Cybersecurity Today and Tomorrow:

Assurance or Insurance?

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A look at the challenges today

- **Key facts in the Verizon 2016 Report**

most attacks exploited known vulnerabilities where a patch has been available for months, often years.

no one is immune

most breaches are about money

main reason - 58% of business don't have "mature" patch management processes

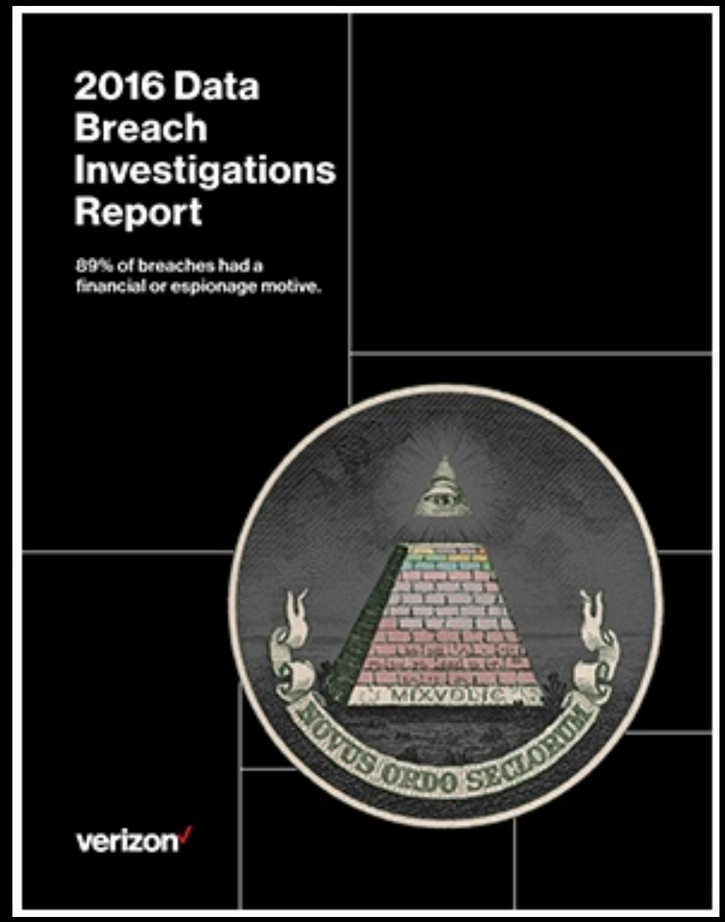


Image Courtesy: verizonenterprise.com/verizon-insights-lab/dbir/2016/

The root cause

- The economy of cybersecurity slow to emerge

  a market failure in cybersecurity
  www.economist.com/sites/default/files/20140712_cyber-security.pdf

<u>main reason</u> - the way computer code is produced

Cryptography is not immune

- **Cryptography is fundamental for cybersecurity**
  - **by far the dominant means for protecting data in transit and at rest**
- **Susceptible to issues plaguing general computer code**
- **… but there are special areas of concerns, especially when implemented in hardware**

