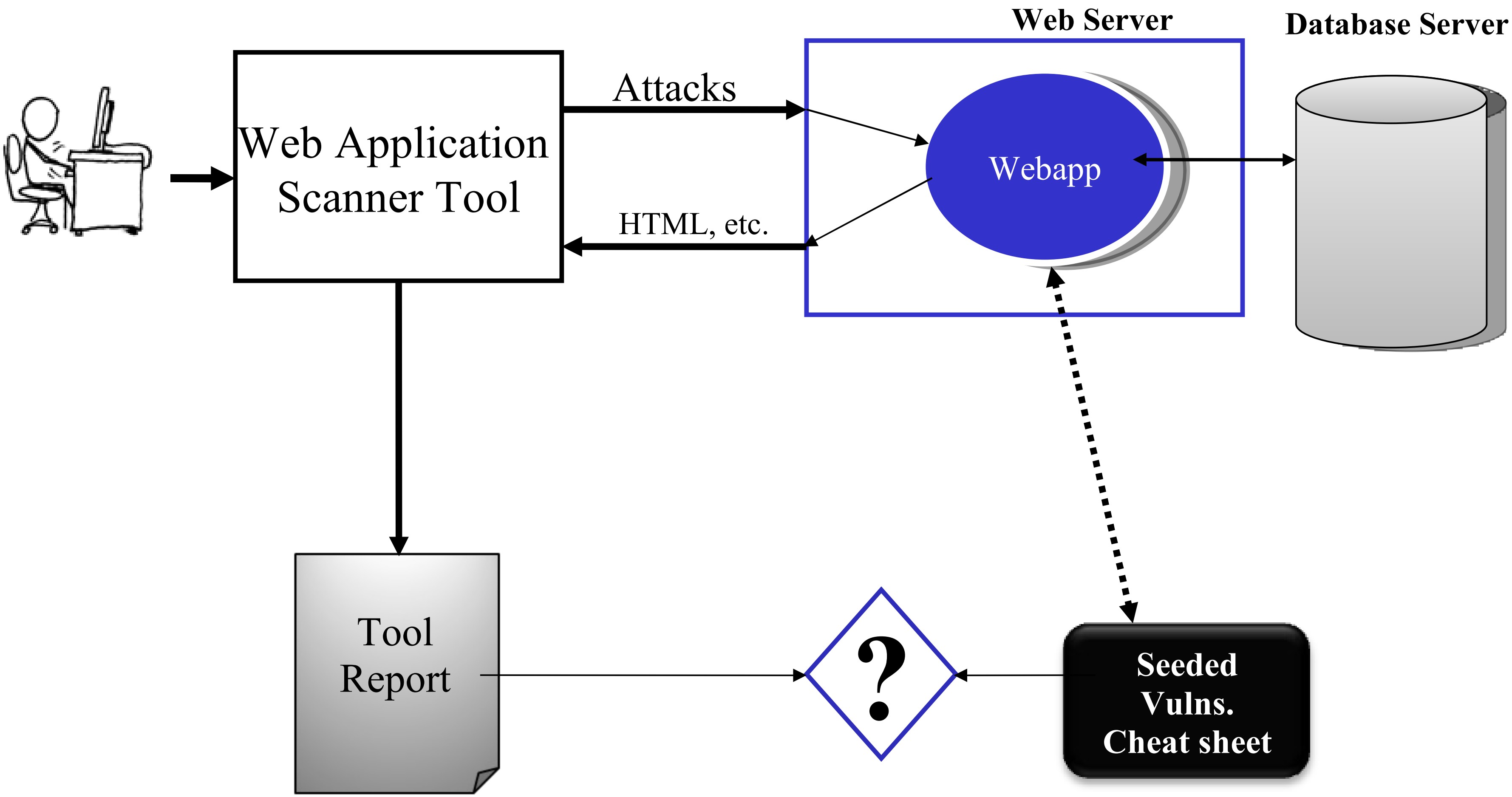
Untrusted.c0m redirects to MyShopping.Com
GET /shop.aspx?**ItemID=42&Accept=Yes**

MyShopping.Com

Thanks For Buying
This Item!

