# PBKDF2: performance matters

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**Origin**

RSA labs, 1999. Described in PKCS#5 and then RFC2898

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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.

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\text{where} & \\
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\text{and typically} & \\
\mathrm{PRF}(\mathrm{pw}, \mathrm{x}) &= \text{HMAC-H}(\mathrm{pw}, \mathrm{x}) \\
H &= \text{SHA-1, SHA-256 or SHA-512}
\end{aligned}$$

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Assumption: password and salt much shorter than SHA-256's 64-byte block size.

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

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This is actually wrong. Neither PKCS#5 nor RFC2898 mention this, or describe the expected performance.

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**How many times?**

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

# Our survey says...

**Good: compute $2 + 2i$ blocks**

- OpenSSL (after Nov 2013)
- Python core ($\geq$3.4)
- Django (CVE-2013-1443)
- SJCL
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**Bad: compute $4i$ blocks**

- FreeBSD
- GRUB
- Android (BouncyCastle)

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**Bad: compute $4i$ blocks**

- Python (pypi pbkdf2)
- Ruby (pbkdf2 gem)
- Go (go.crypto)
- OpenBSD
- PolarSSL
- CyaSSL
- Java (OpenJDK)
- Common Lisp (ironclad)
- Perl (Crypt::PBKDF2)
- PHP
- C#

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- PBKDF2 is not wonderfully designed.
- Described in an unhelpful way by its authors.
- Most implementations gift a 2x advantage to attackers.

# Thank you!

Questions?

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