Security Testing Fundamentals

SecAppDev 2015
Ken van Wyk, @KRvW

Leuven, Belgium
23-27 February 2015

KRvW Associates, LLC
Ken van Wyk, ken@krvw.com, @KRvW

SecureApplication Development
secappdev.org

Confessions of a pen tester

- Typical scenario looks like this
  - Customer calls and asks for a test
  - 2-3 weeks prior to product going “live”
  - Security test required by auditors
  - Want to ensure “hackers can’t get in”
  - How secure are we?

- What problems do you see here?

The problem

Too many organizations have either:

- Neglected security testing entirely
- Assumed (incorrectly) their QA testing will catch security issues
- Adopted a late-cycle penetration test process as their sole security test

When you ask the wrong questions, you won't get the answers you need!

Security testing is different

Security focus should primarily be on non-functional aspects of the software

- Not just focused on what the software can or should do
- Active deception of software intent
- Need to test every aspect of app

QA team often has a tough time "thinking like an attacker"

Uninformed “black box” testing

Advantages

- Unencumbered by prejudices of how things “should” behave
- Accurately emulates what an outsider might find
- Can be inexpensive and quick

Disadvantages

- Coverage is abysmal (10-20% LOC not abnormal)
- No notion of risk prioritization

Informed testing

- Advantages
  - Effort can be allocated by risk priority
  - Can ensure high coverage through careful test design
  - Emulate an insider attack
- Disadvantages
  - Functional “blinders” might miss things

Testing methods

- Common practices include
  - Fuzzing
  - Penetration testing
  - Dynamic validation
  - Risk-based testing

Fuzzing

- Basic principle
  - Hit software with random/ garbage
  - Look for unanticipated failure states
  - Observe and record
- Any good?
  - MS estimates 20-25% of bugs found this way
  - Watch for adequate coverage

Fuzzing techniques

Smart fuzzing and dumb fuzzing

“Dumb” refers to using random, unchosen data

“Smart” implies using chosen garbage

Example - fuzzing a graphic renderer

- Dumb approach is to throw it randomness
- Smart approach is to study its expected file formats and to construct garbage that “looks” like what it expects, but isn’t quite right

What to fuzz

Fuzz targets

- File fuzzing
- Network fuzzing
- Other I/O interfaces

Constructing "dumb" scenarios for each is easy, so let's look at some smart approaches

File fuzzing

Smart scenarios

- Really study the expected file format(s)
- Look for things like parameters in data
- Construct nonsensical input data parameters
  - Negative or huge bitrate values for audio/video
  - Graphic dimensions

Network fuzzing

- Smart scenarios
  - Really study the software-level network interfaces
    - Coverage here must include state
  - Look for things like flags, ignoring state
  - Also, HTTP/HTTPS interfaces
    - GET/POST
    - SOAP and RESTful interfaces too
      - Don't stop with the functions specified in the WSDL
  - Construct nonsensical input data parameters
    - "Insane" packet sizes
    - Data overflows and underflows

Interface fuzzing

Smart scenarios for all other "surfaces"

Really study the data interfaces

- APIs, registry, environment, user inputs, etc.

Construct nonsensical input data parameters

- Overflows and underflows
- Device names when file names are expected

Automation is your friend...

…and your foe

- Lots of fuzz products are appearing
- How can one size possibly fit all?
- How would you fuzz a browser Javascript (AJAX) function?
- Best fuzzing tools are in fact frameworks

