

# NSAC

Network Security and Applied  
Cryptography Laboratory

<http://crypto.cs.stonybrook.edu>

# Towards Regulatory Compliance in Data Management

CSE690 Lecture

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STONY  
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# Let's talk about ... ENRON ☺

## Enron (1930-2001)

Electricity, gas, paper, communications.

## 2001

Stock drops from \$90+ to pennies over allegations of corporate fraud.

## December, 2001

Bankruptcy filing.

## October 23 – November 9, 2001

Accounting firm Arthur Andersen destroys tens of thousands of digital/paper documents, *despite knowledge of a forthcoming U.S. SEC subpoena.*

## November 8, 2001

SEC said: "stop the shredding!"

9>8 ☺

## January 2001

Forensic experts start trying to recover missing documents with limited success.

## 2002

Congress issues the Sarbanes Oxley Act in direct response to the Enron scandal.

## Finance

National Association of Insurance Commissioners, **Graham-Leach-Bliley Act**, 1999; The U.S. Securities and Exchange Commission, **Rule 17a-3&4, 17 CFR Part 240**: Electronic Storage of Broker-Dealer Records, 2003; U.S. Public Law No. 107-204, 116 Stat. 745, The Public Company Accounting Reform and Investor Protection Act, 2002 (**Sarbanes-Oxley**)

## Healthcare

U.S. Dept. of Health & Human Services, The Health Insurance Portability and Accountability Act (**HIPAA**), 1996; The U.S. Department of Health and Human Services Food and Drug Administration, **21 CFR Part 11**: Electronic Records and Signature Regulations 1997

## Government

U.S. Public Law 107-347. The E-Government Act, 2002 (Federal Information Security Management Act **FISMA**); The U.S. Department of Defense, **Directive 5015.2**: DOD Records Management Program, 2002; The U.S. Department of Education. 20 U.S.C. 1232g; 34 CFR Part 99: The Family Educational Rights and Privacy Act (**FERPA**), 1974

## Title I

Continuing health insurance coverage.

## Title II

- **Privacy Rule** (all PHI)
- Transactions and Code Sets Rule
- **Security Rule** (electronic PHI)
  - Safeguards
    - administrative (policies and procedures)
    - physical
    - technical safeguards
- Unique Identifiers Rule
- Enforcement Rule

SEC. 1173 (d) (“Security Standards for Health Information”) mandates: “safeguards [. . . ] to **ensure the integrity and confidentiality** [. . . ] of the information” and “to protect against any reasonably anticipated [. . . ] threats or hazards to the [. . . ] integrity of the information” (e.g., once stored).

<http://www.cms.hhs.gov/HIPAAGenInfo/Downloads/HIPAAALaw.pdf>

## Hardware

Tamper-resistance, magnetic Residues, emanations

## OS

I/O device drivers and kernel

## Storage

Block level: WORM assurances, secure migration (1)

FS level: secure indexing, secure deletion, secure provenance, history independent data structures, secure migration (2)

