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Hybrid Analysis Mapping:

Making Security and Development Tools Play Nice Together

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This presentation contains information about DHS-funded research:

Topic Number: H-SB013.1-002 - Hybrid Analysis Mapping (HAM)

Proposal Number: HSHQDC-13-R-00009-H-SB013.1-002-0003-I

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Dan Cornell

- Dan Cornell, founder and CTO of Denim Group
- Software developer by background (Java, .NET, etc)
- OWASP San Antonio
- 15 years experience in software architecture, development and security
- Heads Denim Group's application security team

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Denim Group Overview

- **Headquarters in San Antonio, TX**
  - *Remote offices: San Francisco, Seattle, New York City, Dallas and Austin*
  - *Founded in 2001, 90 employees, profitable since inception*
  - *Inc. Magazine 5000 Fastest Growing Company (5 consecutive years)*

- **Secure software services and products company**
  - *Builds secure software*
  - *Helps organizations assess and mitigate risk of existing software*
  - *Provides e-Learning and classroom training so clients can build secure software*

- **Customer base spans Fortune 500 and DoD**
  - *Market Focus: Financial Services, Banking, Insurance, Healthcare, and U.S. Air Force*

- **Software-centric view of application security**
  - *Application security experts are practicing developers delivering a rare combination of expertise in today's industry*
  - *Development pedigree translates to rapport with development managers*
  - ***Business impact: shorter time-to-fix application vulnerabilities***

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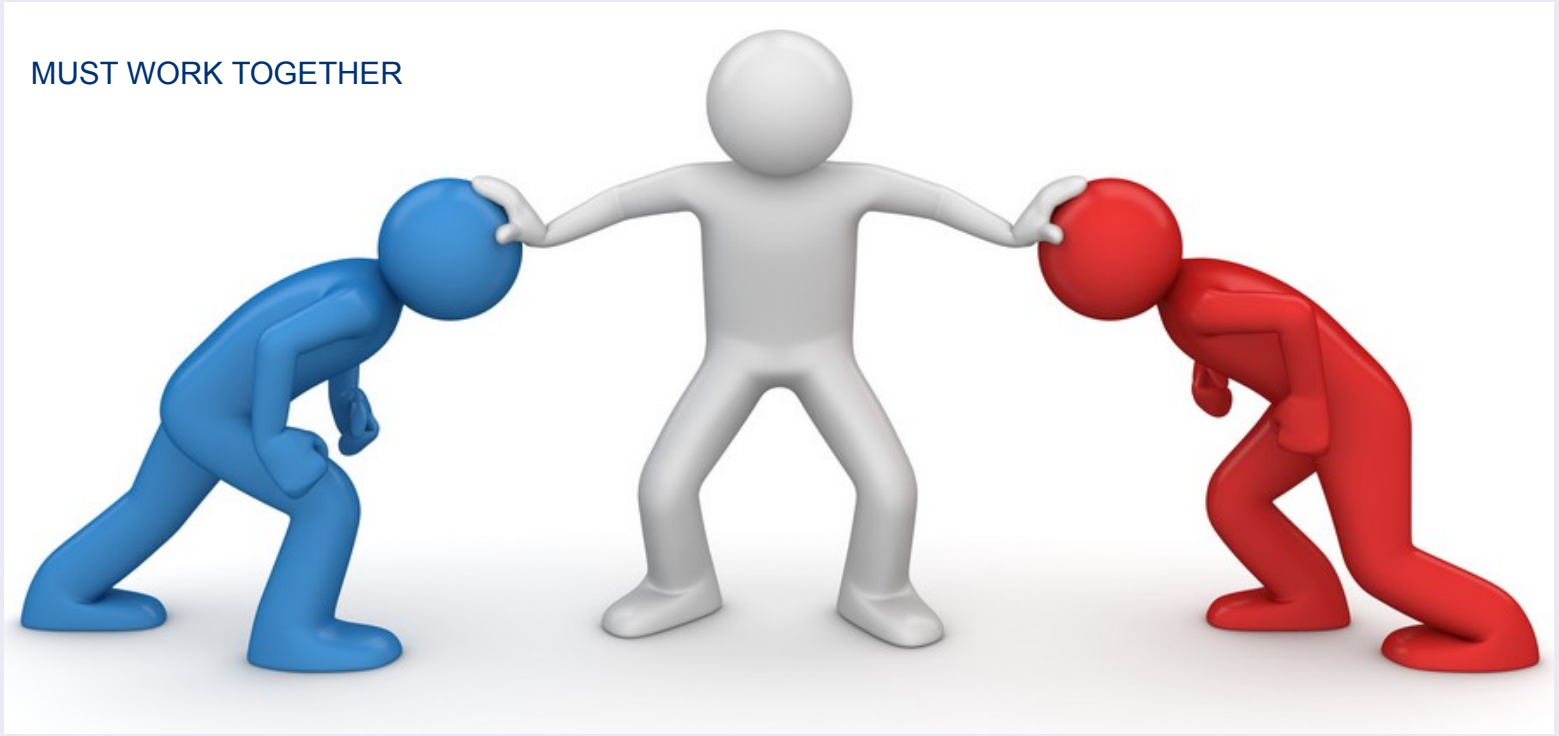
Agenda

- Security versus Development
  - *Teams*
  - *Tools*
- Hybrid Analysis Mapping (HAM)
  - *ThreadFix Overview*
  - *DHS SBIR Phase 1 Work*
- Demonstrations
- Next Steps
- Questions

Development and Security

- Have different goals
- Use different tools
- MUST WORK TOGETHER



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Development

- Features, functions timelines
  - *Get it done!*
- Manage workload: Defect tracking systems
- Write code: Integrated Development Environment (IDE)

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Security

- Policies, standards, risks
  - *Keep the world safe!*

- Network and infrastructure tools/paradigms adapted for applications
  - *Network scanners -> Application scanners*
  - *Network firewalls -> Web application firewalls*

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Problems with Security Tools (if you are in Security)

- Code analysis (static) tools can be challenging
  - *Often require coding experience to use effectively*
  - *Provide LOTS of results (often including false positives)*

- Application scanning (dynamic) tools have their own challenges
  - *Have to be properly configured to get good coverage*
  - *Have to learn about the application*

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Problems with Security Tools (if you are a Developer)

- Developers Don't Speak PDF
  - *Developers also don't speak Excel*

- Taking action based on dynamic scan results can be challenging
  - *What code needs to be changed and how?*

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How Do We Make Things Better?

