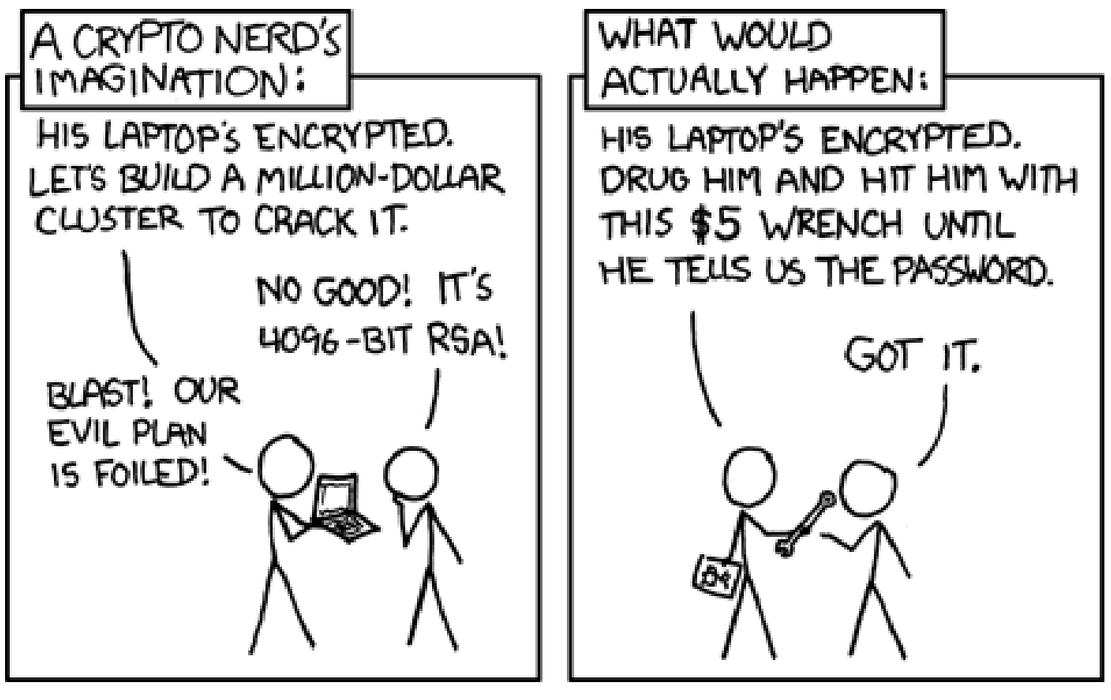
Cleaning up crypto

D. J. Bernstein, U. Illinois Chicago
& T. U. Eindhoven
Tanja Lange, T. U. Eindhoven

Joint work with:
Peter Schwabe, R. U. Nijmegen



http://xkcd.com/538/

AES-128, RSA-2048, etc.
are widely accepted standards.

Obviously infeasible to break
by best attacks in literature.

Implementations are available
in public cryptographic libraries
such as OpenSSL.

Common security practice is
to use those implementations.

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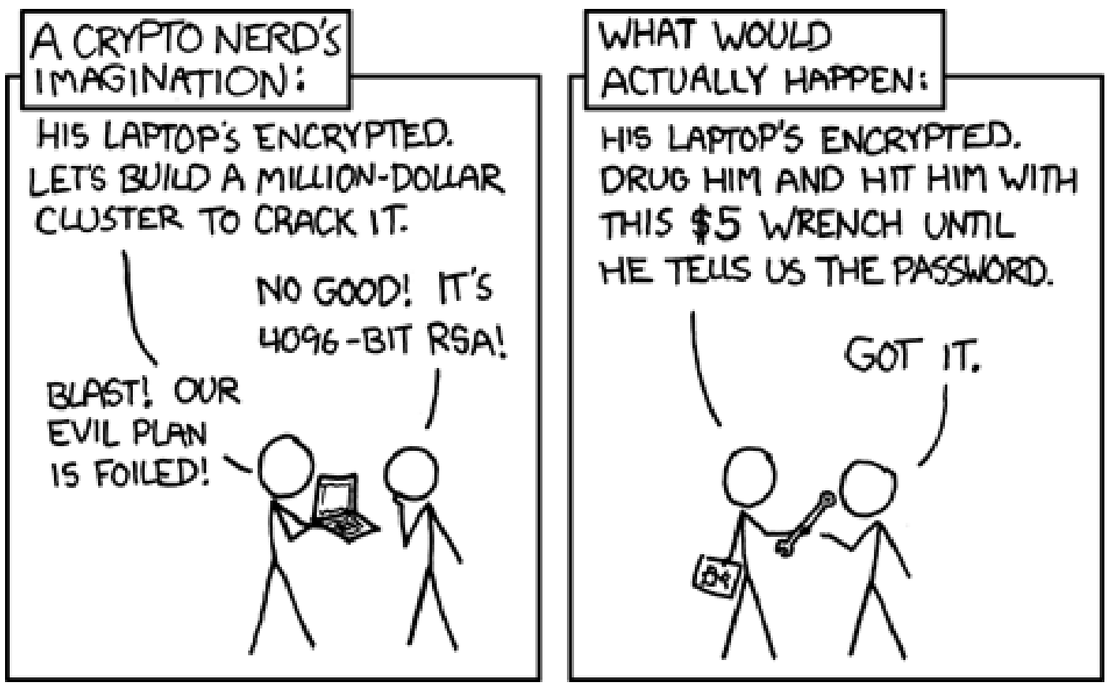