## Databases

History Independence – novel indexing

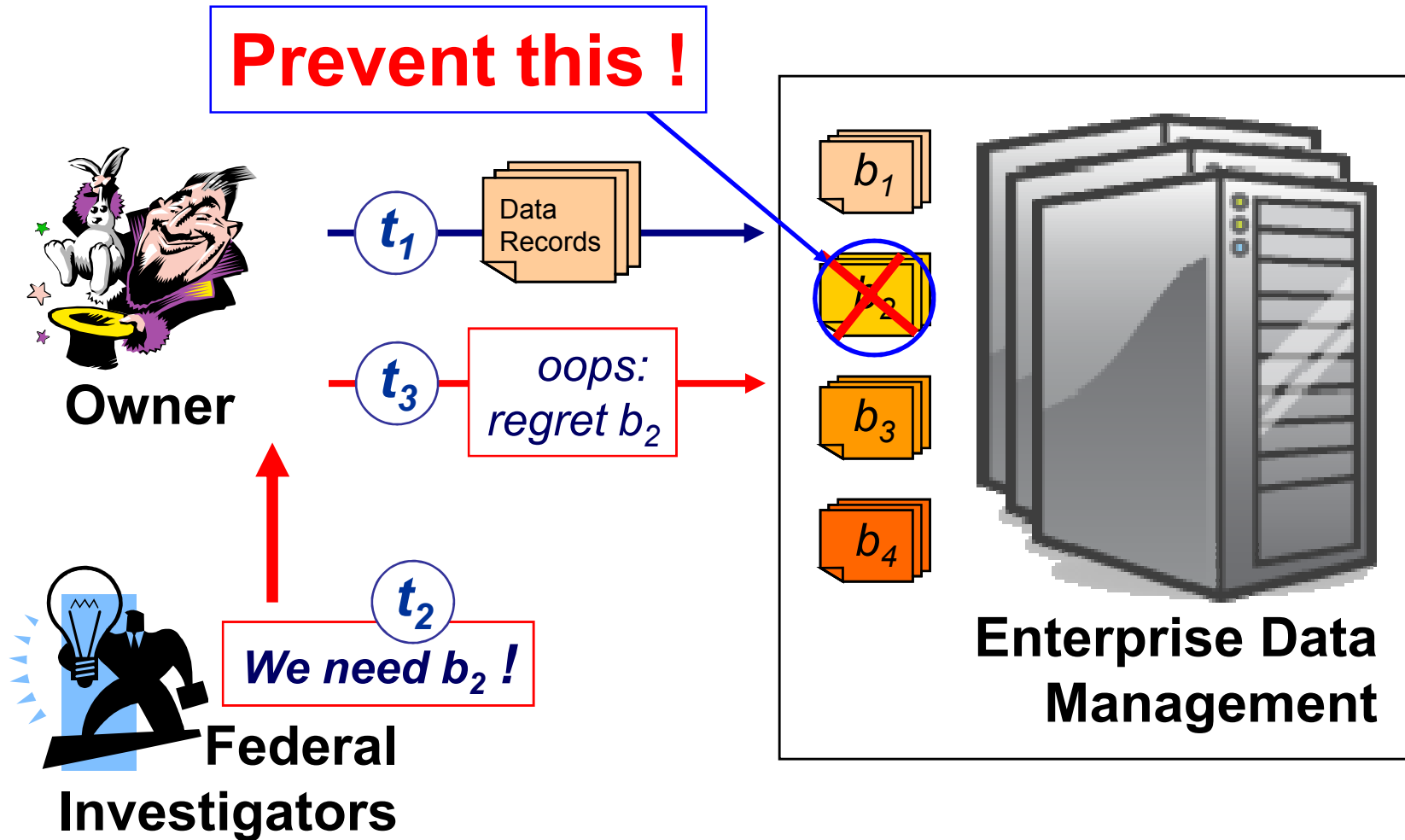
ACID still holds ?

## Networks

Physical level: wireless spectrum sharing behavior

Packet level: anti-spam, flow labeling

# WORM: Overview



## **We do not prevent history. Just history *rewriting*.**

A bit artificial in scope – why do we trust the owner to correctly log the entries and then mistrust her later ? If I were a malicious owner, I would simply not log suspicious emails 😊

## **Do we trust owner for the next 5 minutes too ?**

What is  $\Delta t = t_3 - t_1$  (“time warp”) ? If we know this, we can deploy all kinds of optimizations.

## **Trustworthy Indexing.**

When is this an issue? Searches usually conducted through indexes.

## **Secure Deletion.**

Is a problem only if trustworthy indexing is required.

## **Secure Migration.**

Relatively straightforward. Build trust chain, deal with obsolete encryption, lack of keys.

## **Litigation support.**

Need to make sure retention can be prolonged in the case of an ongoing litigation.

## Tape-based

Assumption: specific reader is used.  
Checksums (keyed) are written onto tape. Keys are managed inside readers.

## Optical Disks

Problem: physical storage space, cost, replication attacks, high latency. No secure deletion.

## Hard Disks

Main problem: “soft”-ware.

## DLTSage WORM

Assurances of the tape systems are provided under the assumption that compliant tape-readers are deployed. “DLTSage WORM provides features to assure compliance, placing an electronic key on each cartridge to ensure WORM integrity. This unique identifier cannot be altered, providing a tamperproof archive cartridge that meets stringent compliance requirements to ensure integrity protection and full accessibility with reliable duplication.”

### **Sony Disk for Data**

Holds only 23 GB per disk side. Because it is faster than tape and cheaper than hard disks, optical WORM storage technology is often deployed as a secondary, high-latency storage medium to be used in the framework of a hard disk-based solution. Care needs to be taken in establishing points of trust and data integrity when information leaves the secured hard disk store for the optical media.

### EMC Centera

Content addressed storage (CAS) software solution with regulatory compliance capabilities. Data records have “two components: the content and its associated content descriptor file (CDF) that is directly linked to the stored object [...] A digital fingerprint derived from the content itself is the content’s locator. [...]”

The CDF is used for access to and management of the record. Within this CDF, the application will assign a retention period for each individual business record. Centera will permit deletion of a pointer to a record upon expiration of the retention period. Once the last pointer to a record has been so deleted, the object will be eliminated”, and, in the Plus version, also “shredded” (from the media).

### Hitachi Message Archive for Compliance

The Data Retention Utility is a software-based “virtual” WORM mechanism for mainstream Hitachi storage systems. It allows customers to “lock down archived data, making it non-erasable and non-rewritable for prescribed periods, facilitating compliance with governmental or industry regulations”.