Levels of Defense

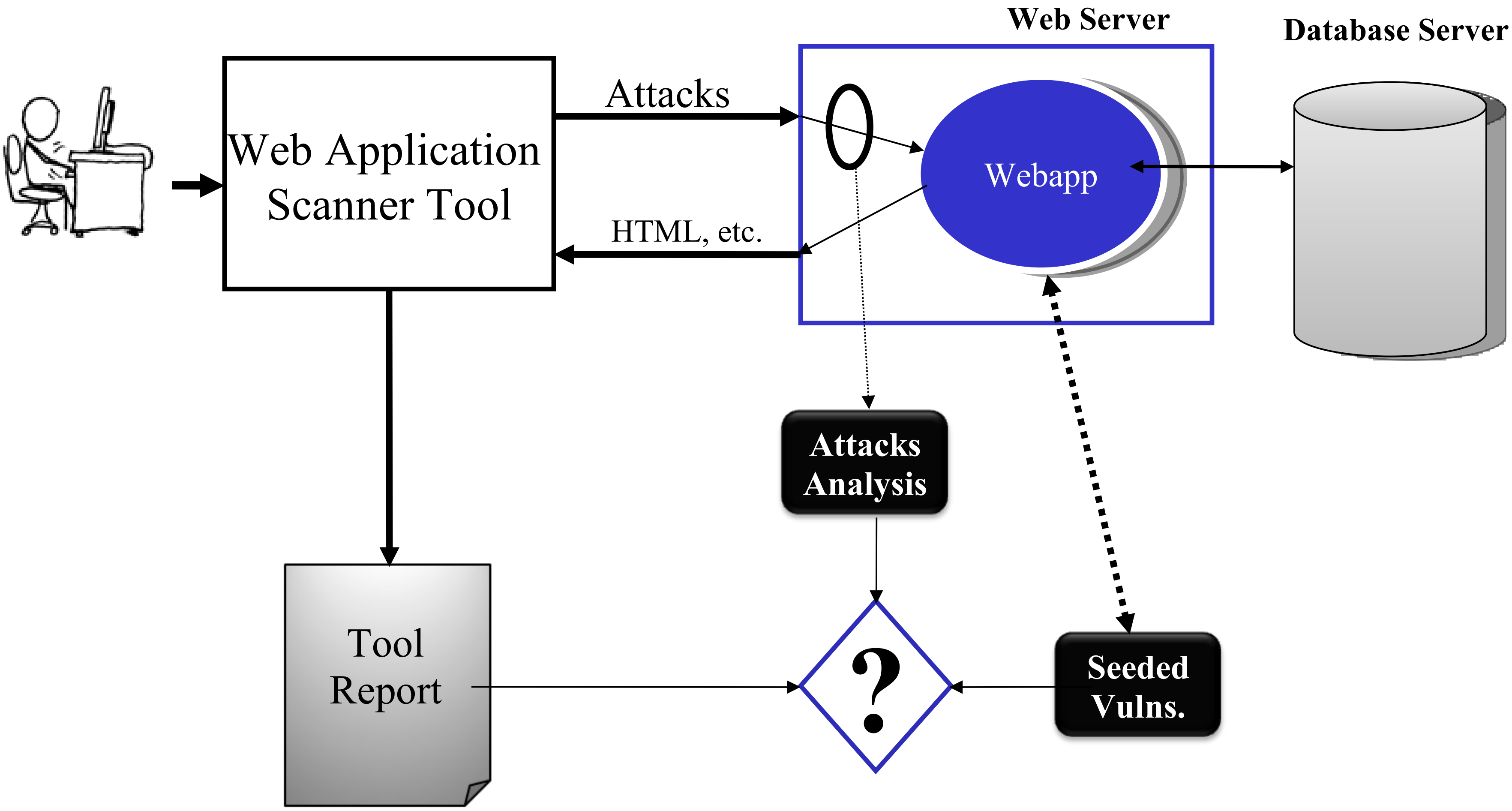
- Example: Cross-Site Request Forgeries
  - Level 0: No Protection (bad)
  - Level 1: Using only POST (well...)
  - Level 2: Checking the referrer (better but referrer may be spoofed)
  - Level 3: Using a nonce (good)
- Higher level means harder to break


Web Server
Database Server
Web Application Scanner Tool
Attacks
HTML, etc.
Webapp
Tool Report
?
Seeded Vulns. Cheat sheet

Attacks Analysis

- An action that exploits a vulnerability
- What exactly is the tool testing?
- What do I need to test in my application?