The case of modern crypto

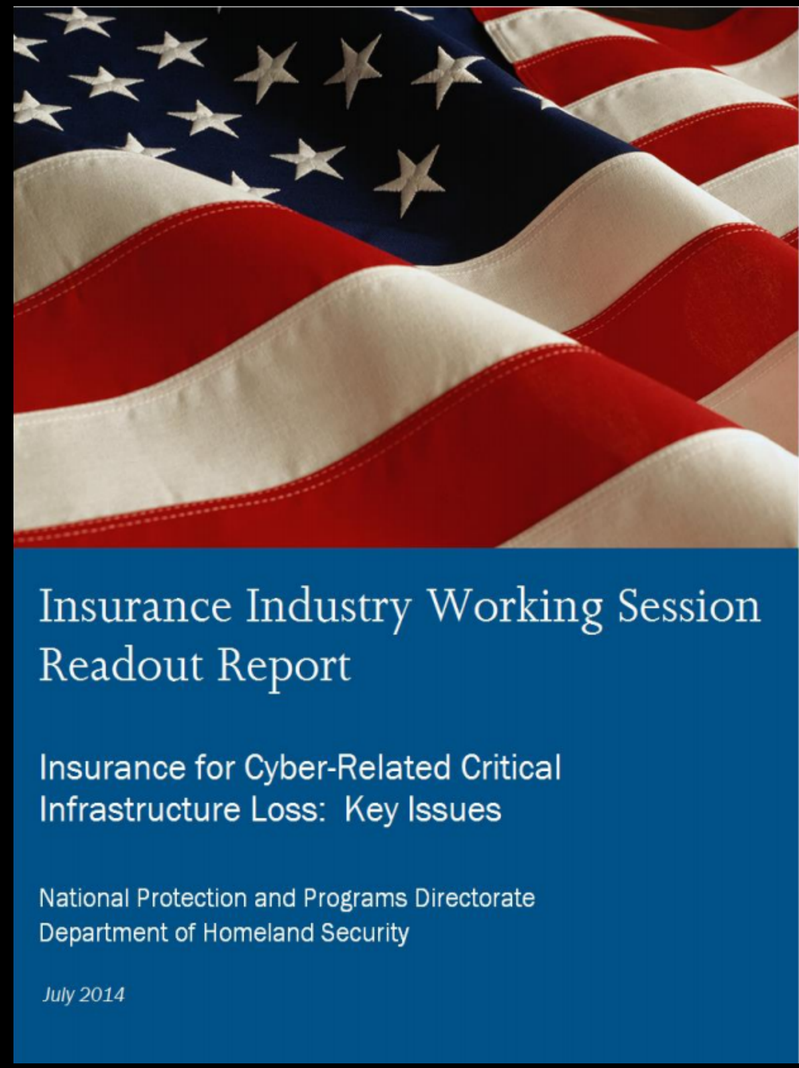
Courtesy of XKCD, https://en.wikipedia.org/wiki/Xkcd

- **The algorithms are well-known:**
  - **e.g., RSA, AES**
- **Security depends largely on the black box principle:**
  - **e.g., secrecy of keys and internal state**
  - must be (nearly) impossible to guess
- Side-channel leakage is very problematic for H/W
  - due to inherent properties of algorithms
  - undermines the assurances from crypto

The insurance case

- **The cybersecurity insurance market is a nascent one**

  - **Carriers cited several reasons for this:**
    - **a lack of actuarial data;**
    - **aggregation concerns;**
    - **the unknowable nature of all potential cyber threat vectors.**



www.dhs.gov/sites/default/files/publications/July%202014%20Insurance%20Industry%20Working%20Session_1.pdf

Assurance or Insurance today?

Courtesy of Wikipedia

Odysseus facing the choice between Scylla and Charybdis

A useful example

- Automotive industry experience

  - turning car safety into
    a competitive advantage

    the Volvo effect

IT SHOULDN'T TAKE AN ACT OF CONGRESS TO MAKE CARS SAFE.

Volvo was committed to safety long before it became mandatory.

In 1956, for example, we installed padded dashboards: 12 years before the government insisted on them.

In 1959, Volvo became the first mass-produced car in the world with safety belts as standard equipment. Nine years later all cars had safety belts, inspired by Federal regulations.

We don't just settle for the legal minimum, either:

The law says all cars must have two brake circuits. Volvos have two *triangular* circuits, each controlling three wheels. So if one circuit fails, you still have about 80% of your braking power.

Volvos also have many safety features not required by law:

Like front and rear ends which absorb the impact of collisions. Four-wheel disc brakes with a pressure-proportioning valve to reduce the chances of rear-wheel lock-up. Child-proof rear doors. Rear window defrosters.

Now who would you rather buy a car from?

A company that builds a safe car because someone else made them do it?

Or a company that builds a safe car because their conscience made them do it?