- Developers need to learn more about security
  - *To better understand what impact their actions have on their organization's security posture*
- Security teams need to learn more about development
  - *What tools do they use?*
  - *How do they manage their workload*
- These interactions need to become more natural

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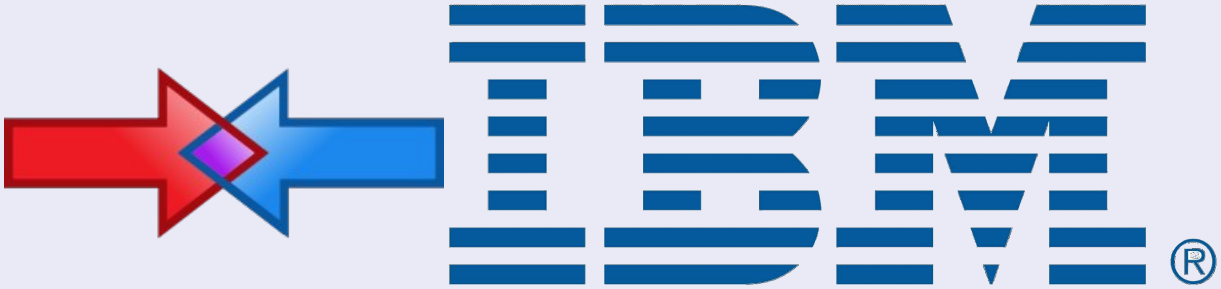
So What?

- Genesis of this presentation was some DHS-funded research
  - *Looking into "Hybrid Analysis Mapping" (HAM) via their SBIR program*
- Looking into better integration between dynamic and static scanners
  - *Found interesting applications above and beyond our original goals*

Hybrid Analysis Mapping – Phase 1 Goal

- Determine the feasibility of developing a system that can reliably and efficiently correlate and merge the results of automated static and dynamic security scans of web applications.



IBM AppScan Standard

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Dynamic Application Security Testing

- Spider to enumerate attack surface
- Fuzz to identify vulnerabilities based on analysis of request/response patterns

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Static Application Security Testing

- Use source or binary to create a model of the application
  - *Kind of like a compiler or VM*
- Perform analysis to identify vulnerabilities and weaknesses
  - *Data flow, control flow, semantic, etc*

```
String username = request.getParameter("username");
String sql = "SELECT * FROM User WHERE username = '" + username + "'";

Statement stmt;
stmt = con.createStatement();
stmt.execute(sql);
```

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Hybrid Analysis Mapping – Phase 1 Sub-Goals

- Standardize vulnerability types
- Match dynamic and static locations
- Improve static parameter parsing

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Hybrid Analysis Mapping

Phase 1 - Technical Objectives

- **Technical Objective 1: Create common data structure standards for both automated static and dynamic security scanning results.**
  - *Task 1: Create a Data Structure for Automated Dynamic Security Scanning Results*
  - *Task 2: Create a Data Structure for Automated Static Security Scanning Results*

- **Technical Objective 2: Research and prototype methods of mapping the results of automated static and dynamic security scanning.**
  - *Task 1: Create a Structured Model for Hybrid Analysis Mapping*
  - *Task 2: Investigate Approaches for Vulnerability Type Mapping*
  - *Task 3: Investigate Approaches for Mapping Source Code Files to URLs*
  - *Task 4: Investigate Approaches for Determining Injection Points*

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- **Open source vulnerability management and aggregation platform:**
  - *Allows software security teams to reduce the time to remediate software vulnerabilities*
  - *Enables managers to speak intelligently about the status / trends of software security within their organization.*

