Hacking the EULA: Reverse Benchmarking Web Application Security Scanners
Overview

Each year thousands of work hours are lost by security practitioners sorting through web application security reports separating out erroneous vulnerability data. Individuals must currently work through this process in a vacuum, as there is little to no publicly available information that is helpful. Compounding this situation, restrictive vendor EULAs (End User License Agreements) prohibit publishing of research about the quality of their signature base. Due to these agreements, a chilling effect has discouraged public research into the common types of false positives that existing commercial web application scanner technologies are prone to exhibit.
About the speakers…

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Introduction
Web Application Security Scanning Technology
The Problem of False Positives
What is Reverse Benchmarking?
Reverse Benchmarking Methodology
10 Common False Positive Types
Further Research
Business as usual…

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What is Reverse Benchmarking?
Whoever is first in the field and awaits the coming of the enemy, will be fresh for the fight; whoever is second in the field and has to hasten to battle will arrive exhausted.

-- Sun-Tzu “The Art of War”
Analyzing Application Security Scanners

- Security Assessment ‘quality’ criteria
  - Functionality (Black vs White Box)
  - Ergonomics & Usability
  - Performance
  - Feature Sets
  - Bling
  - Accuracy
  - False Positive Rates i.e. Signal to Noise
• Benchmarking Concepts
  – Benchmarking black box scanners is ultimately a systematic comparison

  – Most common Benchmarking technique is ‘positive’ or ‘comparative’ benchmarking

  – The goal is to see which scanner does the best against a selected application
Positive and Negative Accuracy concepts

<table>
<thead>
<tr>
<th>Positive Detection (True +)</th>
<th>Negative Detection (True -)</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Invalid or false result.</td>
<td>False Negative (a missed detection)</td>
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Benchmarking: Accuracy

Positive Benchmarking is a measure of the number of valid results relative to the total number of vulnerabilities in the application.

- **Example:** Scanner Foodizzle found 8 out of 10 vulnerabilities in the target application, i.e. it was 80% relative to the vulnerability-set.

- **Use:** Measures of ‘accuracy’ are commonly used during positive benchmarking, bake-offs, etc.

- **Challenges:** Accuracy is difficult to measure because it's often difficult to know exactly how many vulnerabilities there are in the target application.
Benchmarking Limitations

Positive Benchmarking relies on objective knowledge of vulnerabilities in the target application, and thus breaks down when not performed by experts

- **Selection Bias**: Scanner Foodizzle found 8 out of 10 vulnerabilities in the target application, i.e. it was 80% relative to the vulnerability-set.
- **Interpreting the Data**: Measures of ‘accuracy’ are commonly used during positive benchmarking, bake-offs, etc.
- **Tuning Against the App**: Accuracy is difficult to measure because its often difficult to know exactly how many vulnerabilities there are in the target application.
- **Analysis Gaps**: typical bake-off or benchmarking methods do not rigorously test important scanner characteristics like the spider, because the spider is only indirectly related to accuracy.
Benchmarking Limitations

Positive Benchmarking relies on objective knowledge of vulnerabilities in the target application, and thus breaks down when not performed by experts.

- Tuning Against the App: It's not uncommon for vendors to download the well-known sample applications and ‘tune’ their technology to detect most or all of the security issues.
Reverse Benchmarking enlarges the eye of the EULA needle...
What is Reverse Benchmarking?

- It’s a type of passive Reverse Engineering.
- Its Designed to Kick a Scanner’s Ass™
- Causes Massive False Positives
- Facilitates an understanding vulnerability detection methods
- Think of it as Detection Logic Fuzzing

- Exposes poor coding, faulty detection logic
- Reveals Security Testing design flaws
- Confuses Stateless Testing Mechanisms
Rationale for Reverse Benchmarking

Most of the Common False Positive Types have been around since 1999-2000

Most testing mechanisms are entirely stateless and have evolved little

Very little is known about False Positives, as a science

There are no taxonomies or Top 10 lists for Common False Positive Types
Reverse Benchmark Target

- Enumerates and Categorizes False Positive Types
- Reveals Vacuous or Meaningless results
- Reveals Semantic flaws in vulnerability Categorization
- Reveals systemic flaws in application spider technology

Web Application Scanner
Web Application Security Scanners
Key Trends 2000-2007

GUI’s have gotten prettier but the underlying technology hasn’t changed much since 2000.

Many technologies are still using stateless stimulus-response mechanisms for most security tests (XSS is becoming the exception to this rule).

False Positives related to the detection of SQL injection and Blind SQL Injection are rampant.

Mechanics of file scanning is still largely based on Whisker-Nikto, and prone to false positives.

AJAX and Web Services support has increased the numbers of false positives, due to re-use of legacy security testing procedures.

Signal-to-Noise Ratio is still very bad, with False Positives exceeding useful results usually by 2:1, and this is a conservative figure.

Most application spiders do poorly against javascript and flash, and some technologies cannot automatically navigate Form-based logins.

Semantic problems with security tests are widespread, i.e. mislabeled vulnerabilities, ambiguous vulnerabilities, meaningless results.

Each year the problem gets worse, and acquisitions may further set back innovation.
The Problem of False Positives
(A scanner darkly)
Common False Positive Types are not Easily Studied...

