Security testing using JUnit and Perl scripts

(Reproduced in 2021 as the original publication is no longer available for you)

Julian Harty
Commercetest Limited
High Wycombe, UK
julianharty@gmail.com

Abstract
In this paper, I describe a recent practical experience where JUnit was used for testing security bugs in addition to functional bugs. Perl scripts were also used during the exploration phase. The application being tested was mature, but insecure.

Categories and Subject Descriptors D2.5 [Testing and Debugging]; D4.9 [perl]; scripts
General Terms Experimentation, Security, Verification.
Keywords JUnit, Security testing.

1. Introduction
This presentation describes how I used a combination of short, basic scripts written in Perl, and more structured tests written in Java, using the JUnit framework to test the security of a custom file transfer program. Some details of the example have been changed to maintain confidentiality of the project, and to simplify some non-essential details, however the lessons are generally applicable to other networked software applications.

Section 2 describes the background of the case study, Section 3 describes the exploration process and how using Perl scripts helped to improve the effectiveness and efficiency of the testing. The rationale behind the choice of JUnit, and how the test framework was structured to perform the security testing is contained in Section 4. Section 5 contains a summary of the results of the testing, and some conclusions. Section 6 describes opportunities for further work, and includes suggestions for how readers may apply some of the lessons learnt and techniques covered in this presentation. Section 7 contains the acknowledgements, and finally Section 8 contains references and further reading.

Optionaly, an additional section can be added to describe how Threat Modelling helped motivate the project management into fixing the security flaws identified during the exploration phase. This would be added between the current sections 3 & 4. The presentation would probably take a double-session to cover the topic adequately.

2. Background
The case study was the result of a consultancy assignment to assess, test and trouble-shoot the performance of a 20,000 node, distributed client-server application in Europe. During the initial assessment, the file transfer programs were identified as giving ‘cause for concern’ as they underpinned a number of vital infrastructure services within the 20,000 network, including: software distribution, and collection of audit data. Failure of the file transfer subsystem would have had very serious financial, business and political implications.

While trying to analyze the behavior of the file transfer software, by entering commands manually via a software interface, miss keying of the commands caused the system to expose sensitive information. As a result, I was given permission to explore the system to find possible security flaws.

3. Exploring using Perl scripts
3.1 Why scripts?
Manual testing helped to find some security flaws with the file transfer software, however a number of reasons justified automating a number of the tests. These reasons included:

• Making the tests more repeatable
• Simplifying the correct population and formatting of binary length fields

However we did not have the budget or time to use a commercial security-testing tool. Furthermore none of the commercial security testing tools supported the custom file transfer protocol, so the effort required to automate the tests for a commercial tool might have taken as long as doing so with homebrew scripts.

3.2 Why Perl?
We picked Perl for two main reasons:

• We had a Perl guru on the team, who offered to help create the scripts
• The Perl community provided numerous add-on modules, such as mod-telnet, which reduced the effort of creating suitable tests to a minimum.

3.3 The tests
Approximately 6 short tests were created using Perl scripts. An initial script was simply copied and pasted before being edited to create the next test. No test program exceeded 20 lines of code, including comments, and the effort of creating a more structured, or more modular code was not justified during the exploration phase.

The tests included:

• Sending a correctly formatted PUT (send file)
• Directory attacks to determine whether sensitive files and directories could be accessed
• Sending messages that might cause a buffer overrun in the
  destination software, by ‘breaking’ the rules of the protocol.

3.4 Supporting tools
An open-source, free network analyzer called Ethereal [2], and
Telnet, a commonly available system utility were used during the
test automation process. Four source code analyzers were also used
to help identify other potential flaws in the underlying source code
of the file transfer programs.

Ethereal allowed network requests and responses to be captured
and reviewed. Some of the network traffic came from a typical,
working system, which were used to reverse-engineer certain as-
pects of the file transfer protocols. Other traffic was captured to
help debug initial teething-problems when creating the first few
Perl scripts, owing mainly to our lack of understanding of how to
use the Net-telnet library.