Examples

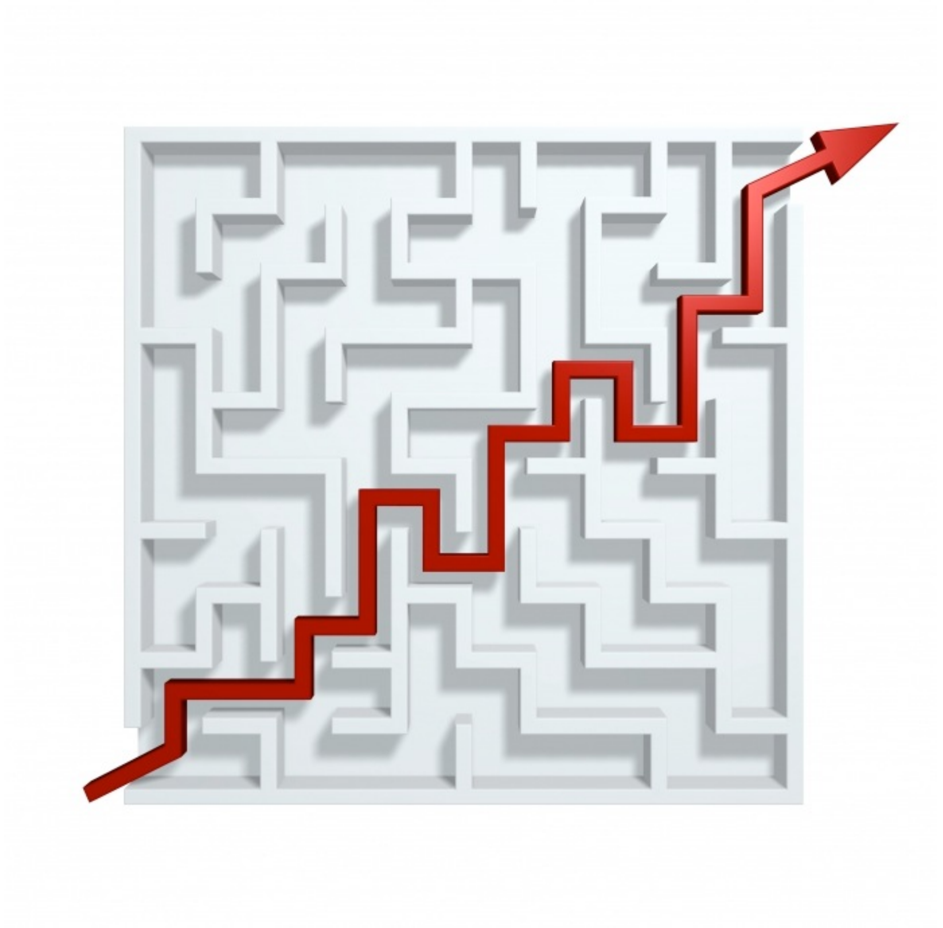
- OWASP’s JBroFuzz, PEACH, SPI Fuzzer

Finding value in pen testing

- Enough with what’s wrong
  - Consider informed testing
  - Quick form of attack resistance analysis
  - Risk-based prioritization
  - Nightmare scenarios from architectural risk analysis
  - Abuse case stories
  - Start with vendor tools, but then roll your sleeves up and do it yourself
    - Scripting tools can help tremendously

Pen testing strategies

- Inside => out approach is most likely to yield meaningful results
  - It doesn’t hurt to also do an outside => in test
  - One very small part of overall testing
  - Adversarial approach
  - Surprises happen



Basic pen testing methods

- Target scan
  - Take inventory of target space
- Vulnerability scan
  - What potential preliminary weaknesses are present?
- Vulnerability exploit
  - Attempt entry
- Host-based discovery
  - What interesting “stuff” is on each breached system?
- Recursive branching
  - Repeat until finished

Pen test results

- Results need to be actions for dev team
  - Traditional pen test teams report to IT
  - Need to adapt to different audience
  - Map findings to modules and code

Automation is really your friend

- Pen test tool market is (arguably) one of the strongest in the security business
  - Choices abound in commercial and open source
  - Many are quite mature
  - Almost a commodity market
- Examples include
  - Nmap, nessus, Metasploit, ISS, Core Impact, Retina

Dynamic validation

- Time to verify all those security requirements and functional specs
  - QA will have easiest time building test cases with these
  - Fault injection often used
  - Helps if requirements verbiage is actionable
- Can also be driven by design
  - Look for key assumptions
    - E.g., “session token is always HTTPS”

Automation, what's that?