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Most EULAs prevent a comparison between technologies
Reverse Benchmarking Methodology

Active False Positive Solicitation and Reverse Fault Injection via a sample web application.

A reverse benchmarking target can be used to model a production application, thereby decreasing the semantic gap between triggered false positives and false positives found within the production environment.
Reverse Benchmarking Goals

The goal of Reverse Benchmarking is not to malign vendors, but to aid the security community and help developers avoid the same mistakes with each new generation of technology.

Systematically performed, Reverse Benchmarking can help security practitioners learn to quickly distinguish false positives from valid security issues, as they will learn the conditions under which the technology they are using fails.

Based on the type of trigger that elicits the false positive, a taxonomy of false positive types can be developed. A set of common causes or contributing factors for each type can be outlined.
Common Causes of False Positives

 Erotic Partial Match Problems

 Detection strings may be a subset of existing content and triggered by the presence of unrelated words or elements within the HTML or DOM

GET /search.pl~bak

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200 OK
Parameter Echoing

Parameter values may be echoed back in places within a web application, and this can trigger false positives.

```php
<?php
// get the form data
$field1 = $_POST['comments'];
// Echo the value of the comments parameter
echo "Backacha Biatch: $field1";
?>
```

```html
 TEXTAREA rows=3 ls=100>
  •  <?php
  •  // get the form data
  •  $field1 = $_POST['comments'];
  •  // Echo the value of the comments parameter
  •  echo "Backacha Biatch: $field1";
  •  ?>
  •  </TEXTAREA>
```
Mistaken Identity

Some security tests look for vulnerability conditions so general that the vulnerability reported must be disambiguated in order to be verified.

Many types of PHP forum software, Calendars, Blogs reuse a common code base and so overlapping URI and application responses

- Alibaba Search Overflow
- Paul’s Search SQL InjXn
- YABB Search.pl XSS
- GET /search.pl
Semantic Ambiguity

Signature-based detection is often relies on signatures that are generic and thus are neither necessary nor sufficient for the vulnerability to be present.

Many false positives arise because the vulnerability is more complex than the vulnerability conditions checked for by the signatures.
Response Timing

Slow, unresponsive, or delayed server-side processing can trigger security checks that are timing dependent.

Some SQL injection tests use a `wait_for_delay` expression and measure the timing.
Custom 404 Pages

Simple file scanning routines and other security tests will trigger erroneously in the presence of custom 404 pages.

Some signatures are based on 302 Redirects

```
GET /search.pl~bak
```

```
302
200
```
Custom 404 Pages

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Some signatures are based on 302 Redirects

GET /search.pl~bak

302 200
Creating a Reverse Benchmark target

- Nature of the target will depend on your goals as a researcher

**Reverse Engineering**

1. Emphasis on exposing as much of the signature base and rule set as possible without inspecting datafiles or code. Clear generic cases that will likely impact the largest portion of the rule base.

2. Focus on generic trigger signatures, including available open source scanners. (i.e. use of Nikto detections strings in response data.)
Creating a Reverse Benchmark target

Nature of the target will depend on your goals as a researcher

Bakeoffs/Comparisons

1. Emphasis on exposing false positives or signature flaws of all varieties, including the uncommon or essoteric. Use of non-standard or overly difficult application configuration to stress test the scanner.

2. Focus on unusual or non-standard trigger signatures. i.e. Javascript or Flash road test
Creating a Reverse Benchmark target

Nature of the target will depend on your goals as a researcher

**Reverse Engineering**

1. Emphasis on exposing as much of the signature base and rule set as possible without inspecting datafiles or code.

2. Focus on generic trigger signatures
Open Reverse Benchmarking Project

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Backatcha Roadtest Results

- Took 4 popular blackbox web application security scanners
- Ran their default policies against the target reverse benchmarking application
- Put the results into high level buckets
- Generated a few graphs with the results
Total False Positives

- Scanner 1: 92%
- Scanner 2: 4%
- Scanner 3: 2%
- Scanner 4: 2%
Scanner 1 False Positives

- 42% Known Vulnerabilities
- 30% Misconfigurations
- 14% Command Injection
- 0% XSS
- 7% SQL Injection
- 2% File Disclosure
- 5% Path Manipulation
- 2% Path Manipulation
- 7% Command Injection
- 0% XSS
- 2% SQL Injection
- 1% File Disclosure
- 5% Path Manipulation
- 2% Misconfigurations
Scanner 3 False Positives

- Path Manipulation: 0%
- Command Injection: 1%
- XSS: 0%
- SQL Injection: 1%
- File Disclosure: 0%
- Known Vulnerabilities: 2%
- Misconfigurations: 29%
- 67% Misconfigurations
- 2% Path Manipulation
Scanner 4 False Positives

- 53% Misconfigurations
- 36% SQL Injection
- 4% Command Injection
- 0% XSS
- 0% File Disclosure
- 0% Known Vulnerabilities
- 0% Path Manipulation
- 7% Other
Conclusions

- All Scanners had simple problems
- One scanner did really badly
- Further Research is needed
- Community support is needed
- Examples of false positives
Further Research
- Improve reverse benchmarking target
- Add more tests
- Improve testing methodology
- Test with more scanners

Partner with OWASP
- Help develop Reverse Benchmarking Module for SiteGenerator