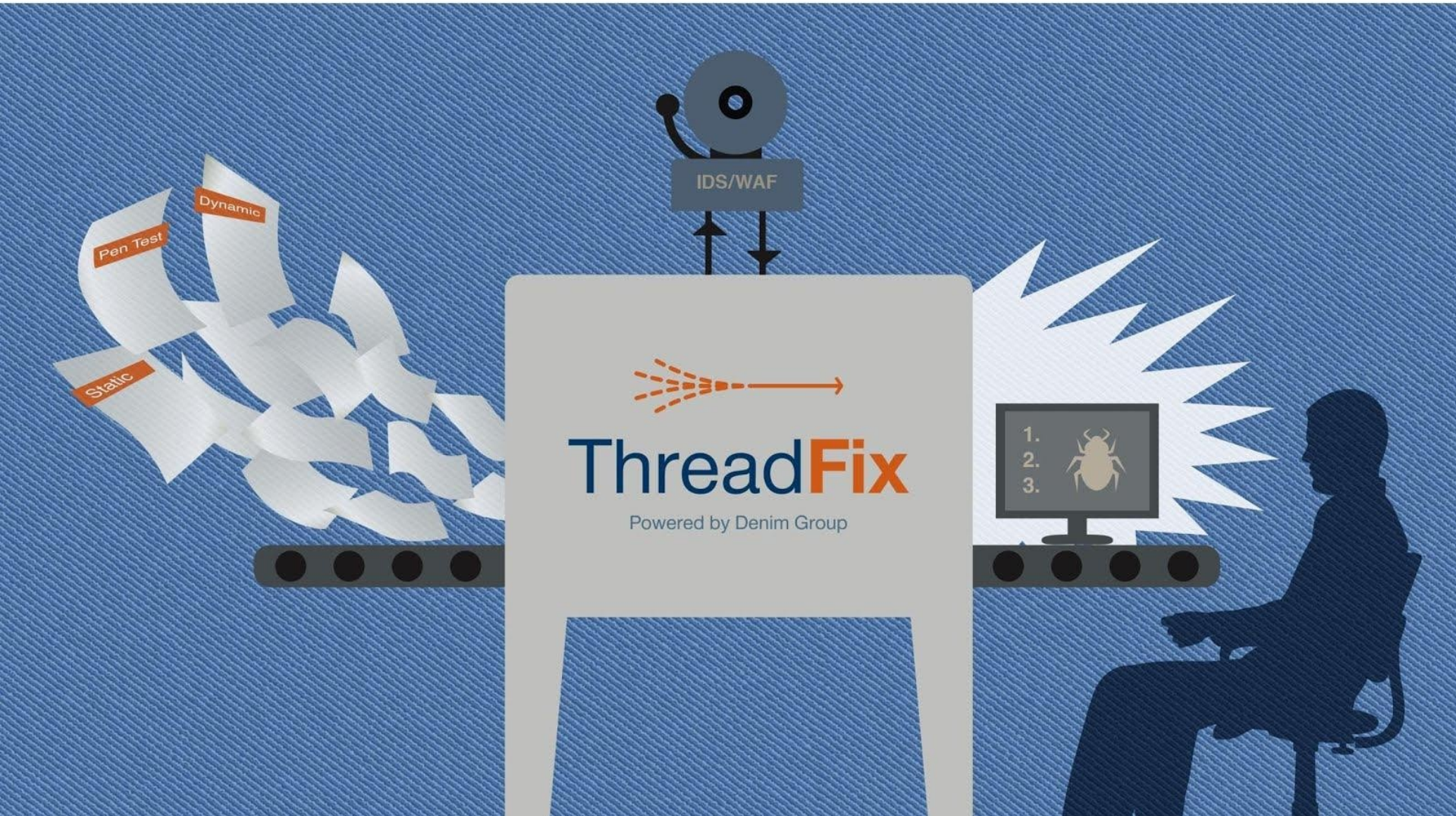
- **Features/Benefits:**
  - *Imports dynamic, static and manual testing results into a centralized platform*
  - *Removes duplicate findings across testing platforms to provide a prioritized list of security faults*
  - *Eases communication across development, security and QA teams*
  - *Exports prioritized list into defect tracker of choice to streamline software remediation efforts*
  - *Auto generates web application firewall rules to protect data during vulnerability remediation*
  - *Empowers managers with vulnerability trending reports to pinpoint issues and illustrate application security progress*
  - *Benchmark security practice improvement against industry standards*

- Freely available under the Mozilla Public License (MPL) 2.0
- Download available at: www.denimgroup.com/threadfix

ThreadFix

Accelerate Software Remediation

ThreadFix is a software vulnerability aggregation and management system that helps organizations aggregate vulnerability data, generate virtual patches, and interact with software defect tracking systems.



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List of Supported Tools / Technologies:

Dynamic Scanners

Acunetix

Arachni

Burp Suite

HP WebInspect

IBM Security AppScan Standard

IBM Security AppScan Enterprise

Mavituna Security Netsparker

NTO Spider

OWASP Zed Attack Proxy

Tenable Nessus

Skipfish

w3aF

Static Scanners

FindBugs

IBM Security AppScan Source

HP Fortify SCA

Microsoft CAT.NET

Brakeman

SaaS Testing Platforms

WhiteHat

Veracode

QualysGuard WAS

IDS/IPS and WAF

DenyAll

F5

Imperva

Mod_Security

Snort

Defect Trackers

Atlassian JIRA

Microsoft Team Foundation Server

Mozilla Bugzilla

Known Vulnerable Component Scanner

Dependency Check

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Large Range of Tool Compatibility

VERACODE

HP WebInspect

IBM

PortSwigger web security

w3af

Web Application Attack and Audit Framework

IMPERVA

ATLASSIAN JIRA

UNIVERSITY OF MARYLAND 18 56

FindBugs

because it's easy

SNORT™

skipfish

OUNCE LABS

Bugzilla

www.bugzilla.org

acunetix

Nessus®

hp Enterprise Security

arachni

web application security scanner framework

netsparker

WhiteHat SECURITY

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What is a Unique Vulnerability?

- (CWE, Relative URL)
  - *Predictable resource location*
  - *Directory listing misconfiguration*
- (CWE, Relative URL, Injection Point)
  - *SQL injection*
  - *Cross-site Scripting (XSS)*
- Injection points
  - *Parameters – GET/POST*
  - *Cookies*
  - *Other headers*

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Why Common Weakness Enumeration (CWE)?

- Every tool has their own “spin” on naming vulnerabilities
- OWASP Top 10 / WASC 24 are helpful but not comprehensive

- CWE is exhaustive (though a bit sprawling at times)
- Reasonably well-adopted standard
- Many tools have mappings to CWE for their results

- Main site: http://cwe.mitre.org/

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Information Used

- Source Code (Git URL)
- Framework Type (JSP, Spring)
- Extra information from Fortify (if available)

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Vulnerability Types

- Successful CWE standardization
- Investigation into trees and Software Fault Patterns
  - *Meant to correct for human errors*
  - *Hard to do in an automated fashion*

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Unified Endpoint Database (Static and Dynamic)

- EndpointQuery
  - *dynamicPath*
  - *staticPath*
  - *Parameter*
  - *httpMethod*
  - *codePoints [List<CodePoint>]*
  - *informationSourceType*

- EndpointDatabase
  - *findBestMatch(EndpointQuery query): Endpoint*
  - *findAllMatches(EndpointQuery query): Set<Endpoint>*
  - *getFrameworkType(): FrameworkType*