VOLVO

Ad, 1973

An approach for getting strong assurances from cryptography

- Develop modern standards for cryptography and security
- Provide powerful incentives to the industry to adopt them
- Improve conformance testing to guarantee assurances

Traditional Conformance Testing

Example: FIPS 140-2

Intended to improve the security and technical quality of cryptographic modules employed by Federal agencies (U.S. and Canada) and industry by

- **leveraging accredited independent third-party testing laboratories**

Issues w/ Laboratory Testing

- **Labs burdened with labor-intensive and ineffective test methodology**
  - having trouble testing in depth, w.r.t. state-of-the-art in security testing
  - rely on the English essay model for reporting test results

- **Labs' competency in challenging technical areas**
  - entropy & physical security testing competency unevenly distributed among labs

- **Labs' business conflicts of interest**
  - operate w/ own revenue and profit targets
  - enter in paid contracts w/ industry clients

The metamorphosis effect

Module validated <u>without</u> a single implementation change

Test report review uncovers <u>significant</u> discrepancies

documentation-only metamorphosis

A systemic problem casting doubts on security assurances due to lack in trust in laboratory testing

Automate as much as possible

C. Chaplin, “Modern times”, 1936

- Reduce the validation cycle length;
- Enable Just-In-Time validations;
- Reduce the validation costs;
- Introduce a three-tier assurance model with trusted vendors;
- Refocus laboratories on testing beyond what is already tested by industry vendors.

Powerful economic incentives for the industry

Research and Innovation

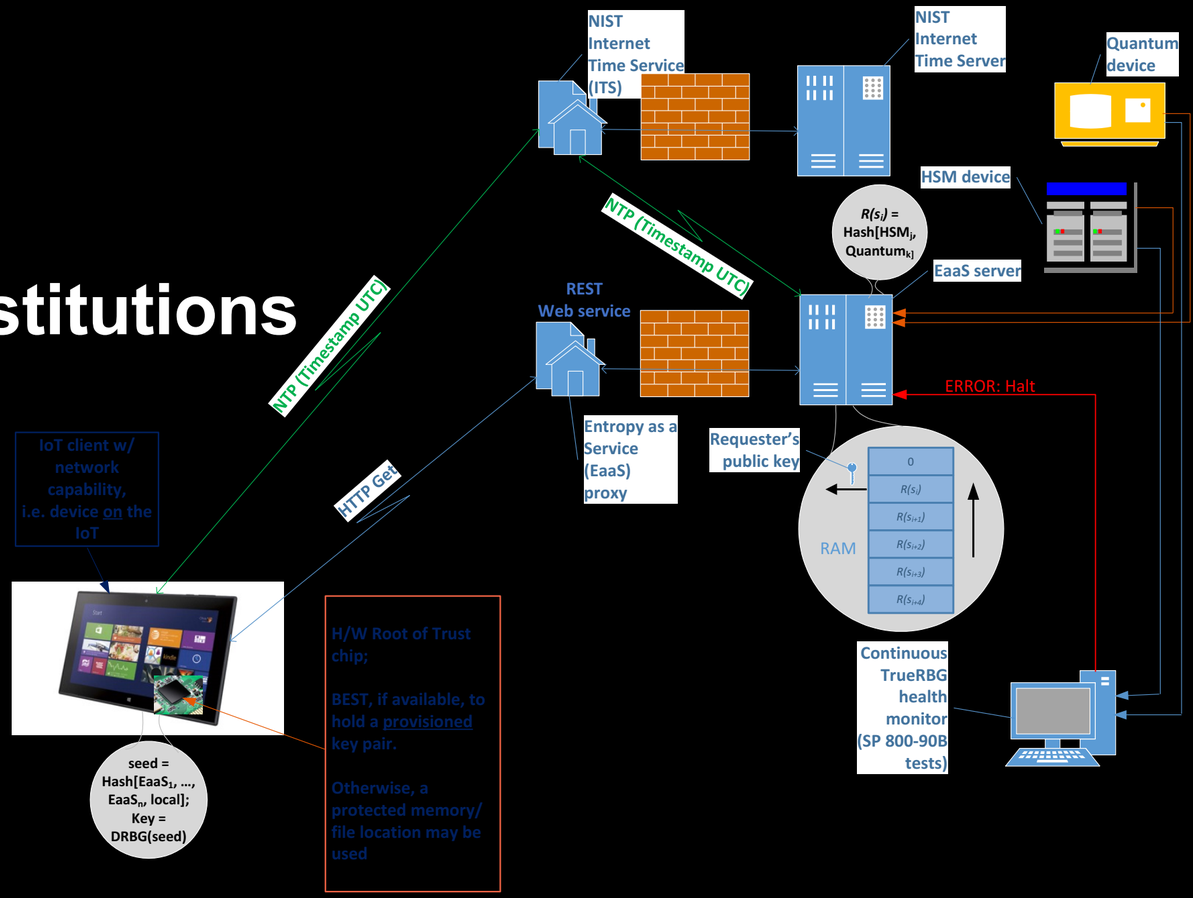
- **Help the industry meet difficult security requirements through technology innovation**
  - Entropy as a Service (EaaS)
  - Advanced physical security
  - IoT security