- Do the results match?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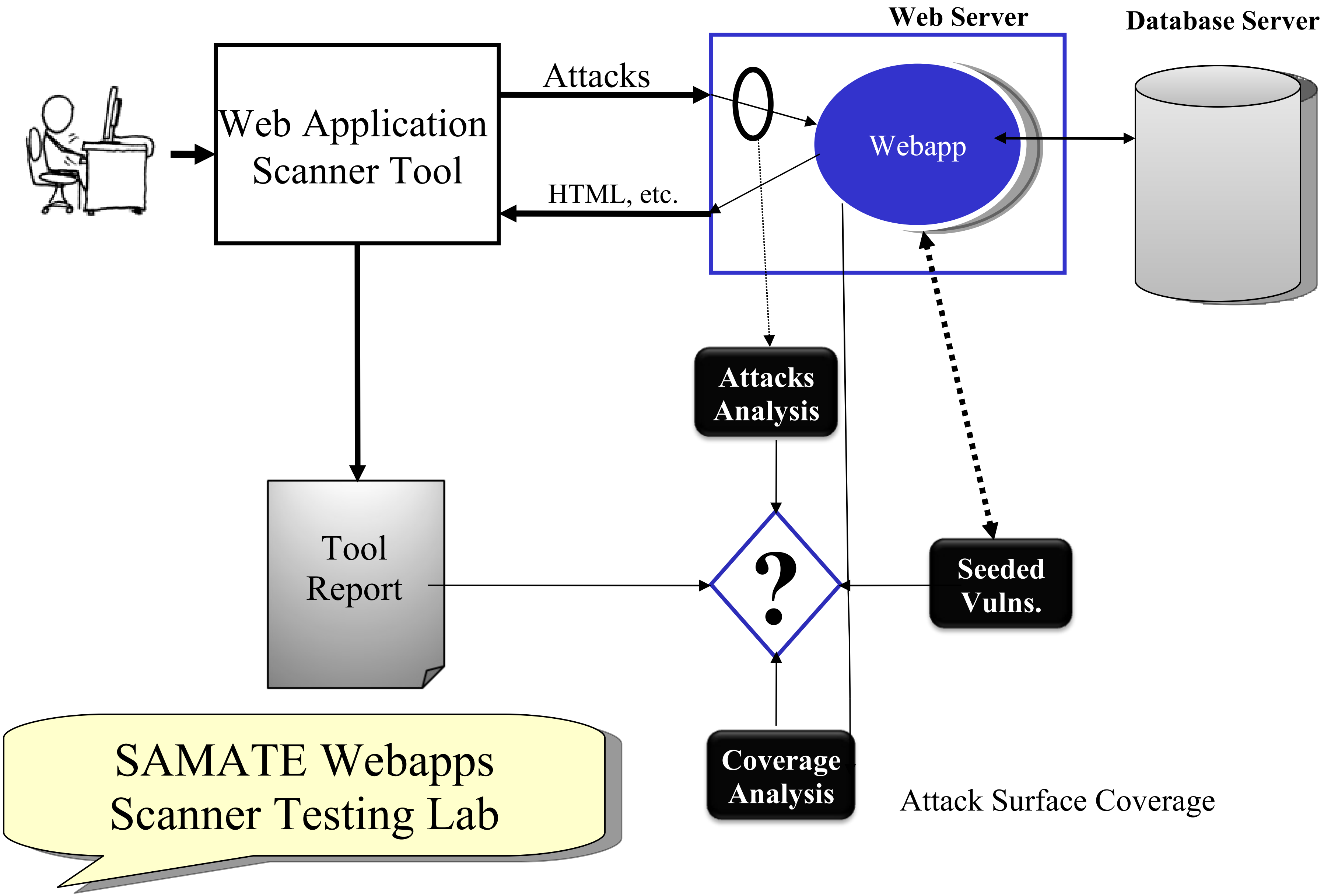
Attack Surface Coverage

- **Testing the tool accuracy** by inserting check points in most of the attack surface
- Is the tool testing all the application surface?

