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Science for better Security.

Database Forensics

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ISSI2009, NII

Introduction

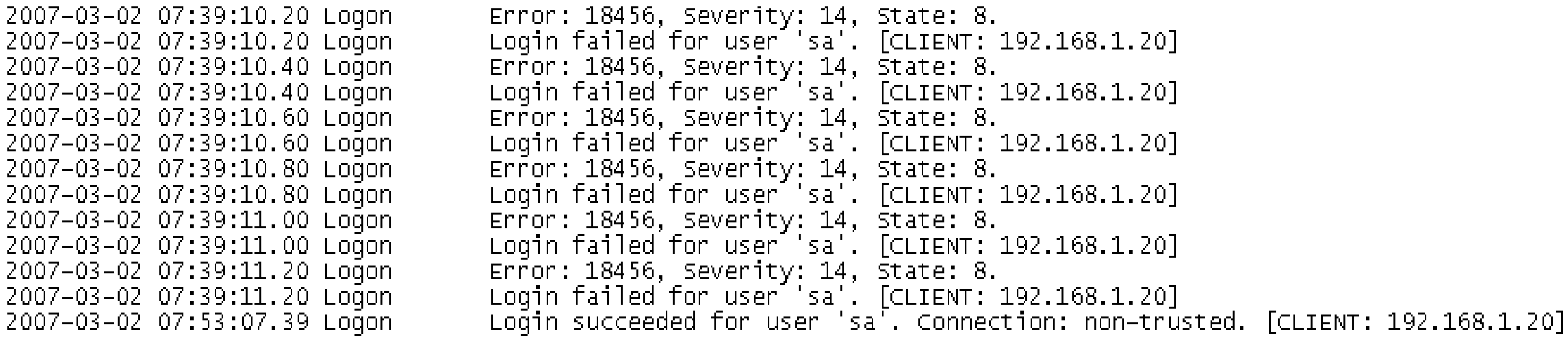
- Importance of database forensics
  - Critical/sensitive information stored in databases, e.g. bank account data, health data
  - Loss caused by security incidents, corporate governance
- Aims of database forensics
  - To find out what happened when
  - To revert any unauthorized data manipulation operations
- Things to consider
  - How to gain access to the system
  - Live vs. dead system
  - Integrity
  - Images
  - Data encryption
  - Goal

Information Sources

- Files
  - MAC - (last) Modified time, Access time, Change/Create time (file attributes)
  - Timeline analysis
- Internal structures
  - SQL Server artifacts: data cache, plan cache, VLF, error logs, ….
  - Forensic tools (e.g. Windows Forensic Toolchest), automated scripts
  - Volatility, file locks
- Logical structures (index)
  - B-trees
  - Different trees for different node entry sequences

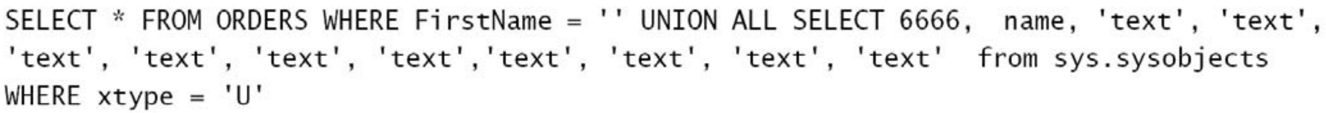
System breach suspected.
What now?

- Find out if system was actually breached
  - –Error logs – failed logins



```
2007-03-02 07:39:10.20 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:10.20 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:39:10.40 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:10.40 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:39:10.60 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:10.60 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:39:10.80 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:10.80 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:39:11.00 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:11.00 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:39:11.20 Logon       Error: 18456, Severity: 14, State: 8.
2007-03-02 07:39:11.20 Logon       Login failed for user 'sa'. [CLIENT: 192.168.1.20]
2007-03-02 07:53:07.39 Logon       Login succeeded for user 'sa'. Connection: non-trusted. [CLIENT: 192.168.1.20]
```

  - –Plan cache – UNION, single quotes (‘), double dashes (--)