### IBM LockVault compliance software

Software layer that operates on top of IBM System Storage N series to provide “disk-based regulatory compliance solutions for unstructured data”.

### IBM System Storage Archive Manager

The IBM Tivoli Storage Manager is part of the IBM Total Storage Software and provides certain software data retention protection. It “makes the deletion of data before its scheduled expiration extremely difficult. *Short of physical destruction to storage media or server, or deliberate corruption of data or deletion of the Archive Manager database, Archive Manager will not allow data [...] to be deleted before its scheduled expiration date.*”

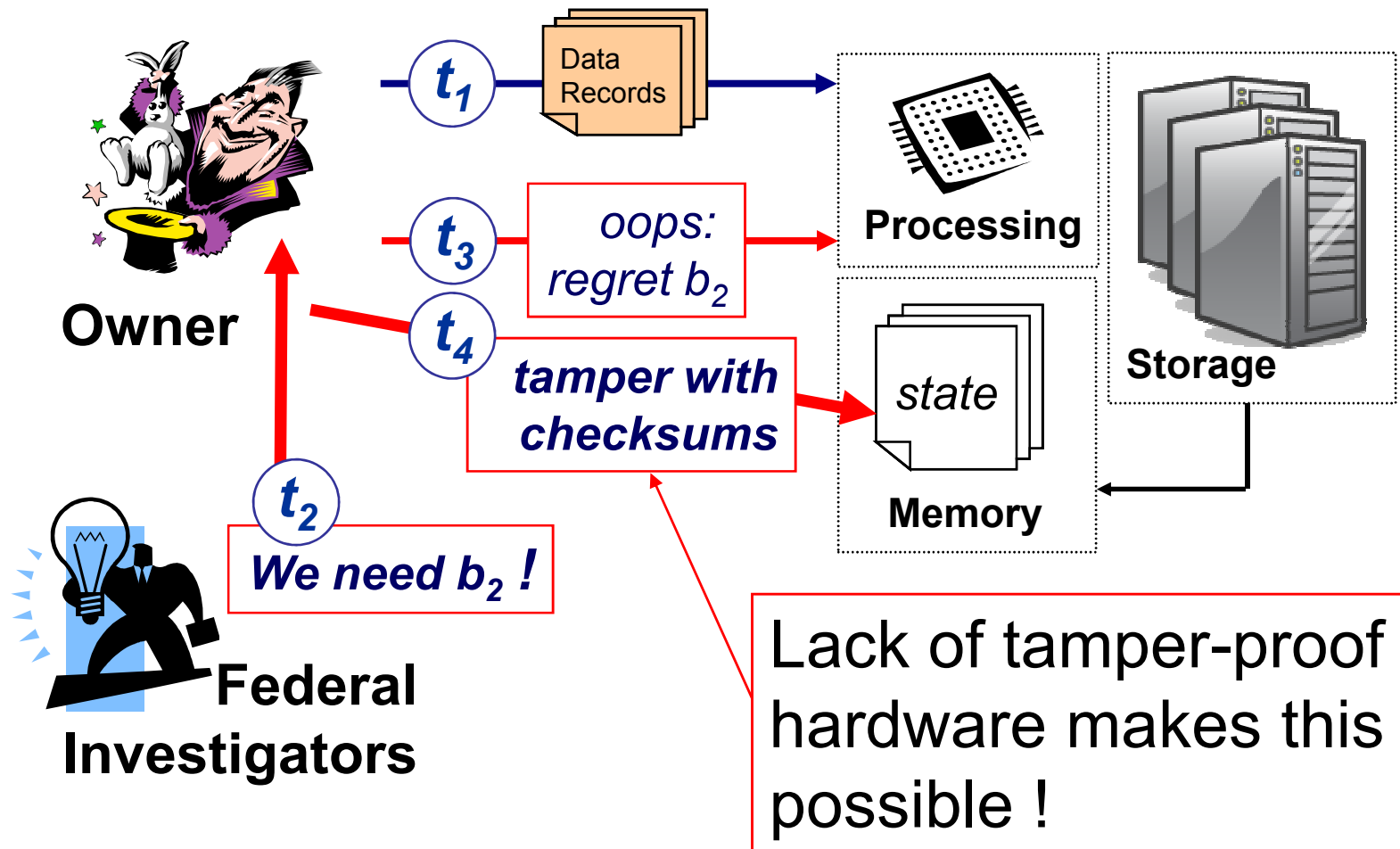
## Snaplock Compliance/Enterprise Software

A software suite designed to work on top of NetApp NearStore and FAS storage systems. It provides soft-WORM assurances, “preventing critical files from being altered or deleted until a specified retention date”. As opposed to other vendors, NetApp SnapLock supports open industry standard protocols such as NSF and CIFS.

