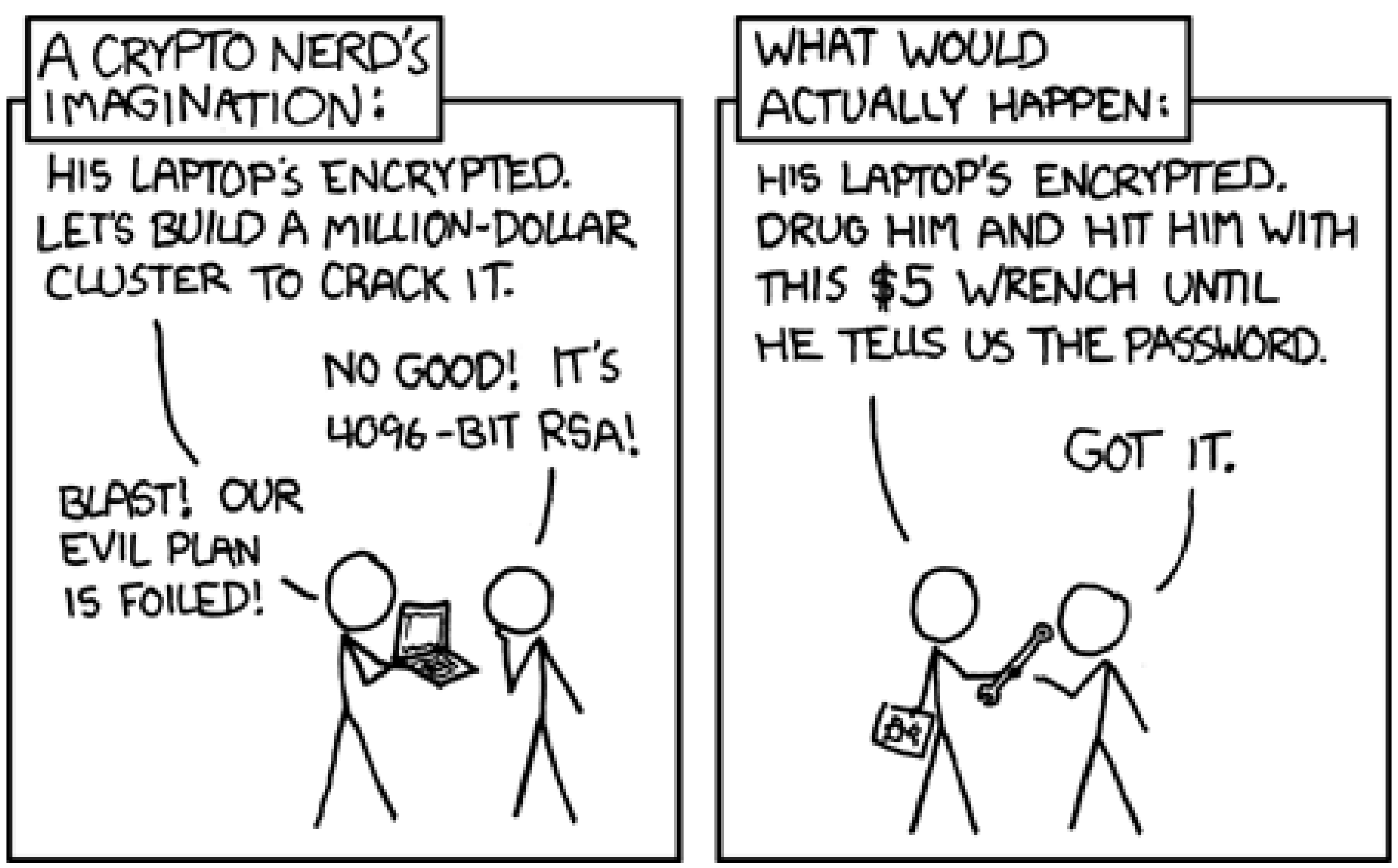
NaCl: a new crypto library

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

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



