How cryptographic benchmarking goes wrong

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Today: in CPUs costing ≈ 2 EUR. Cortex-A7 is even more popular.
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More general situation:
Paper analyzes impact of crypto upon an application.
If the crypto sounds fast:
Why is the paper interesting?
Why should it be published?
If the crypto sounds slower:
Paper is more interesting.
Look, here's a speed problem!
More likely to be published.
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Obvious question whenever an application considers crypto deployment: “Is it fast enough?”

Many random methodologies for answering this question: CPU to test? What to take from literature and libraries? Reuse mulmod, or curve ops, or more?

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Why is the paper interesting? Why should it be published?

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Reasonably simple ref implementation compiled with `-fomit-frame-pointer` slower than fastest implementation.

Implementation with "machine-independent" optimizations and best of 121 compiler options: 4.52× slower.

Another interesting example: lattice-based signing typically means generating a huge number of random Gaussian samples.


Qualitatively large impacts: choice of RNG ⇒ cost of sampling ⇒ cost of signing.

Two examples of speed reported in this 2017 paper for a 3.4GHz Skylake (Intel Core i7-6700): 383.69 MByte/sec (8.86 cycles/byte) for AES CTR-DRBG using AES-NI; 106.07 MByte/sec (32 cycles/byte) for ChaCha20.
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April 24, 2014

Posted by Elie Bursztein, Anti-Abuse Research Lead

Earlier this year, we deployed a new TLS cipher suite in Chrome that operates three times faster than AES-GCM on devices that don’t have AES hardware acceleration, including most Android phones, wearable devices such as Google Glass and older computers. This improves user experience, reducing latency and saving battery life by cutting down the amount of time spent encrypting and decrypting data.

To make this happen, Adam Langley, Wan-Teh Chang, Ben Laurie and I began implementing new algorithms – ChaCha 20 for symmetric encryption and Poly1305 for authentication – in OpenSSL and NSS in March 2013. It was a complex effort that required implementing a new abstraction layer in OpenSSL in order to support the Authenticated

Today we are adding a new feature — actual form of encryption — that improves mobile performance: ChaCha20-Poly1305 cipher suite today, Google services were the only major sites on the Internet that supported this new algorithm; all sites on CloudFlare support it, too. This means mobile browsers get a better experience when visiting sites using CloudFlare.

As of the launch today (February 23, 2015), 10% of https connections to CloudFlare use these ciphersuites. The following graph shows the rate when we turned ChaCha20/Poly1305 on global
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As of the launch today (February 23, 2015), nearly 10% of https connections to CloudFlare use the new ciphersuites. The following graph shows the uptick when we turned ChaCha20/Poly1305 on globally:
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Maybe Skip SHA-3 (31 May 2017)

In 2005 and 2006, a series of significant break-throughs, as cryptographers questioned whether SHA-1 was secure at all. After all, many hash functions from the past had already been broken.

In the wake of this, NIST announced [1][2][3] that they would create SHA-3, in order to hedge the risk of SHA-2 failing. I believe SHA-1 was actually broken earlier, but NIST didn’t extend to SHA-2 and the SHA-3 hash functions, all of which are secure according to the designers. Even if it existed, it was no longer clear that SHA-3 was better than SHA-2.

As I’ve mentioned before, diversity of opinion is good. It contributes to the exponential number of designs that are tested and hardened; it draws on limited resources. Deployment on platforms typically need separate, optimized code-size, which is a worry again in the future. SHA-3 is no slower than the SHA-2 which is already slower than MD5, and the cost of primitives.
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In 2005 and 2006, a series of significant results were published [1][2][3]. These repeated break-throughs caused something of a panic as cryptographers questioned whether we knew how to build hash functions at all. After all, many hash functions from the 1990's had not been broken.

In the wake of this, NIST announced (PDF) a competition to order to hedge the risk of SHA-2 falling. In 2012, Keccak ("keccak", I believe) won (PDF) and became SHA-3. But the competition proved that we do know how to build hash functions: the searches in 2005 didn't extend to SHA-2 and the SHA-3 process produced new hash functions, all of which are secure as far as we can tell. Though it existed, it was no longer clear that SHA-3 was needed. Yet there's a tendency to assume that SHA-3 must be better than SHA-2 because it's bigger.

As I've mentioned before, diversity of cryptographic primitives is important. It contributes to the exponential number of combinations that can be tested and hardened; it draws on limited developer resources to platforms typically need separate, optimised code; and it limits code-size, which is a worry again in the mobile age. SHA-3 is, in fact, even slower than SHA-2 which is already a comparative liability for crypto primitives.
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In 2005 and 2006, a series of significant results were published against SHA-1[1,2,3]. These repeated break-throughs caused something of a crisis of faith as cryptographers questioned whether we knew how to build hash functions at all. After all, many hash functions from the 1990’s had not aged well [1,2].

In the wake of this, NIST announced (PDF) a competition to develop SHA-3 in order to hedge the risk of SHA-2 falling. In 2012, Keccak (pronounced “ket-chak”, I believe) won (PDF) and became SHA-3. But the competition itself proved that we do know how to build hash functions: the series of results in 2005 didn’t extend to SHA-2 and the SHA-3 process produced a number of hash functions, all of which are secure as far as we can tell. Thus, by the time it existed, it was no longer clear that SHA-3 was needed. Yet there is a natural tendency to assume that SHA-3 must be better than SHA-2 because the number is bigger.

As I’ve mentioned before, diversity of cryptographic primitives is expensive. It contributes to the exponential number of combinations that need to be tested and hardened; it draws on limited developer resources as multiple platforms typically need separate, optimised code; and it contributes to code-size, which is a worry again in the mobile age. SHA-3 is also slow, and is even slower than SHA-2 which is already a comparative laggard amongst crypto primitives.