## **StorageTek Compliance Archiving Software**

Software that runs on top of the Sun StorageTek 5320 NAS Appliance to “provide compliance-enabling features for authenticity, integrity, ready access, and security”.

# “soft”-WORM



### **Tamper-proof Hardware.**

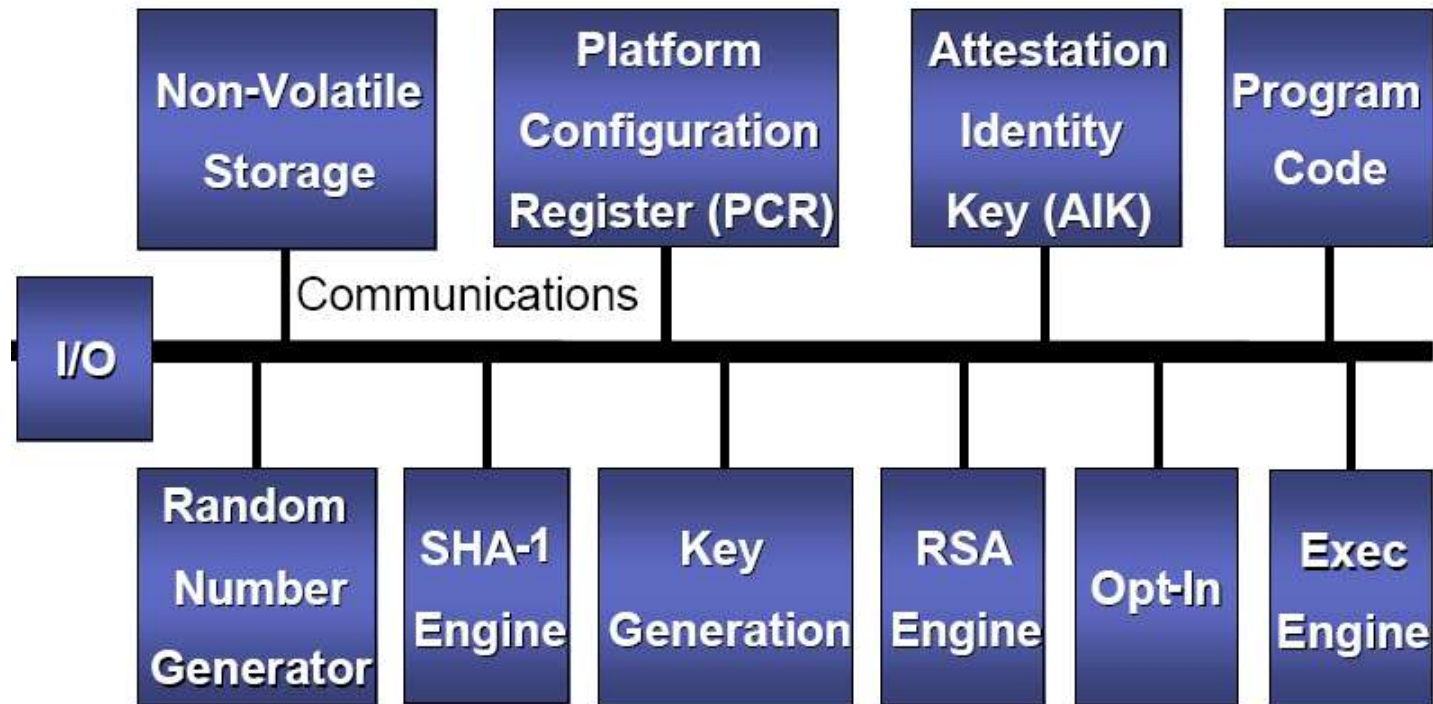
Achieving WORM in the absence of tamper-proof hardware is not possible.