  Ex: login correctly, with errors, etc.

```
(1) Touch the file [login.php]
if ( all fields are set ) then
    (2) All fields are set [login.php]
    Boolean goodCredentials = checkThisUser(fields)
    if ( goodCredentials ) then
        (3) Credentials are correct; Log in [login.php]
        registerSessionCurrentUser()
    else
        if ( available login test > 0 ) then
            (4) Login information incorrect [login.php]
            displayErrorLogin()
            available login test -= 1
        else
            (5) Too many tries with bad info [login.php]
            displayErrorLogin()
            askUserToSolveCAPTCHA()
        endif
    endif
endif
```



Web Server

Database Server

Web Application Scanner Tool

Attacks

HTML, etc.

Webapp

Attacks Analysis

Tool Report

?

Seeded Vulns.

Coverage Analysis

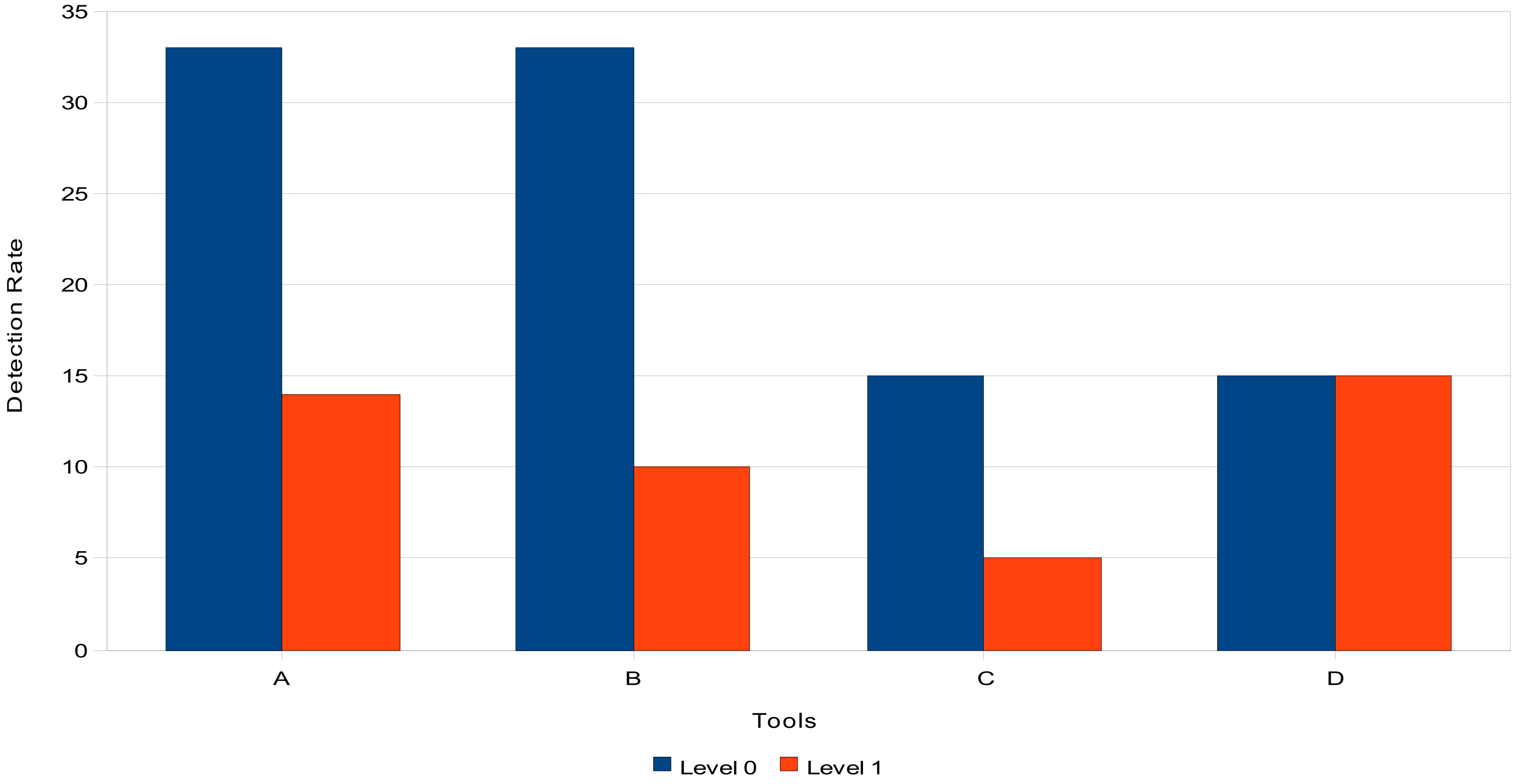
