

PBKDF2: performance matters

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1. Quick intro to PBKDF2



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2. The standard is bad





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3. Your implementation is bad





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4. A faster PBKDF2



PBKDF2: quick intro



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Usage

- ▶ Password verification (web sites, network services, etc.)
- ▶ Key derivation (disk encryption, key management, etc.)

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Simplification

PBKDF2 can produce arbitrary length output.
We're going to ignore this capability from here on in: only considering the first block of output.

PBKDF2: how it was described



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and typically

$$\text{PRF}(\text{pw}, x) = \text{HMAC-H}(\text{pw}, x)$$

$H = \text{SHA-1, SHA-256, SHA-512, or ...}$

Zoom, enhance

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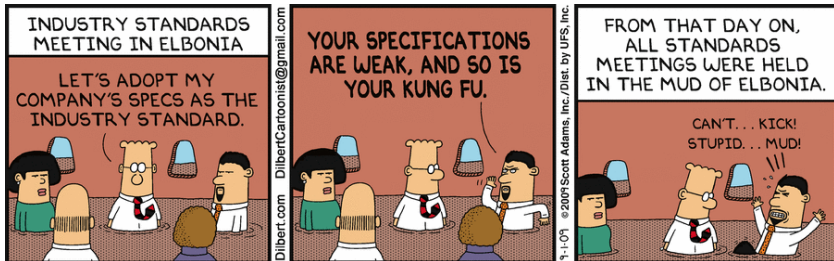
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Therefore, we need to compute $4i$ SHA-256 blocks.

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Actually, we only need compute $2 + 2i$ SHA-256 blocks.

Survey of defender implementations

I looked at the following PBKDF2s:

- ▶ FreeBSD 10
- ▶ GRUB 2.0
- ▶ Truecrypt 7.1a
- ▶ Android (disk encryption)
- ▶ Android (BouncyCastle)
- ▶ Django
- ▶ OpenSSL
- ▶ Python core (≥ 3.4)
- ▶ Python (pypi pbkdf2)
- ▶ Ruby (pbkdf2 gem)
- ▶ Go (go.crypto)
- ▶ OpenBSD
- ▶ PolarSSL/mbedTLS
- ▶ CyaSSL/wolfSSL
- ▶ SJCL
- ▶ Java
- ▶ Common Lisp (ironclad)
- ▶ Perl (Crypt::PBKDF2)
- ▶ PHP5
- ▶ .NET framework
- ▶ scrypt/yescrypt¹
- ▶ BouncyCastle

¹never called for scrypt/yescrypt with iterations != 1

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Measured on Intel Atom N2800 (1.86GHz), best of five runs, CPU time in user mode.

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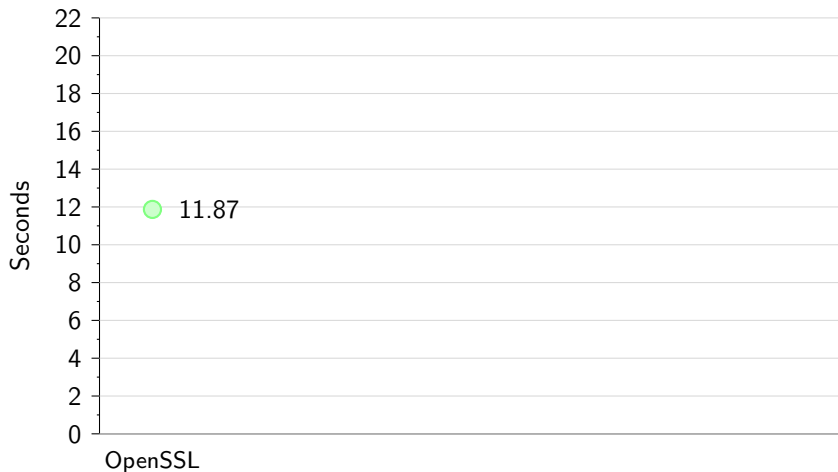


Figure : PBKDF2-HMAC-SHA1, one block output, 2^{22} iterations

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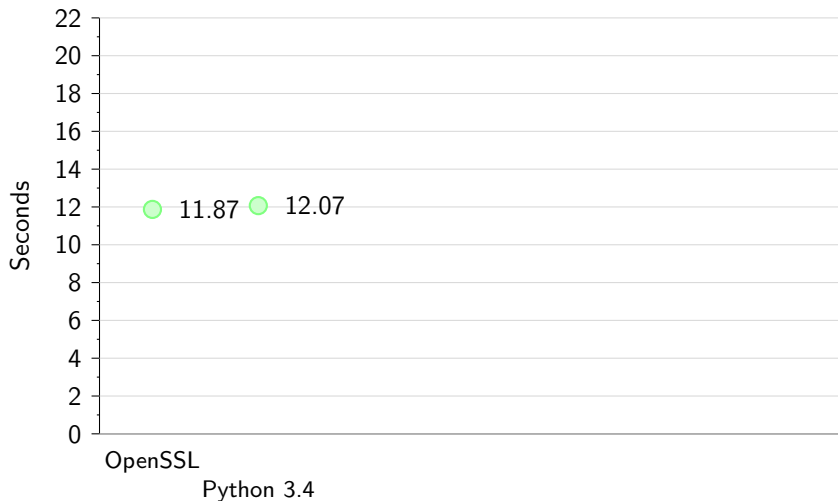