**Q:** *What **kind** of tamper-proof hardware ?*

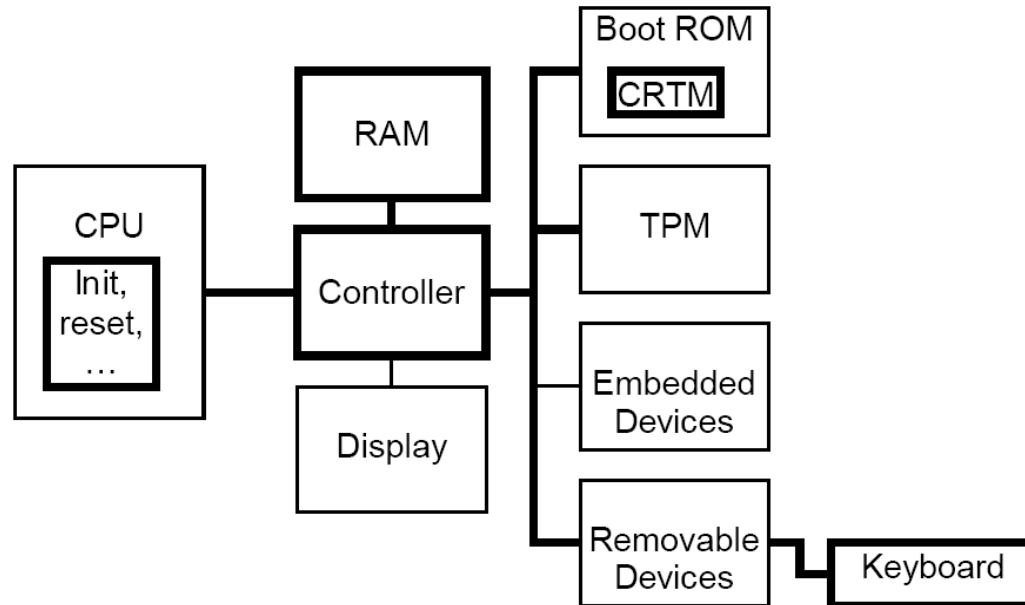
# TPM



Microcontroller that stores keys, passwords and digital certificates.



# TPM: Trust Chain



## Can the Trusted Platform Module control what software runs?

No. [...] it can only act as a 'slave' to higher level services and applications by storing and reporting pre-runtime configuration information. [...] At no time can the TCG building blocks 'control' the system or report the status of applications that are running.

## Would a TCG/TPM help ?

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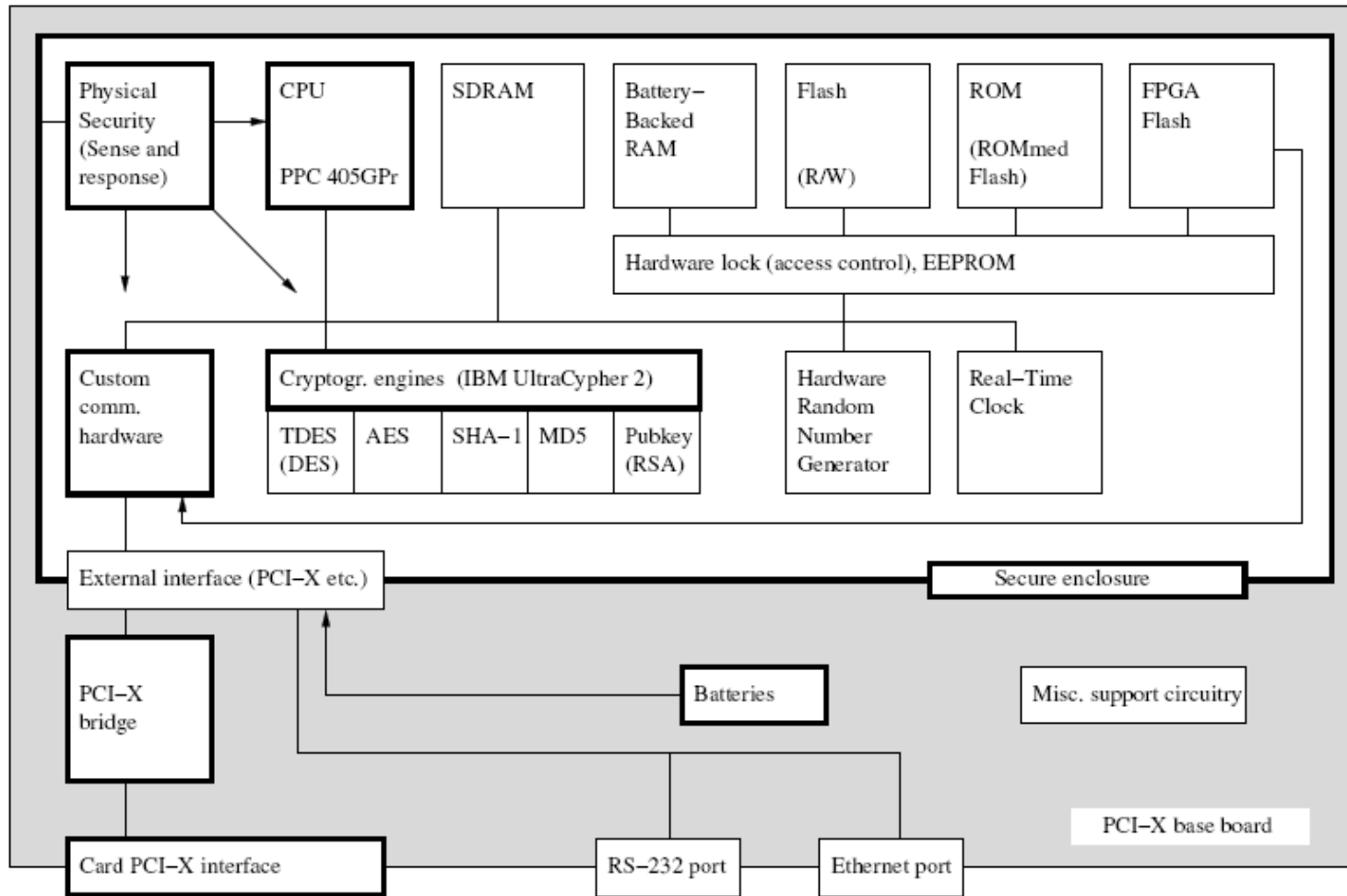
The passive nature of a TPM would require an additional point of blank trust in upper layer code. The ability to virtualize makes this hard to achieve.