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Parsing Attack Surface Locations

- JSP: Start with root JSP folder
- Spring: Parse @Controller classes

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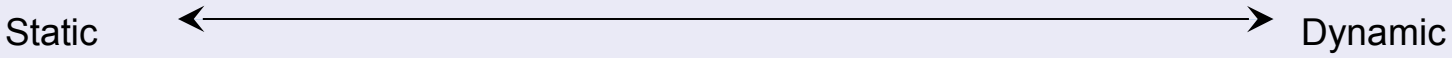
Parsing Parameters

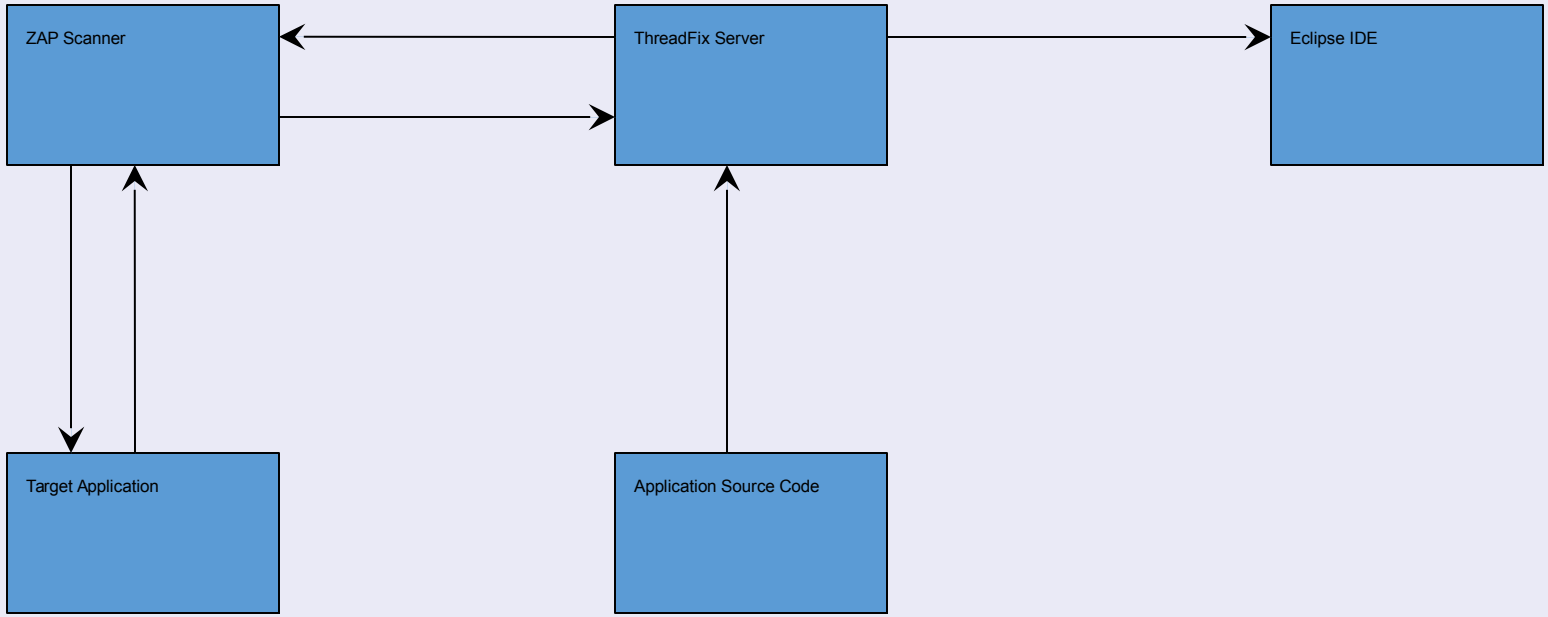
- JSP: Look for request.getParameter() calls
  - *Coupled with lightweight dataflow analysis*
- Spring: Parse @RequestParam, @PathVariable, @Entity annotations

HAM Bridge



- EndpointDatabase enables more than merging
- Scanner integration allows smarter scanning
- IDE plugin shows all vulnerabilities inline

System Structure



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Demonstrations

- Show me my application's attack surface
- Merge static and dynamic scanner results
- De-duplicate dynamic RESTful scanner results
- Pre-load my scanner with attack surface data
- Map my dynamically-identified vulnerabilities to their source code location