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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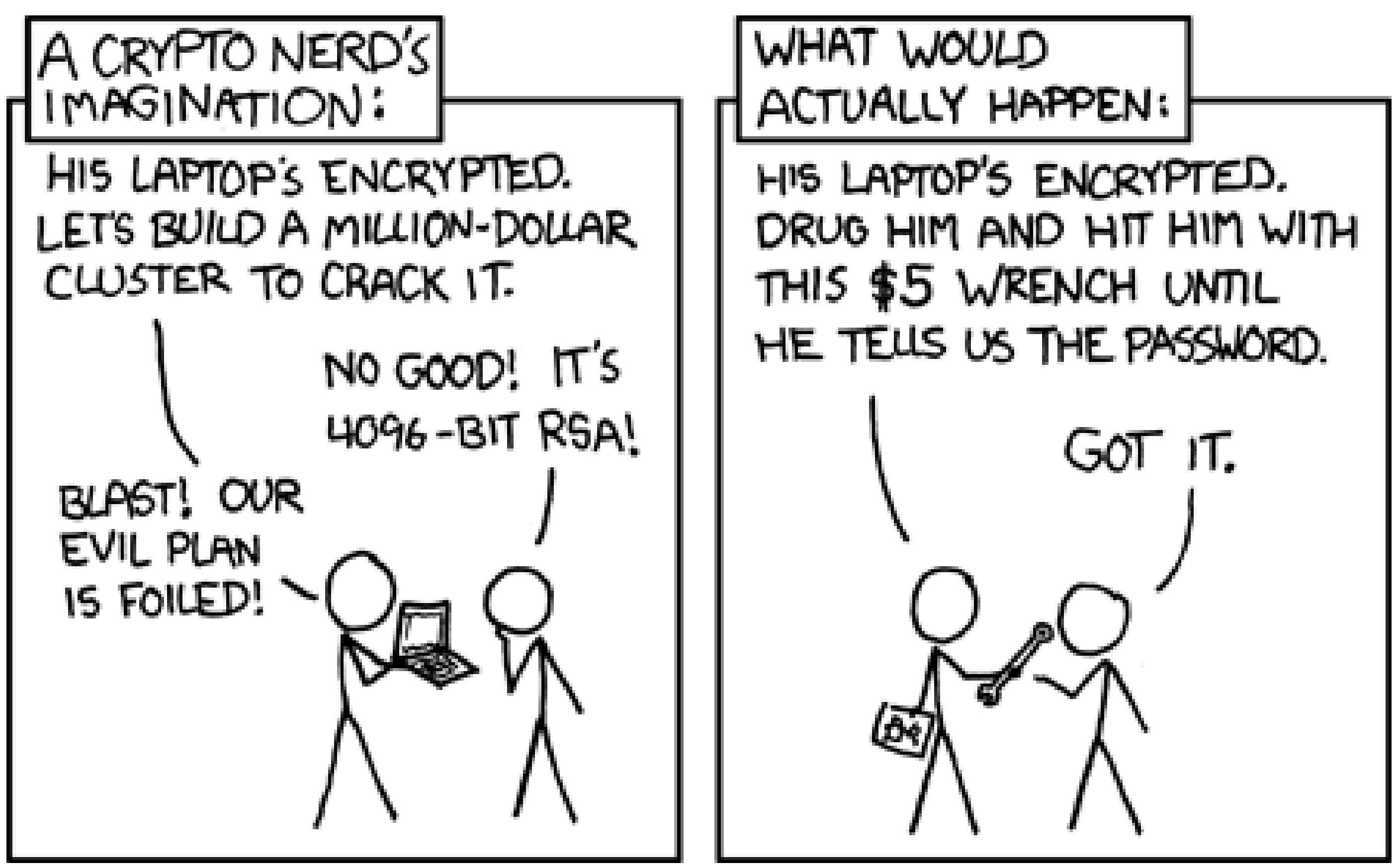