- Dearth of available tools
  - Some process monitors are available and helpful
  - Test cases are easiest to define
- Specific tool hints
  - Web app proxies (work great with mobile apps too)
  - Single stepping debuggers with key breakpoints
  - MITM tools between app and OS

Examples – HTTP 1

```
POST http://www.example.com/AuthenticationServlet HTTP/1.1
Host: www.example.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; it; rv:
1.8.1.14) Gecko/20100404
Accept: text/xml,application/xml,application/xhtml+xml
Accept-Language: it-it,it;q=0.8,en-us;q=0.5,en;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: http://www.example.com/index.jsp
Cookie:
JSESSIONID=LVrRRQQXgwyWpW7QMnS49vtW1yBdqn98CGlkP4jTvVCGdyPkmn3S!
Content-Type: application/x-www-form-urlencoded
Content-length: 64

delegated_service=218&User=test&Pass=test&Submit=SUBMIT
```

Examples – HTTP 2

```
POST https://www.example.com:443/login.do HTTP/1.1
Host: www.example.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; it; rv:
1.8.1.14) Gecko/20100404
Accept: text/xml,application/xml,application/xhtml+xml,text/html
Accept-Language: it-it,it;q=0.8,en-us;q=0.5,en;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: https://www.example.com/home.do
Cookie: language=English;
Content-Type: application/x-www-form-urlencoded
Content-length: 50

Command=Login&User=test&Pass=test
```

Examples – HTTP 3

```
POST https://www.example.com:443/login.do HTTP/1.1
Host: www.example.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; it; rv:
1.8.1.14) Gecko/20100404
Accept: text/xml,application/xml,application/xhtml+xml,text/html
Accept-Language: it-it,it;q=0.8,en-us;q=0.5,en;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: http://www.example.com/homepage.do
Cookie:
SERVTIMSESSIONID=s2JyLkvDJ9ZhX3yr5BJ3DFLkdphH0QNSJ3VQB6pLhjkW6F
Content-Type: application/x-www-form-urlencoded
Content-length: 45

User=test&Pass=test&portal=ExamplePortal
```

Examples – HTTP 4

```
GET https://www.example.com/success.html?
user=test&pass=test HTTP/1.1
Host: www.example.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; it;
rv:1.8.1.14) Gecko/20100404
Accept: text/xml,application/xml,application/xhtml
+xml,text/html
Accept-Language: it-it,it;q=0.8,en-us;q=0.5,en;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: https://www.example.com/form.html
If-Modified-Since: Mon, 30 Jun 2010 07:55:11 GMT
If-None-Match: "43a01-5b-4868915f"
```

Risk-based testing

Time to animate those “nightmare scenarios” you uncovered in the architectural risk analysis

- Start with abuse cases, weakness scenarios
- Describe and script them
- Try them one step at a time

Begin at the beginning and go on till you come to the end; then stop. − Lewis Carroll

Automation, what's that?

- Dearth of available tools
  - It's rare that these scenarios lend themselves to general purpose automation
  - Test cases are really tough to define
- But many of same tools used in dynamic validation can be useful

Additional considerations

There's plenty other things to think about

- Threat modeling
- Results tracking
- Five stages of grief
- Knowledge sharing
- Improvement and optimization

Threat modeling can help drive

Who would attack us?
What are their goals?
What resources do they have?
How will they apply technology?
How much time do they have?