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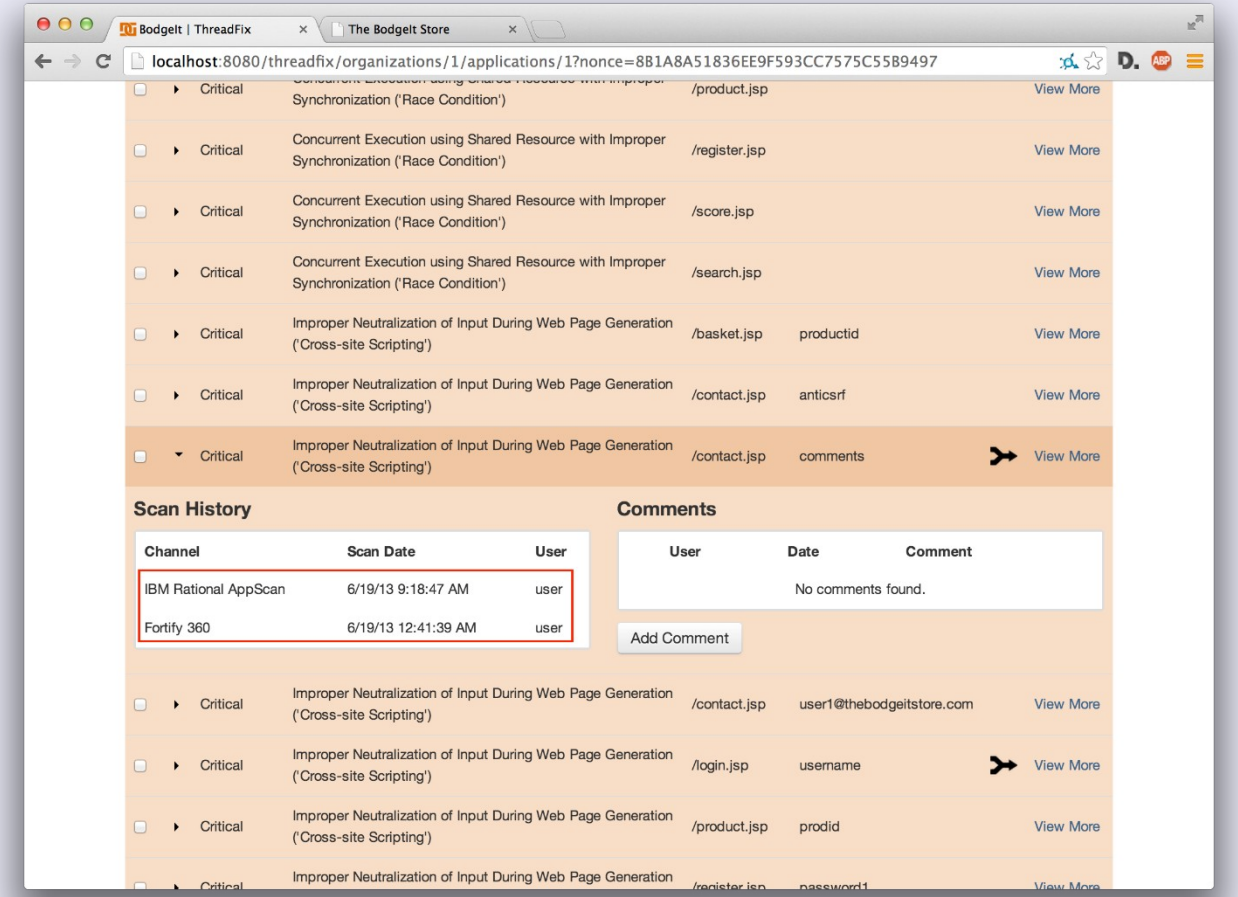
Application Attack Surface (CLI)

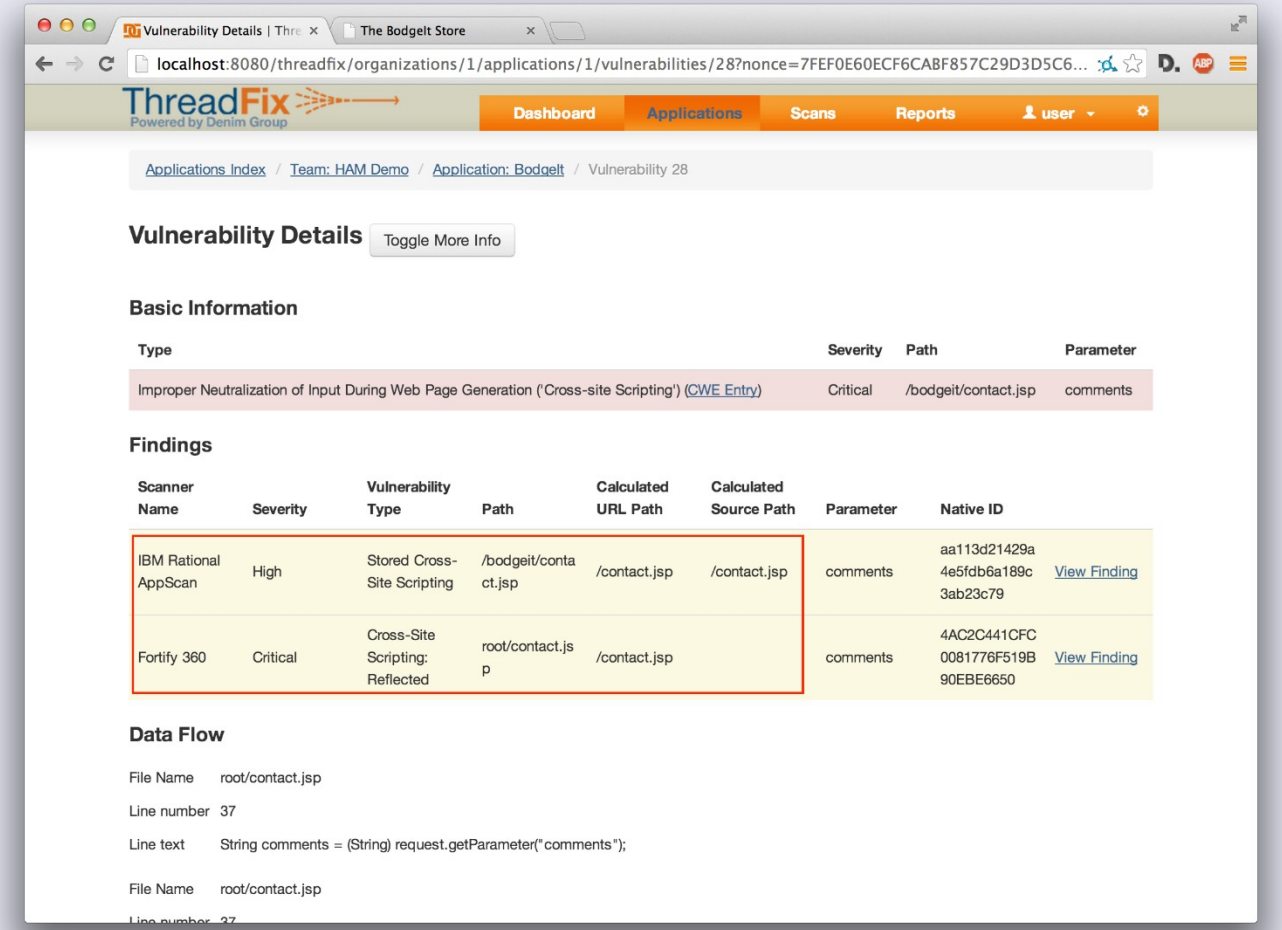
ham — bash — 124×40

```
Dans-MacBook-Pro:ham dcornell$ java -jar endpoints-experimental-20131106.jar ~/git/bodgeit/root/
INFO [main] MergeConfigurationGenerator.getDatabase(20) | Attempting to calculate framework type based on project contents.
INFO [main] MergeConfigurationGenerator.getType(16) | Attempting to guess Framework Type from source tree.
INFO [main] MergeConfigurationGenerator.getType(17) | File: /Users/dcornell/git/bodgeit/root
INFO [main] ServletMappings.guessApplicationType(175) | About to guess application type from web.xml.
INFO [main] ServletMappings.guessApplicationType(217) | Determined that the framework type was JSP
INFO [main] MergeConfigurationGenerator.getType(34) | Source tree framework type detection returned: JSP
INFO [main] MergeConfigurationGenerator.getDatabase(24) | Calculated framework : JSP.
INFO [main] GeneratorBasedEndpointDatabase.<init>(54) | Using generic EndpointGenerator-based translator.
INFO [main] GeneratorBasedEndpointDatabase.buildMappings(69) | Building mappings.
INFO [main] GeneratorBasedEndpointDatabase.buildMappings(82) | Done building mappings. Static keys: 0, dynamic keys: 16
[POST, GET],/about.jsp,[]
[POST, GET],/admin.jsp,[]
[POST, GET],/advanced.jsp,[q, debug]
[POST, GET],/basket.jsp,[update, productid, quantity, debug]
[POST, GET],/contact.jsp,[anticsrf, debug, comments]
[POST, GET],/footer.jsp,[]
[POST, GET],/header.jsp,[debug]
[POST, GET],/home.jsp,[debug]
[POST, GET],/init.jsp,[]
[POST, GET],/login.jsp,[username, debug, password]
[POST, GET],/logout.jsp,[]
[POST, GET],/password.jsp,[password1, password2]
[POST, GET],/product.jsp,[typeid, prodid, debug]
[POST, GET],/register.jsp,[password1, username, password2, debug]
[POST, GET],/score.jsp,[debug]
[POST, GET],/search.jsp,[q, debug]
Dans-MacBook-Pro:ham dcornell$
```