**Discussion:** How would Mallory fake a world view to the TPM. Remember we are talking about *millions of US dollars* worth of incentives here.

And by the way ...

**... TPMs have been successfully hacked** by attackers with almost no resources (see refs).

# SCPU's (IBM 4764)



### **Active Tamper-proof Hardware.**

Achieving WORM in the absence of **active** tamper-proof hardware is not possible.

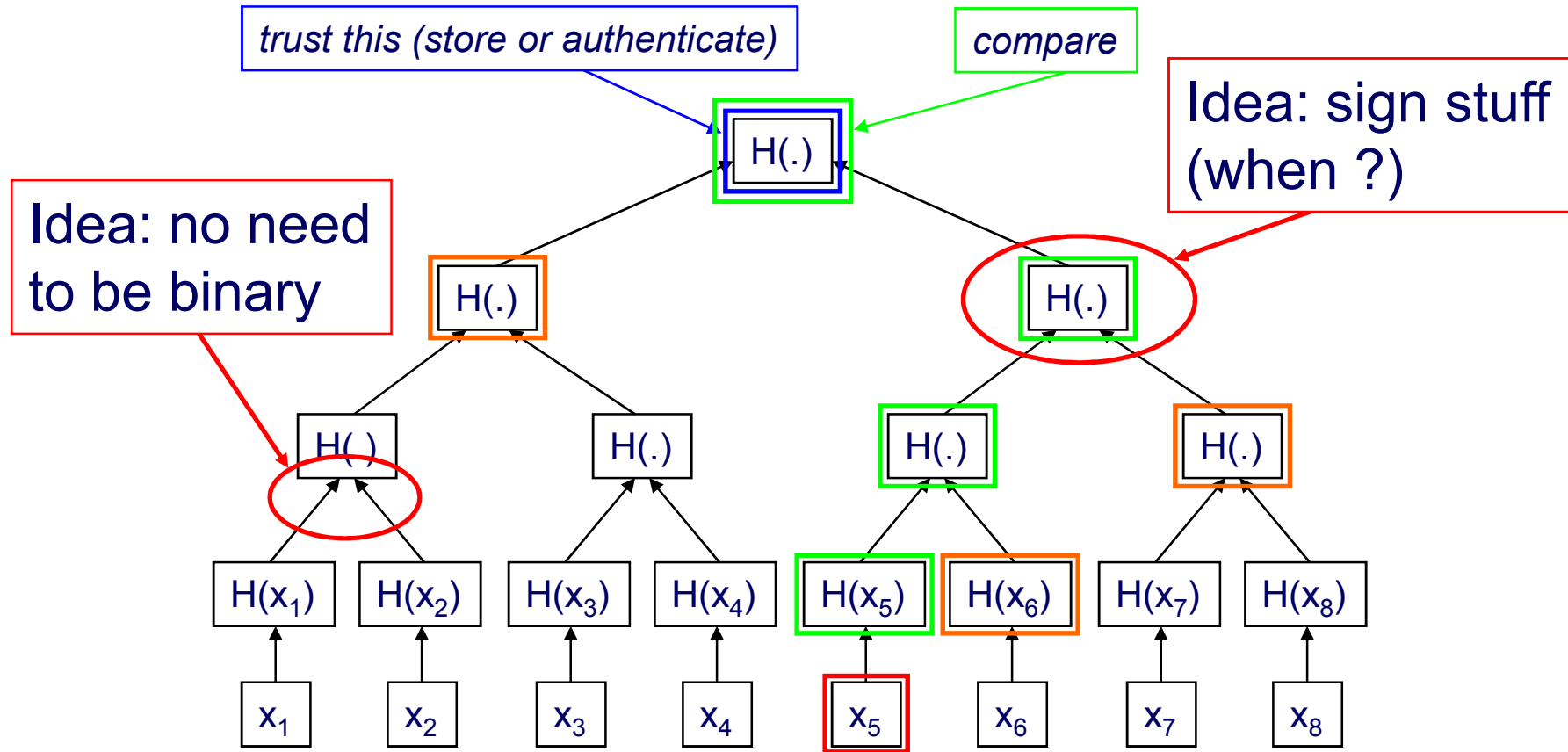
# SCPU: Performance



**RSA1024 Sign: 848/sec**  
**RSA1024 Verify: 1157/sec**  
**3DES: 1-8MB/sec**  
**DES: 1-8MB/sec**  
**SHA1: 1-21MB/sec**