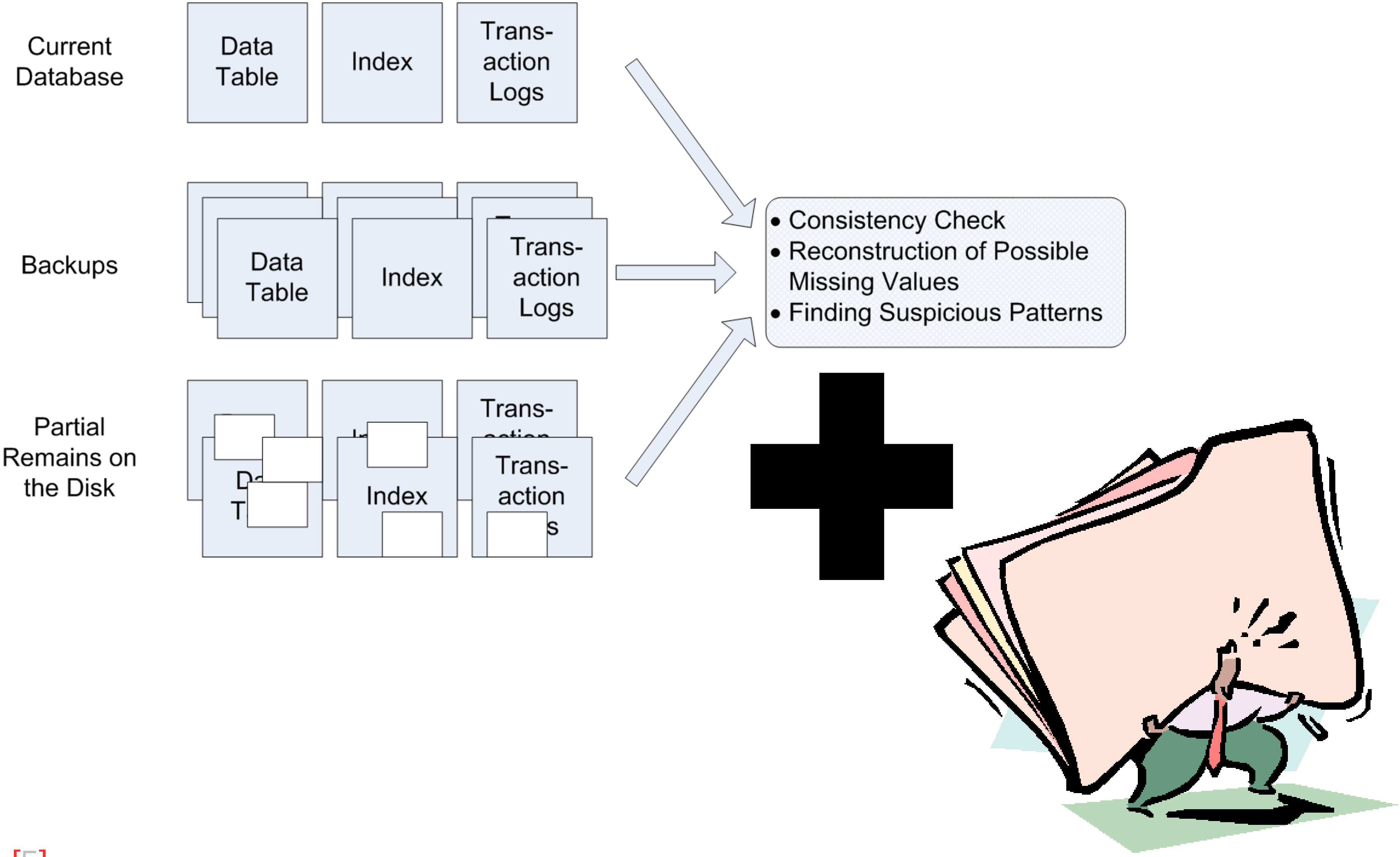


```
SELECT * FROM ORDERS WHERE FirstName = '' UNION ALL SELECT 6666,  name, 'text', 'text',
'text', 'text', 'text', 'text','text', 'text', 'text', 'text'  from sys.sysobjects
WHERE xtype = 'U'
```