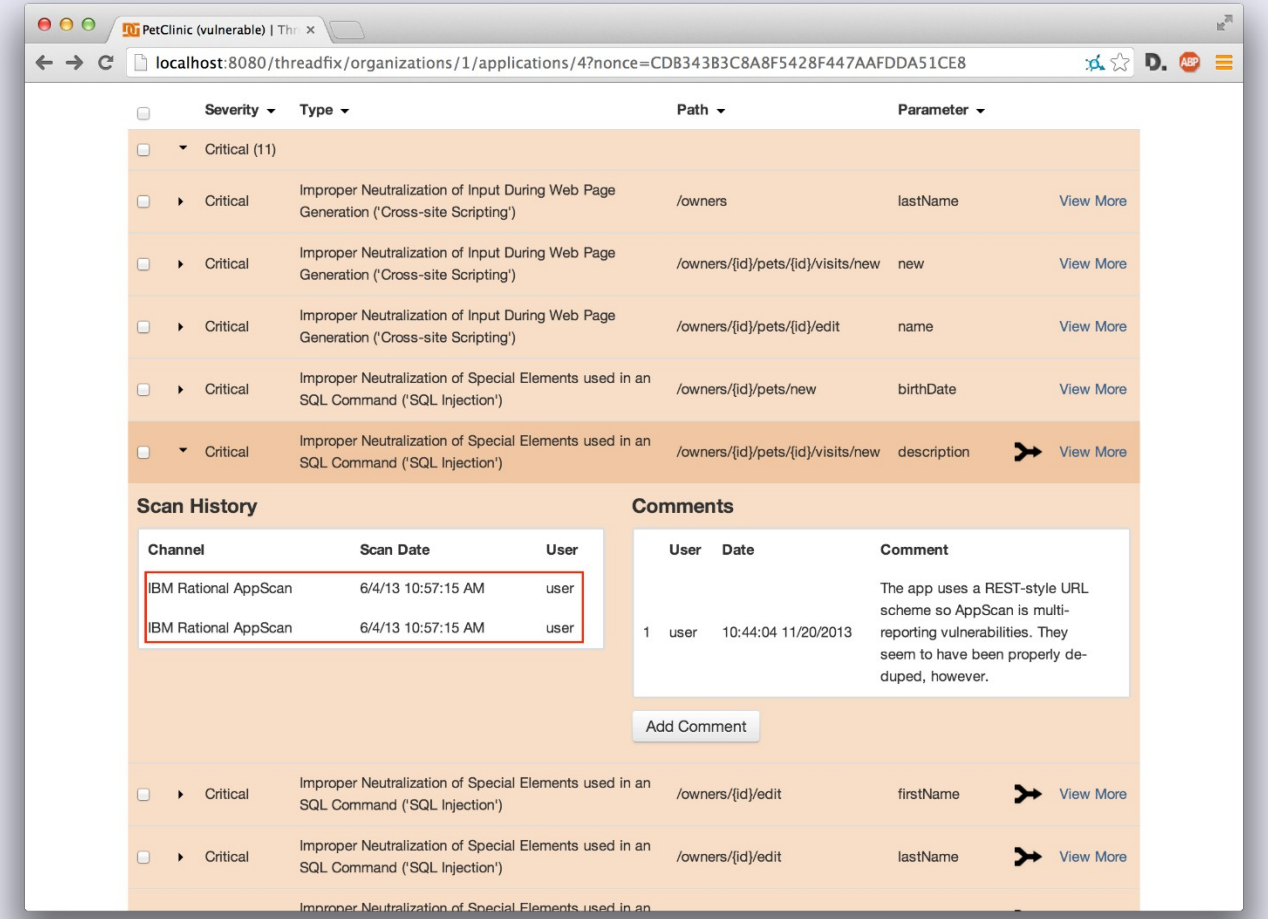
Merging Static and Dynamic Scanner Results