Answers can help in understanding feasibility of attacks

Results tracking

Lots of good reasons to track results

- Use again during regression testing
- Ensure closure
- Knowledge transfer of lessons learned
- Justify time spent

Tools can help
Test Director

Five stages of grief

Security testers are often the bearers of bad news

- Learn from the Kübler-Ross model
  - Denial, anger, bargaining, depression, acceptance
  - Watch out for denial and anger!
- Understand and anticipate
- Diplomacy and tact will optimize likelihood of acceptance

Knowledge sharing

Show the dev team how their code broke

- Best way to learn
- Learning from mistakes visually is hugely powerful

If a picture tells a thousand words, a live demonstration shows a thousand pictures

Improvement and optimization

Immediate goal is to find defects in today’s software, but preventing future defects is also a worthy goal

- Formalize lessons learned process
- Consider papers, blog entries, etc., to share new findings (once fixed) with others
- Learn from medical community model

Getting started

- Some general tips and guidelines
  - Interface inventory
  - Let risk be your navigator
  - Get the right tools for the job
  - Scripting skills can be very valuable

Interface inventory

- Start by enumerating every interface, API, input, output, etc.
  - This should be done per module as well as per application
  - List everything
  - Some call this the “attack surface”
  - This list should become a target list as you plan your tests
  - Flow/architecture charts are useful

Risk navigation

The target list is probably too big to do a thorough job

- Prioritize focus in descending risk order
- Follow the most sensitive data first
- Those flow charts will set you free

See now why rigorous testing should be informed?

Test scenario sources –1

Develop test scenarios throughout SDLC

Start at requirements, such as

- US regs: GLBA, SOX, HIPPA
- ISO 17799 / BS 7799
- PCI
- OWASP's WASS

Warning, they're often fuzzy (no pun…)

- SOX says, "Various internal controls must be in place to curtail fraud and abuse."

Test scenario sources −2

- Also look elsewhere in SDLC for test cases
  - Abuse cases
    - Many cases translate directly to test cases
  - Architectural risk analysis
    - Seek the doomsday scenarios
  - Code
    - Compliance with coding standards

Deployment testing

Rigorous testing of environment

- Network services
- File access controls
- Secure build configurations
- Event logging
- Patch management
- Test for all of this
  - Not your job? Who is doing it? The pen testers?

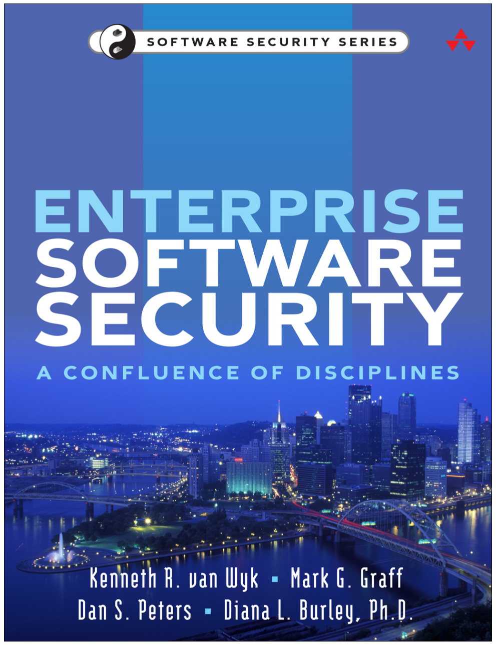
References

Some useful additional reading

- "Adapting Penetration Testing for Software Development Purposes", Ken van Wyk, http://BuildSecurityIn.us-cert.gov
- "The Security Development Lifecycle", Michael Howard and Steve Lipner
- Fuzz testing tools and techniques http://www.hacksafe.com.au/blog/2006/08/21/fuzz-testing-tools-and-techniques/

Kenneth R. van Wyk
KRvW Associates, LLC

Ken@KRvW.com
http://www.KRvW.com
@KRvW


SOFTWARE SECURITY SERIES
ENTERPRISE SOFTWARE SECURITY
A CONFLUENCE OF DISCIPLINES
Kenneth R. van Wyk • Mark G. Graff
Dan S. Peters • Diana L. Burley, Ph.D.