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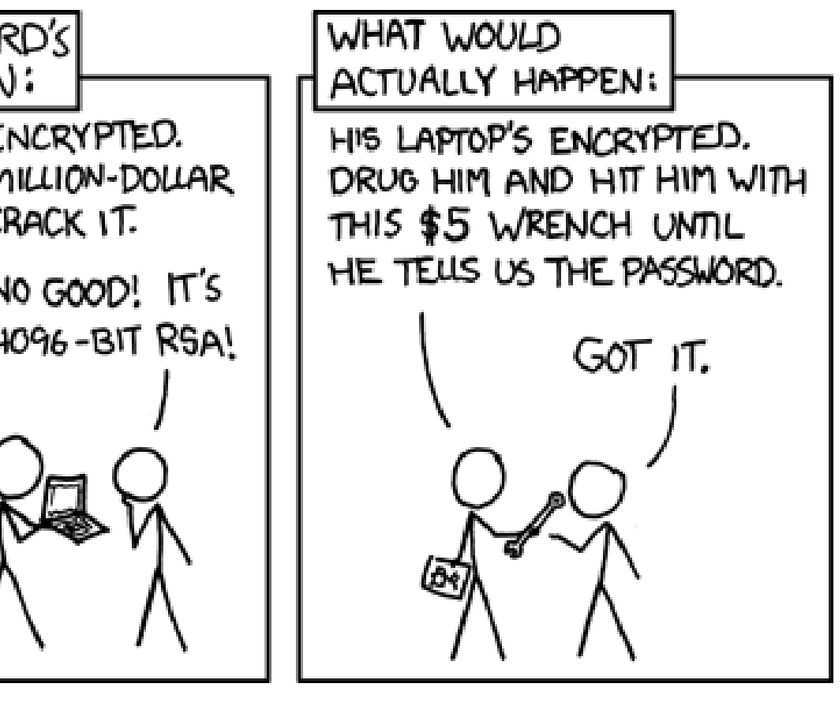

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Use key to sign ha
Read Bob's key fr
Use key to encrypt
Convert to wire fo

Plus more code:
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Generate random AES key.
Use AES key to encrypt pac
Hash encrypted packet.
Read RSA key from wire for
Use key to sign hash.
Read Bob's key from wire fo
Use key to encrypt signature
Convert to wire format.

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Alice using NaCl:

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c = crypto_box(
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Alice using NaCl:
`c = crypto_box(m,n,pk,sk)`

32-byte secret key `sk`.
32-byte public key `pk`.
24-byte nonce `n`.
`c` is 16 bytes longer than `m`.

All objects are C++
`std::string` variables
represented in wire format,
ready for storage/transmission.

C NaCl: similar, using pointers;
no memory allocation, no failures.

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Bob veri

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Bob verifying, decrypting:

`m=crypto_box_open(c,n,p`

Initial key generation:

`pk = crypto_box_keypair`

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Bob verifying, decrypting:

`m=crypto_box_open(c,n,pk,sk)`

Initial key generation:

`pk = crypto_box_keypair(&sk)`

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Initial key generation:

`pk = crypto_box_keypair(&sk)`

Can instead use **signatures**

for public messages:

`pk = crypto_sign_keypair(&sk)`

64-byte secret key,

32-byte public key.

`sm = crypto_sign(m,sk)`

64 bytes overhead.

`m = crypto_sign_open(sm,pk)`

ng NaCl:

`pto_box(m,n,pk,sk)`

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Examples of applications
using NaCl's `crypto_box`:

DNSCurve and DNSCrypt,
high-security authenticated
encryption for DNS queries;
deployed by OpenDNS.

QUIC, Google's TLS replacement.

MinimaLT in Ethos OS,
faster TLS replacement.

Threema, encrypted-chat app.

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`to_box_open(c,n,pk,sk)`

ey generation:
`ypto_box_keypair(&sk)`

ead use **signatures**
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`ypto_sign_keypair(&sk)`
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intended to obscure influence
upon the CPU cache state.
Not confidence-inspiring;
likely to be breakable.

No secret load addresses

2005 Osvik–Shamir–Tromer:
65ms to steal Linux AES key
used for hard-disk encryption.
Attack process on same CPU
but without privileges.

Almost all AES implementations
use fast lookup tables.
Kernel's secret AES key
influences table-load addresses,
influencing CPU cache state,
influencing measurable timings
of the attack process.
65ms to compute influence^{-1}.

Most cryptographic libraries
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NaCl systematically avoids
all loads from addresses
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Eliminates this type of disaster.

2010 Langley `ctgrind`:
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Single entropy source; no backup;
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Avoiding pure crypto failures

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2012 Flame: new MD5 attack.

Fact: By 1996, a few years after the introduction of MD5, Preneel and Dobbertin were calling for MD5 to be scrapped.

NaCl *pays attention to cryptanalysis* and makes very conservative choices of cryptographic primitives.

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Signer generates A and R
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