Merging Static and Dynamic Scanner Results



De-Duplicate Dynamic RESTful Scanner Results



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De-Duplicate Dynamic RESTful Scanner Results

Vulnerability Details | Thre ×

localhost:8080/threadfix/organizations/1/applications/4/vulnerabilities/10982?nonce=C1E9E2E479E2D82DA5AB27724...

ThreadFix
Powered by Denim Group

Dashboard | Applications | Scans | Reports | user

Applications Index / Team: HAM Demo / Application: PetClinic (vulnerable) / Vulnerability 10982

Vulnerability Details

Toggle More Info

Basic Information

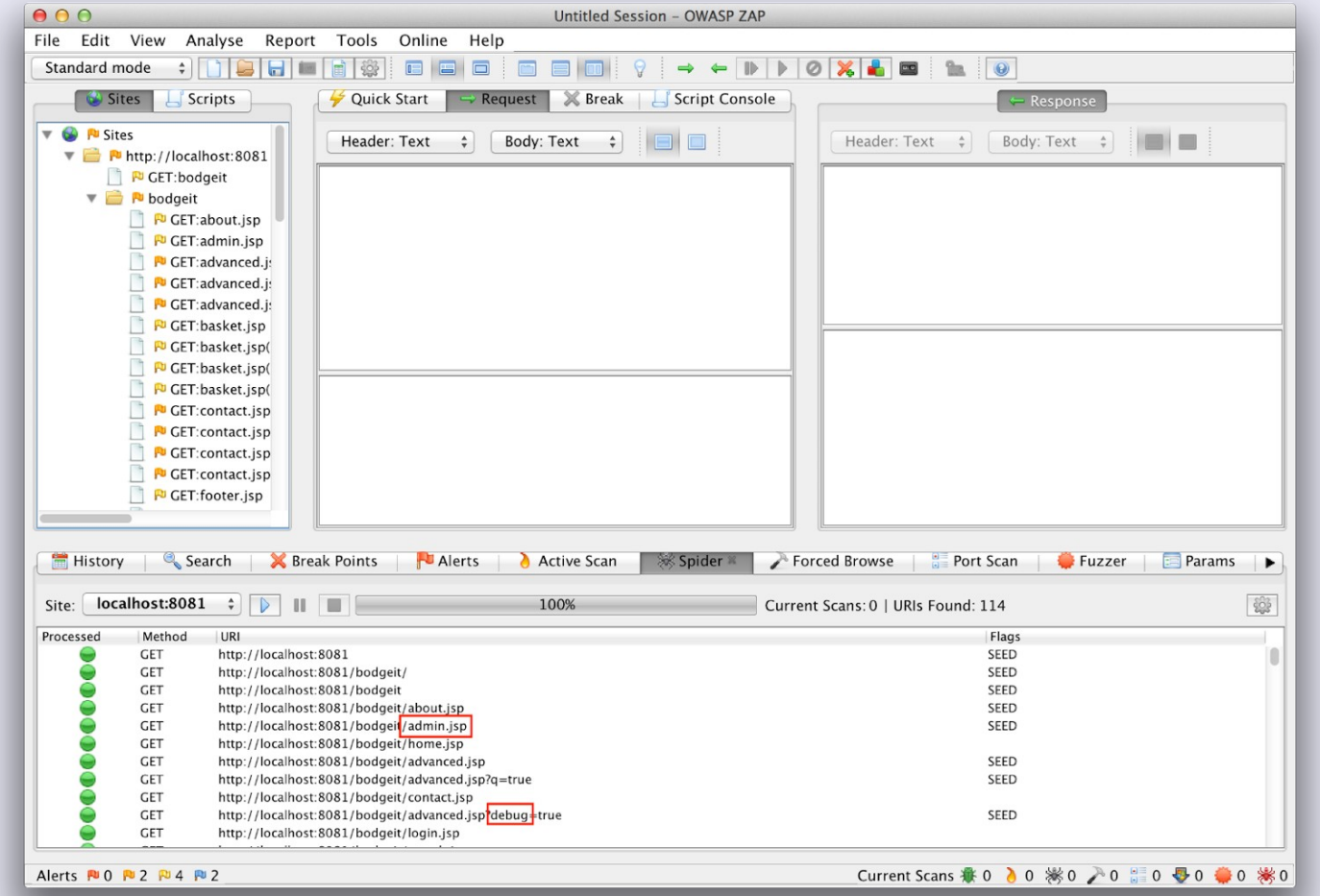
Type	Severity	Path	Parameter
Improper Neutralization of Special Elements used in an SQL Command ('SQL Injection') (CWE Entry)	Critical	/petclinic/owners/10/pets/12/visits/new	description

Findings

Scanner Name	Severity	Vulnerability Type	Path	Calculated URL Path	Calculated Source Path	Parameter	Native ID	
IBM Rational AppScan	High	Blind SQL Injection	/petclinic/owners/10/pets/12/visits/new	/owners/{id}/pets/{id}/visits/new	/src/main/java/org/springframework/samples/petclinic/web/VisitController.java	description	1a07468c95c11f782dee9ab5b7fb6c05	View Finding
IBM Rational AppScan	High	Blind SQL Injection	/petclinic/owners/4/pets/5/visits/new	/owners/{id}/pets/{id}/visits/new	/src/main/java/org/springframework/samples/petclinic/web/VisitController.java	description	4054c867b8edad825d4e4468b3e7ac9a	View Finding