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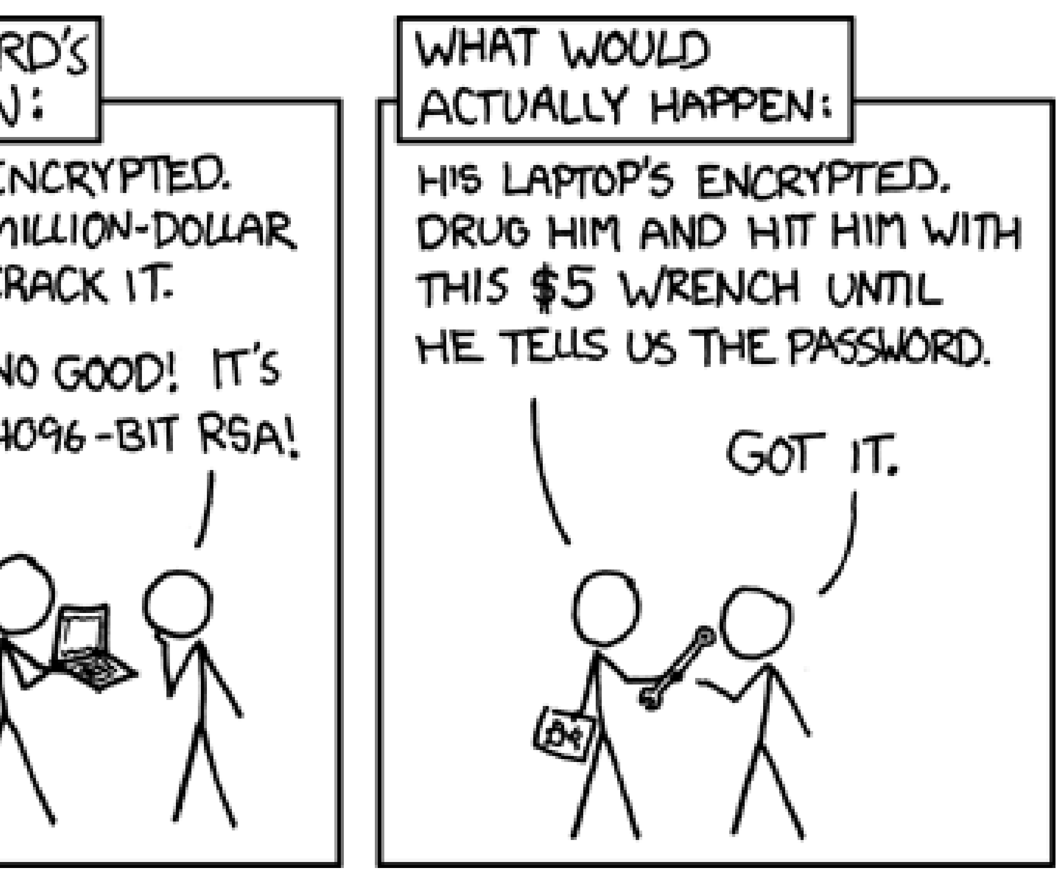

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Sends c to Bob.

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Most of the Internet
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Primary goal of NaCl: Fix th

Main task: **public-key authenticated encryption**.

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Hash encrypted pa
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Use key to sign ha
Read Bob's key fro
Use key to encrypt
Convert to wire fo

Plus more code:
allocate storage,
handle errors, etc.

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typical cryptographic library:

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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`m=crypto_box_op`

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

Initial key generation:

`pk = crypto_box_keypair(&sk)`

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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)

secret key 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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`ypto_sign_keypair(&sk)`

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public key.

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`pto_sign_open(sm,pk)`

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Related

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Related projects

Various ports, repa
language bindings,
github.com/jedi

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<u>Related projects</u>

Various ports, repackaging, language bindings, etc.: e.g.
`github.com/jedisct1/lil`

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

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Crypto performance problem
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Cryptographic details

The main NaCl work we did: achieve very high speeds *without* compromising security.

ECC, not RSA:
much stronger security record.
Curve25519, not NSA/NIST curves: safecurves.cr.yp.to
Salsa20, not AES:
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Poly1305, not HMAC:
information-theoretic security.
EdDSA, not ECDSA:
collision-resilience et al.

Case study: EdDS

1985 ElGamal sign
(R, S) is signature
if $B^{H(M)} \equiv A^R R^S$
and $R, S \in \{0, 1, .$

Here q is standard
B is standard base
A is signer's public
$H(M)$ is hash of m

Signer generates A
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