Telnet provided the interface for manual testing of the file trans-
fer programs.

4. Using JUnit for Security Testing
4.1 Why automate the testing?
As new versions of the file transfer programs were being coded
and released for testing, we realized there was no structured way

to test the programs. In the past the testing seemed to be limited to
manual confirmatory-testing that required over 5000 formatted
binary values in a single network request. Therefore we decided
to automate the testing. As there was an incomplete, but semi-
functional set of functions written in Java we decided to use this
code as the basis for our main suite of test automation code.

We also wanted to prove our tests were effective i.e. that they
were able to generate failures in the existing, flawed file trans-
fer programs, before submitting the newer releases for testing.
This was a variation on typical regression testing as we wanted
to demonstrate that the old code failed, before testing to find out
whether the new code was able to cope with such attacks. As we
needed to test multiple versions of the file transfer programs, some-
times in parallel or on multiple machines test automation seemed
the most practical way to execute the tests.

4.2 Why JUnit?
The project team had experimented with a J2EE framework for test
automation, however the framework code was complex and hard
to configure. JUnit is a well-tried and respected test automation
framework, particularly suited to low-level ‘developer-testing’ so
we chose to use it to structure our test automation code. The
developers liked being able to execute the tests from within their
IDE (Eclipse) while the testers could use JUnit from the command
line on test machines.

4.3 Modifying the interface of the existing Java code
The existing Java functions had been designed and implemented to
encapsulate the inner workings of the file transfer protocol. While
this might have been adequate for functional testing, the security
test cases needed to abuse the protocol e.g. in order to attempt a
buffer-overflow attack. The interface had to be modified to provide the
calling code (the JUnit test cases) with the ability to modify and
subvert aspects of the file transfer protocol.

1 Testing to see whether the software did what it should do, rather than
testing to find failures

4.4 Categories of test cases
A number of types or categories of test cases were designed and
implemented. These included:

• Boundary Value Analysis (BVA) of numeric fields such as
  buffer sizes
• Missing values
• Very large, zero and negative values for numeric fields
• Long strings and messages
• Mal-formed sequences of messages that broke the rules of the
  file transfer protocol

The majority of these tests were coded as separate sets of JUnit
test cases e.g. one file might contain the BVA tests for the buffer
length, and another the negative, zero and large integer values for a
length field. However a few tests, including some for the malformed
sequences of messages were left as Perl scripts as we did not have
the time or need to recode these as JUnit scripts. We would have
first had to create additional functions to support the PUT (send
file) requests.

5. Results and Conclusions
5.1 Results
In summary, the results of the testing framework described in this
paper, enabled a significant number serious security flaws to be dis-
covered, fixed and tested in a safe, controlled environment. When
new flaws were discovered, suitable tests were created in either Perl
or JUnit to ensure the fixes could be tested effectively and effi-
ciently. Detailed results cannot be provided at this stage for various
(undisclosed) reasons.

5.2 Conclusions
By using a combination of JUnit and Perl scripts we were able to create
effective and efficient automated test cases. A number of
supporting tools made the work easier.

Based on my experience of this work I suggest a similar ap-
proach may be fruitful for testing security of other types of net-
worked applications, including web-based and XML-based soft-
ware.

6. Opportunities for further work
This case study is based on a particular experience where many
details are confidential. Therefore some details of the file transfer
protocol, the security flaws found, etc. need to be obscured or ob-
fuscated, which makes some lessons harder to transfer to interested
readers. If a similar, public domain network program, particularly
one that is insecure in its basic version (e.g. from an early version
of the program written before security issues were prevalent) the
case study could be updated to use that program as the software to
be tested. Detailed results, and examples of the actual bugs found,
could then be published.

Acknowledgments
My thanks to Michael Kelly who reviewed a description of this
case study in another form, and to several anonymous people who
helped me on the case study.

References
[1] http://www.junit.org/
[2] http://www.ethereal.com/