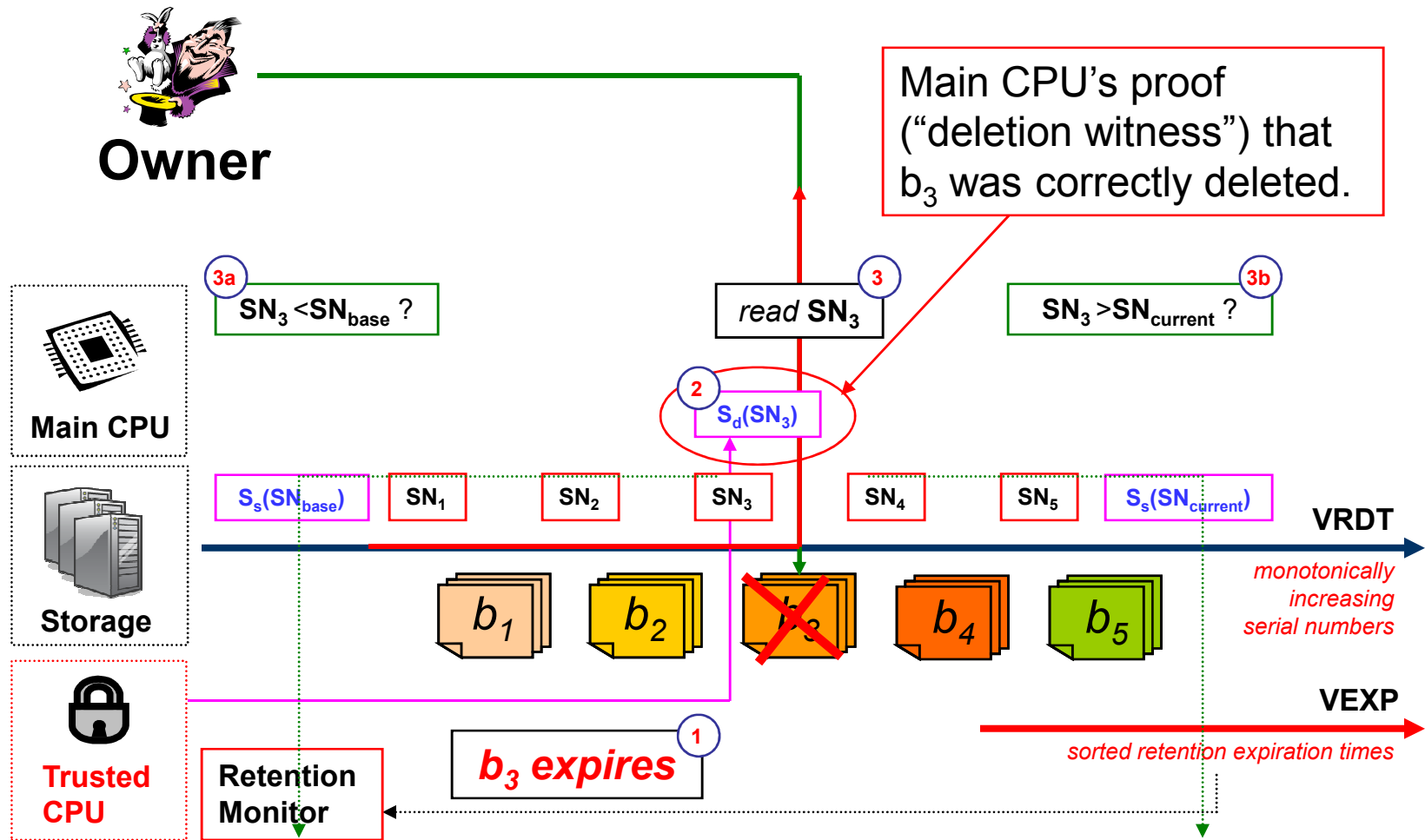
IBM 4764-001: 266MHz PowerPC. 64KB battery-backed SRAM storage. Crypto hardware engines: AES256, DES, TDES, DSS, SHA-1, MD5, RSA. FIPS 140-2 Level 4 certified.

# Strawman Merkle





# Insight (2)



## Issue

SCPU data digestion (hashing) is not very fast.

## Fact

We already assume the stored data is accurate.

## Question

Why not also trust the main CPU to produce correct data digests *at write time*? This should increase throughput.

## How

To prevent cheating we double check during idle times (or mandatory if too much time passes).

# Can We Eat The Cake Too ?

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## How do we maintain the VRDT efficiently.

Hierarchical. Arbitrary “deletion” windows.