Attack Surface Coverage

SAMATE Webapps Scanner Testing Lab

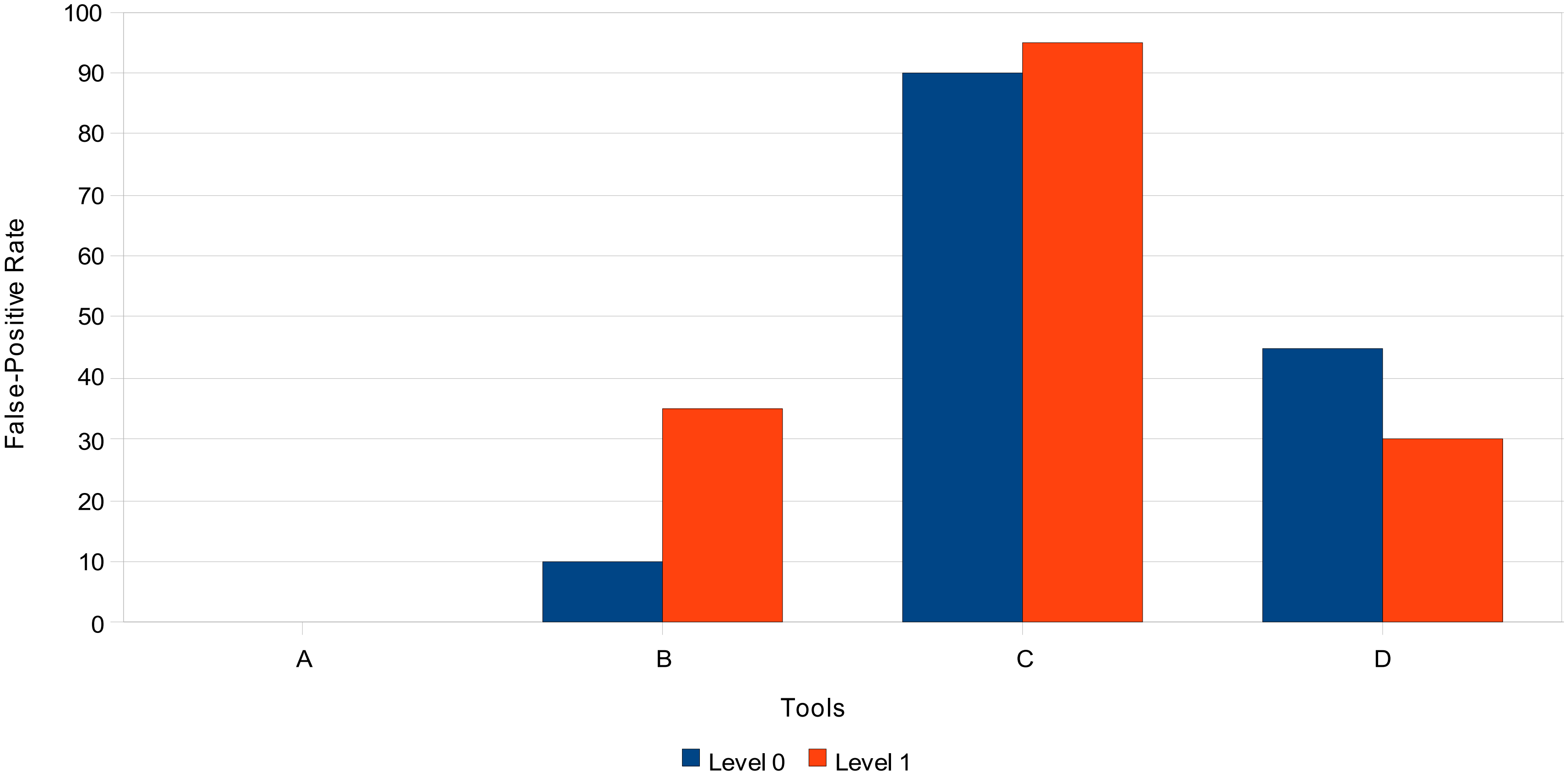
Test Suite Evaluation

- Test Suite with 21 vulnerabilities (XSS, SQL Injection, File Inclusion)
  - PHP, MySQL, Ajax
  - LAMP
- 4 Scanners (Commercial and Open Source)
- One type of vulnerability at the time
- Results (Detection rate, False-Positive rate)

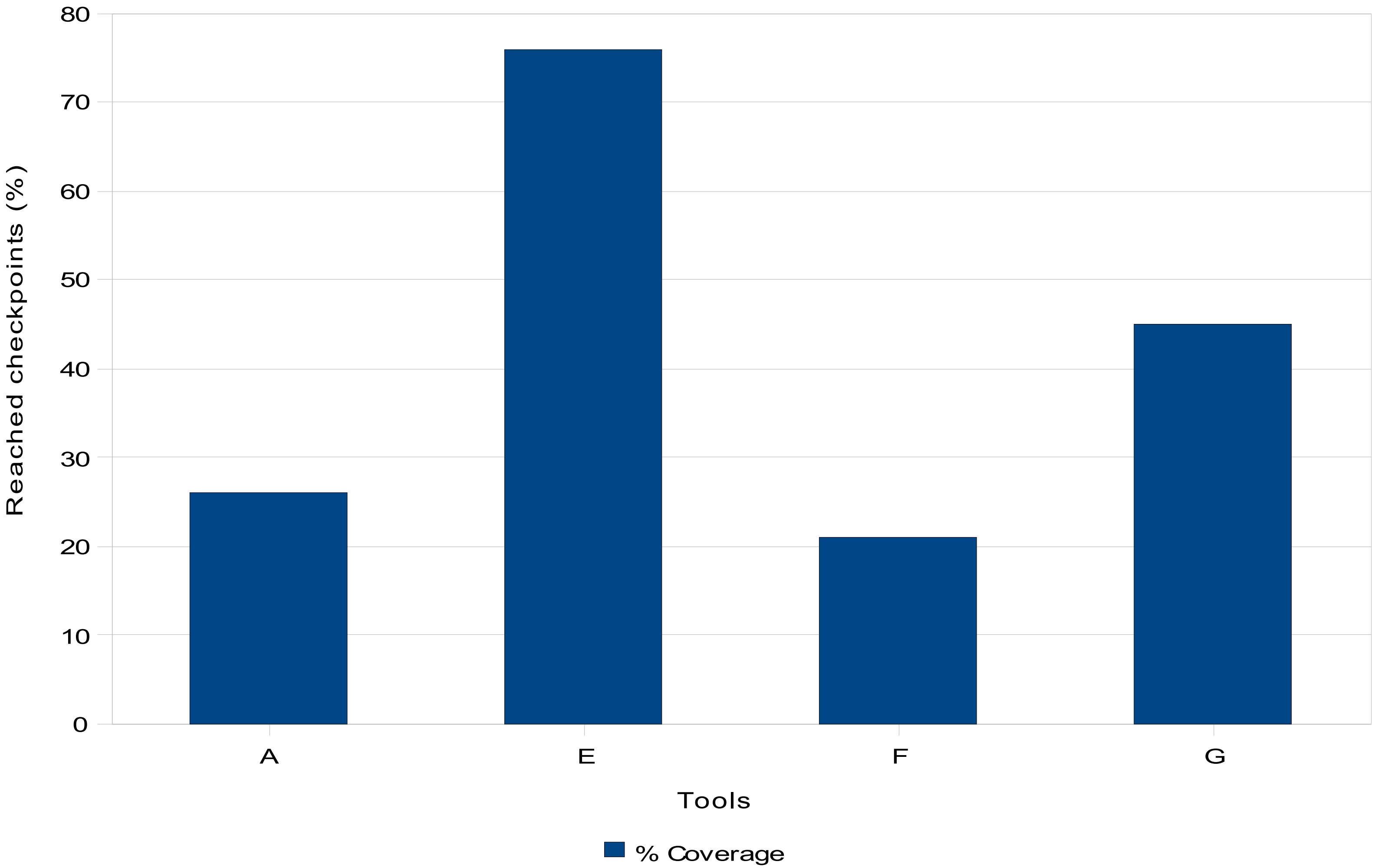
Detection Rates for Different Levels of Defense