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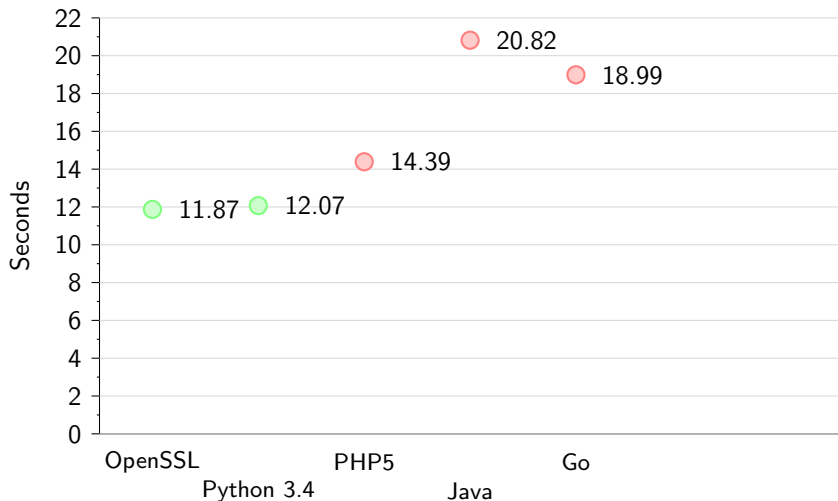


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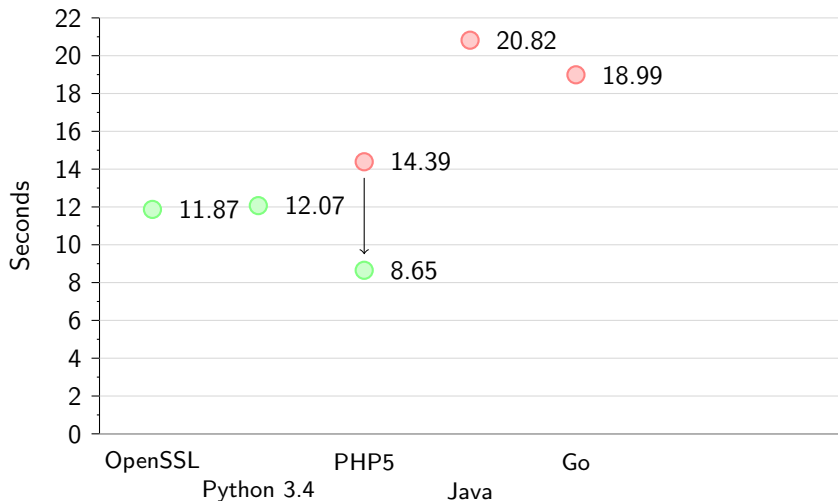


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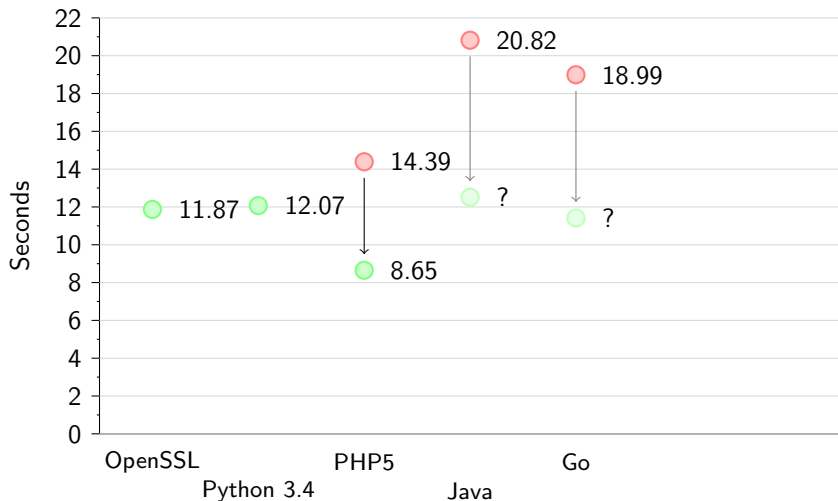


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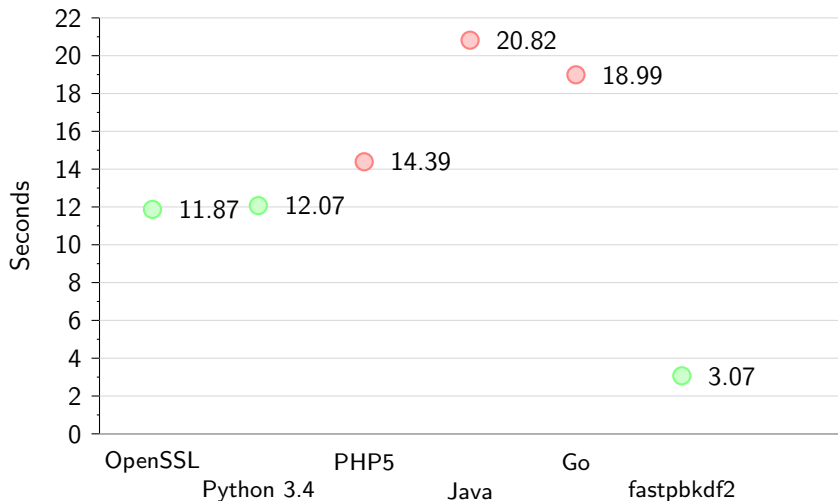


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- ▶ <https://github.com/ctz/fastpbkdf2/>

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- ▶ PBKDF2 is a poor design, and described in an unhelpful way by its authors.
- ▶ Most implementations waste time and power.
- ▶ If you use PBKDF2, you can probably drop in a faster implementation and either increase security margin, or improve time/power performance.
- ▶ Please try not to use PBKDF2 any more.

Thank you!

Questions?

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Web: <https://jbp.io/>

Slides and benchmarking code: <https://github.com/ctz/talks/>