# FIPS Certification and the Bouncy Castle Project, or What Do You Mean I Can't Just Do a New Release Tomorrow?

# A Quick Look at Bouncy Castle

- Collection of APIs in Java and C#
- Provides basic cryptography and implementations for a range of ISO, ITU-T, and IETF standards such as X.509, OpenPGP, S/MIME, and TLS.
- Core Java API 324,000 lines (565,000 including tests and compatibility APIs).
- Core C# API 165,000 lines (237,000 including tests)

# History of Bouncy Castle

- Started in 2000
- Originally just Java, C# added in 2004
- 3 core developers and a bit of extra help

- Core feature set determined by essential and interesting algorithms at the time
- Algorithm set evolved according to the needs of the APIs built on the core crypto library
- APIs evolved according to core developer needs and user feedback

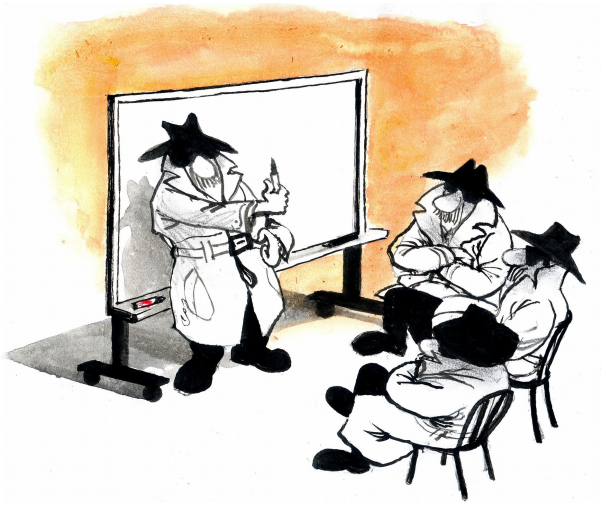
# History of Bouncy Castle (Cont.)

- Original Java API was 27,000 lines
- By around 2007 the effect of adding around 300,000 lines of code in an ad-hoc fashion was starting to be felt
- Started grappling with the issue of whether to simply run from the project, or find some way of funding it
- Decided not to run, but needed some way of moving the dialogue with our users to the fact the work needed to be paid for

# Interest in FIPS 140-2

- We started getting requests for FIPS compliance as soon as the APIs became commonly accepted
- FIPS 140-2 also provides the basis for many other standards
- And, put bluntly, everyone understands FIPS 140-2 has to be paid for, so it provided a way of starting to move to the funding dialogue
- Provided a focus point for raising the quality of the APIs as well

# Launching the FIPS effort



- Had enough money to do an initial product and documentation review, so started there
- Other expenses: lab fees, NIST recovery fees, and the actual cost of doing it
- Preparation for product review showed there were a number of problems with the way BC did things, mainly in the low level, or “light weight” APIs
- Low-level BC was designed for maximum flexibility
- FIPS 140-2 is, in some ways, more protective

# Hindsight

- As it turned out, raising the money, while it took time, was not a huge problem
- Even revamping the low-level API was not a massive effort
- Issues around algorithm testing are easy to deal with as well
- Operational testing, while still more “hands on” than we would like, was not a problem item either
- The update process, on the other hand was, and still is, a killer

# Updates – Non-FIPS

- BC developer either gets inspired, receives a code contribution, or flies into a panic about something
- Makes changes, writes tests, does a full build to do regression testing
- Automated build (Jenkins) takes over and runs some more builds doing further testing
- Beta release gets shipped for Java 1.5 and later
- Eventually an actual release gets done

# Updates – Non-FIPS (Cont.)

- Record for receipt of report to working tested beta with fix is around 2 hours
- Record for roll out of a full release across all the JVMs supported is around 16 hours
- Further work on automation could reduce the roll out time of a full release
- Overall user satisfaction quite high

# Updates - FIPS

- Two categories – before submission, after submission
- Submission represents CAVP and operational testing
- Record for before submission turnaround is about the same as for Non-FIPS
- Once CAVP testing and operational testing are done it suddenly gets a lot harder. Worst case is that a modification results in a full resubmission.

# Culture Issues – Development

- Independent Open Source projects are resource constrained.
- A project's survival depends on successfully doing “as needed” development

- “as needed” means that you do not do things fully up front, opting instead for an evolutionary approach so features are added as required
- “as needed” is also one of the principles of agile development.

# Culture Issues - Testing

- “as needed” also affects testing
- Observer bias – difficult to look in depth at things that you either do not think of or do not care about
- Observer bias is an issue for the library developers
- Correct behaviour which has arisen implicitly from otherwise tested code often not captured in explicit tests
- Identifying bias requires testing tests

# Culture Issues – Testing (Cont.)

- Likewise, user acceptance testing also suffers from observation bias.
- Users generally only care about what works for them.
- Reporting of issues varies according to state of project
- The reality is everyone feels they are short of time
- End result is things get missed because they are “not important”
- Traditionally testing not well budgeted for even in closed source efforts

# FIPS Process

- FIPS certification is managed as a “big up front” process
- From a FIPS perspective CAVP and operational testing guarantee algorithms are correct and health tests are in place
- From a user perspective CAVP and operational testing do not show that the scaffolding that goes around the algorithms is correct
- Unfortunately both the algorithms and the scaffolding end up inside the implementation boundary of a software module

# Why this Matters

- For API users, algorithm correctness is also important, but so is the correctness of the scaffolding
- In the case of the JCA/JCE scaffolding correctness is in two forms: compliance to that which is documented, and compliance to that which is implemented already (so implied)
- In some cases 3rd party vendors assume things about scaffolding which can make an API unusable in an application if the API does not conform

# Changes in Approach - BC

- Needing to write and maintain more tests to cover broad scaffolding issues and test for conformance
- Had to get over misplaced faith in code coverage
- Code coverage becomes less useful as a guide to code health: both branches and combination of branches need to be captured, and also return types (e.g. keys implementing particular interfaces)

# Changes in Approach – BC (Cont.)

- Review work needed to take “big up front” into consideration
- Originally questions were largely around a particular algorithm and broader integration followed
- Now questions need to be raised early about broader integration as well
- Tried to explicitly allow time and budget for broader testing

# End Result

- Luckily we had a bit of prior experience, however the user community of the general APIs and even to a degree the FIPS user community followed the “it works for me” principal
- Biggest problem was testing unwritten “standards” in the JCE/JCA properly
- 28 issues were identified with 1.0.0 in the first 12 months – 2 of these touched on code in the CAVP tested implementation classes
- 12 issues could not be worked around – only 1 of these touched on code in the CAVP tested implementation classes

# Things to Think About

- First, automated testing would help. See:

  https://github.com/usnistgov/ACVP
  https://github.com/usnistgov/AMVP
- As far as software modules go, the boundary idea appears to be based around assembler and a single loadable library
- For higher level languages like C# and Java it should be possible to safely reduce the boundary to avoid a full change process further

# Things to Think About (Cont.)

- The actual safety with which a change can be made depends on a number of things in, and about, a software module
- Some consideration of the nature of the build process used to develop the software module should be made as well

# Who Makes the Call?

Labs are already responsible for code review of non-CAVP tested code.

It might make sense for them to be able to make a call on boundary with modern languages and development processes.

# Another Reason to Worry

# So Finally...

- We are starting to enter a period where change is likely to become the new normal
- It may not be right to assume we can go through a 12-24 month process to get something out the door!

# Thanks for listening.

# Questions?