False Positive Rates for Different Levels of Defense

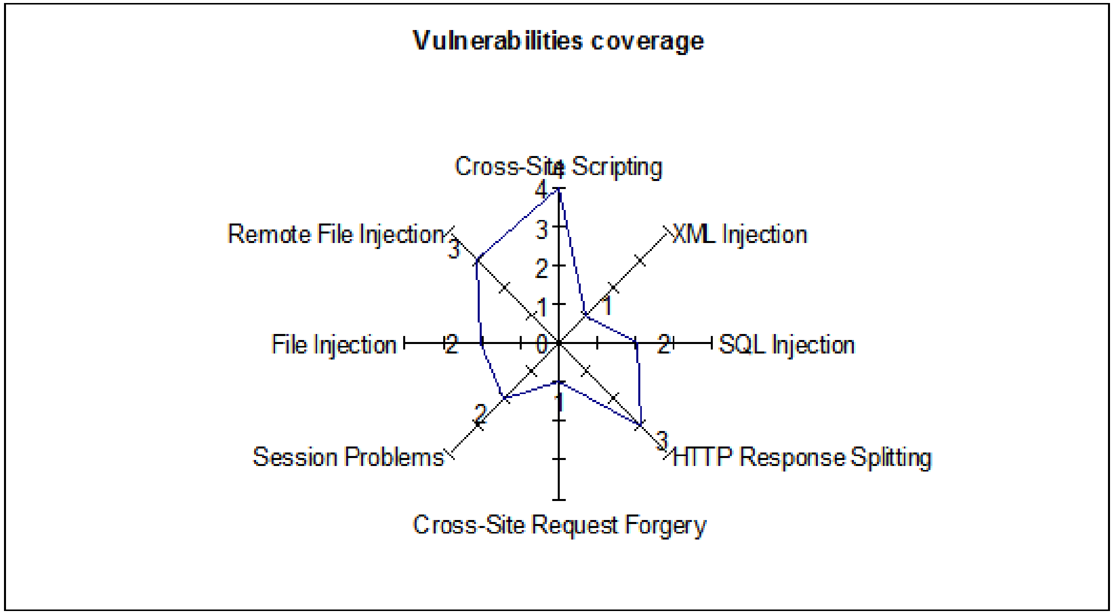


Attack Surface Coverage



Coming next

- Refining level of defense in order to have a better granularity
- Thinking of tool profiles such as:



Coming next (cont.)

- Using different technologies in our test suites (JSP, .NET, etc.)
- More than one vulnerability at a time (combinatorial testing?)
- Metrics? Brian Chess' metric?

t: True Positive
p: False Positive
n: False Negative

$$\frac{100 \cdot t}{t + p + n}$$

Issues with Web Application Scanner Tools

- Tools are limited in scope (companies sell service as opposed to selling tool)
- Speed versus Depth (in-depth testing takes time)
- Difficult to read output reports (typically log files)
- False-Positives
- Tuning versus default mode

We need …

- People to comment on specifications

- People to submit test cases for sharing with the community

- People to help build reference datasets for testing tools?

Contacts

- SAMATE web site **http://samate.nist.gov/**
- Project Leader: Dr. Paul E. Black
- Project Team Members:

  Elizabeth Fong, Romain Gaucher,

  Michael Kass, Michael Koo,

  Vadim Okun, Will Guthrie, John Barkley