Comments

Seed Scanner with Attack Surface



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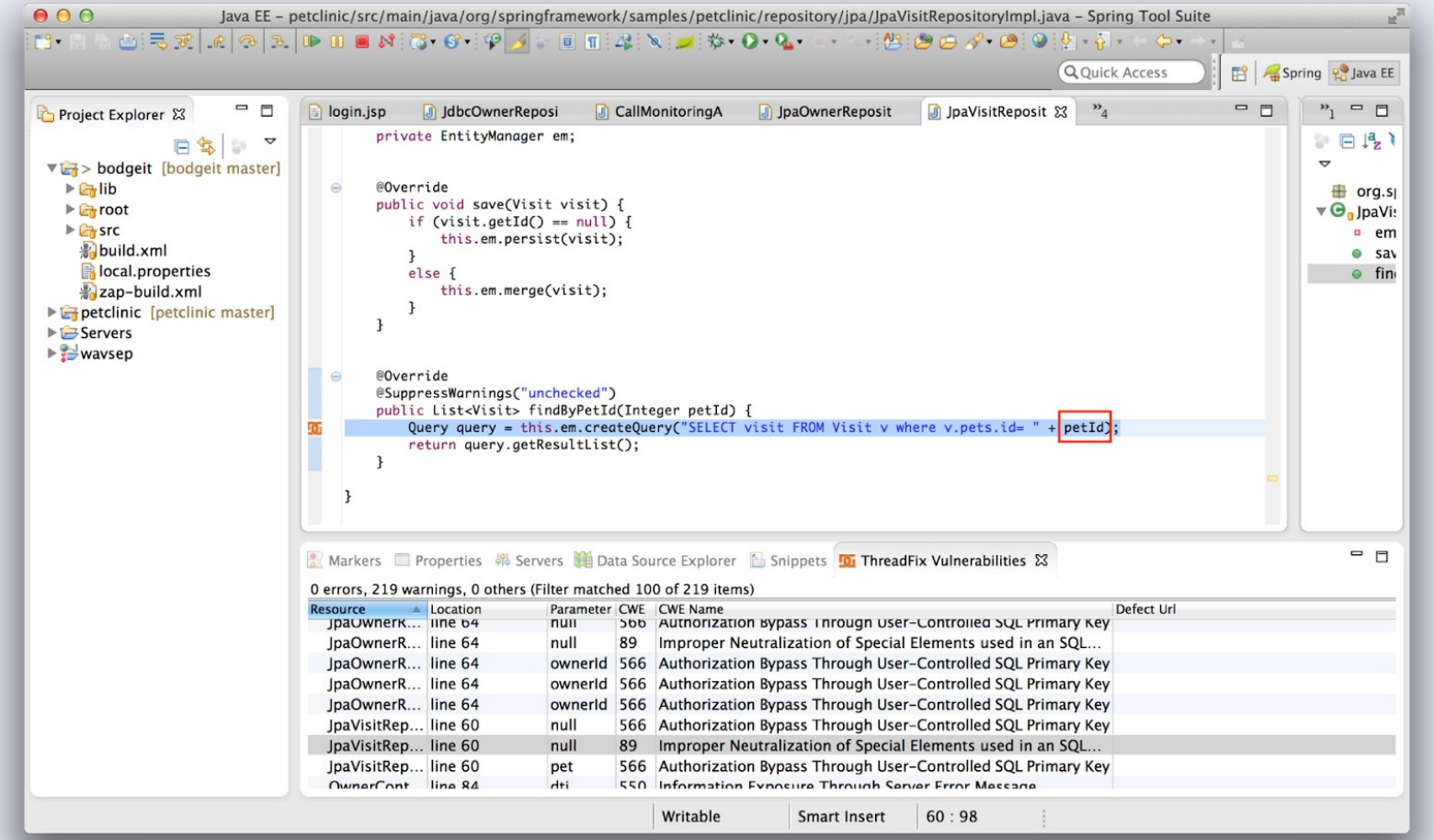
Map Dynamic Scan Results to LoC in IDE



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Framework Support

Level of effort to support current frameworks:

JSP:

Language	files	blank	comment	code
Java	7	167	176	698
SUM:	7	167	176	698

Spring:

Language	files	blank	comment	code
Java	15	370	412	1491
SUM:	15	370	412	1491

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What's Next?

- Started SBIR Phase 2 contract

- More frameworks:
  - *ASP.NET MVC*
  - *ASP.NET*
  - *Python/Django*
  - *Java/Struts*
  - *Java/JSF*
  - *Ruby on Rails*

- More IDEs:
  - *Visual Studio*

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What's Next?

Expand the application model:

- Authentication
- Authorization
- Injection points: Cookies and HTTP headers

Call To Action

- Download the endpoint calculator and run on your code
  - *What works? What doesn't work?*
  - *Currently support: Java/JSP and Java/Spring*
  - *Others in the works*

- Download the ThreadFix ZAP plugin
  - *Pre-seed some scans*
  - *Store scan data in ThreadFix*

- Download the ThreadFix Eclipse plugin
  - *Pull dynamic scan results into your IDE*

- What tools and frameworks do YOU want to see supported?

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Resources

- ThreadFix downloads (please don't download the GitHub ZIPs)
  - *http://www.threadfix.org/download/*
- Endpoint generator
  - *https://github.com/denimgroup/threadfix/wiki/Endpoint-CLI*
- ZAP plugin
  - *https://github.com/denimgroup/threadfix/wiki/Zap-Plugin*
- Eclipse plugin
  - *https://github.com/denimgroup/threadfix/wiki/Eclipse-IDE-Plugin*

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Questions?

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