## How does the SCPU/RM enforce deletion efficiently.

Alarms, efficient index structures of retention expiration times.

## How can we “witness” things fast: amortization.

In times of high-load: defer expensive witnessing and use short-lived constructs.

During idle/low-load times: re-enforce short-lived constructs.

## How fast can we go.

**Writes:** 3600-3700 updates/second (4-6hrs. bursts), 450-500 updates/sec (sustained).

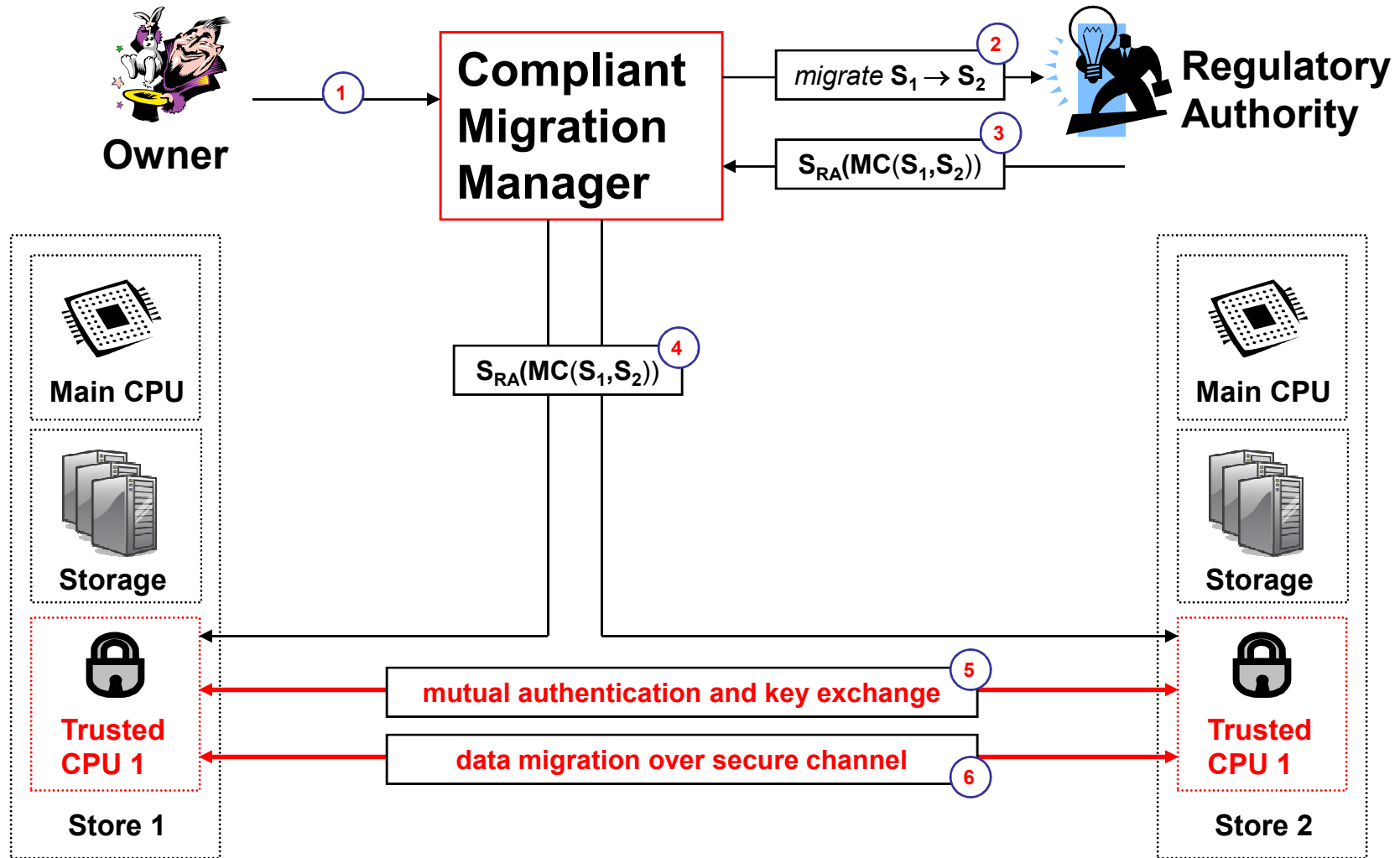
**Reads:** limited only by un-trusted system segment.

## What about litigation support.

Authorized regulatory parties present credentials and are allowed to set/reset litigation holds.



# What about migration?



## **Namespaces, Search Indexes**

Trust-worthy Indexing

## **More Complex Migration**

Complex query-driven migration

## **Secure Deletion**

History Independent Data Structures, logging etc.

## **New Query Languages/Paradigms ?**

Do transactional semantics still hold in the presence of regulatory compliance? Can we extend SQL to deal with e.g., WORM assurances ?

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