  - **Working w/ leading academic institutions**

University of Florida & FICS
EaaS, IoT, H/W testing

KU Leuven, Belgium
Leakage-resistant crypto for H/W

University of Maryland
PQC, EaaS, lightweight crypto for IoT



The PQC Challenge

Quantum computers are 25 years in the future and always will be. ?

How about a hybrid approach for the interim?

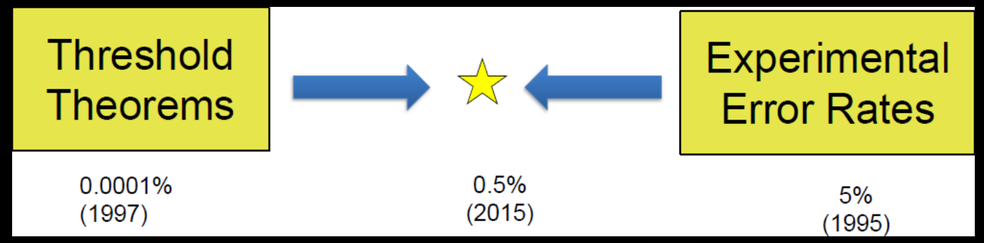
Encrypt: a message or a key K is randomly split to two shares
K = K1 XOR K2.
K1 is encrypted by an approved algorithm (e.g., RSA, DH)
K2 is encrypted by a PQC method (e.g., NTRU).
The receiver decrypts both shares to recover K.

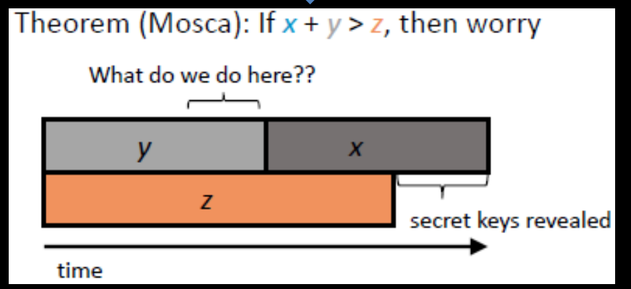
Sign: a message M is signed by two signature schemes
one approved alg Sig_1, (e.g., ECDSA)
another is a PQC signature, Sig_2 (e.g., hash-based Sig)

The signature of M is Sig_1(M) ∧ Sig_2(M).

Trading performance for security

Error rate halves every ≈11 months





***x* – years information to stay secure**
***y* – years to retool infrastructure**
***z* – years to large-scale QC**

Courtesy of: Stephen Jordan, Yi-Kai Liu & Lily Chen, NIST PQC Team

Putting it all together

The Royal Society for
Putting Things on
Top of Other Things

Monty Python, 1970

Assurance/Insurance tomorrow?

- Assurances from crypto are fundamental
  - Industry responding well to the call for action
    - started an Industry Working Group in December 2015 to rebuild crypto validation program and standards
    - great level of participation from all
- Crypto assurances help quantify cyber risks
  - A prerequisite for growing the cyber-insurance market
  - The Volvo effect?
- Assurance or Insurance – not an exclusive choice
  - The enterprise of tomorrow will likely need a blend of both

Questions?