- Find out which data records were retrieved
  - –Data cache – recently accessed data pages
  - –Plan cache – cached database statements
  - –Server state – most recently executed statement by session

Source: Kevvie Fowler – SQL Server Forensic Analysis, Addison-Wesley

Ongoing Research



- Consistency Check
- Reconstruction of Possible Missing Values
- Finding Suspicious Patterns

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Pseudonymization of Health Data

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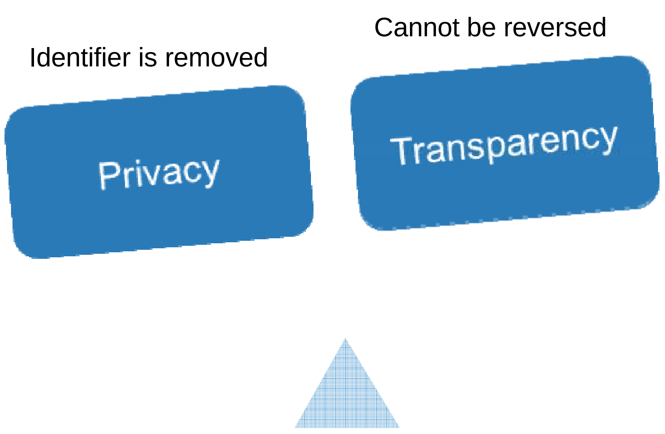
Motivation

- Privacy is one of the fundamental issues in health care today, especially when digitizing medical data
  - Electronic health records (EHR) improve communication between health care providers
- With interconnected systems comes highly sensitive and personal information whose disclosure may cause serious problems for the individual
  - Insurance companies denying health coverage
  - Employers denying employment
- Laws for the protection of privacy
  - Health Insurance Portability and Accountability Act (HIPAA)
  - European Directive 95/46/EC
- Secondary use of medical data in clinical studies

Trade Off – Secondary Use



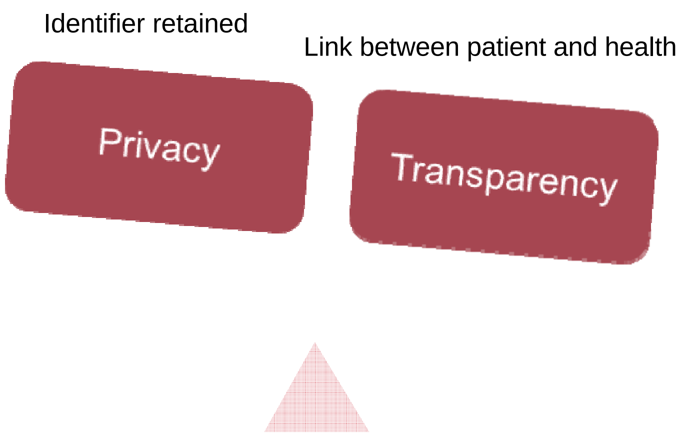
Identifier is removed

Cannot be reversed

Privacy

Transparency

Anonymization



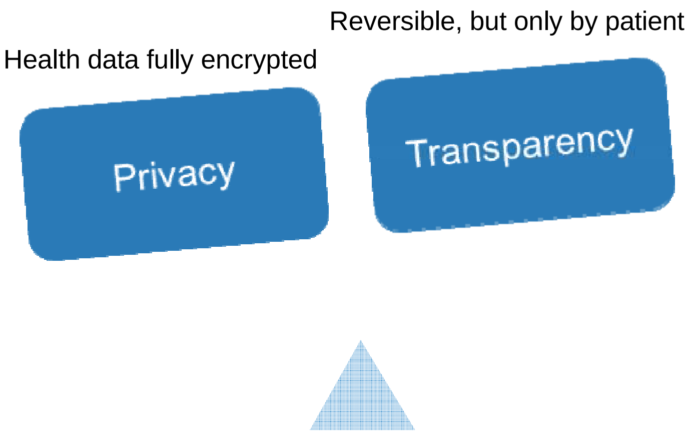
Identifier retained

Link between patient and health data

Privacy

Transparency

Normal Secondary Use



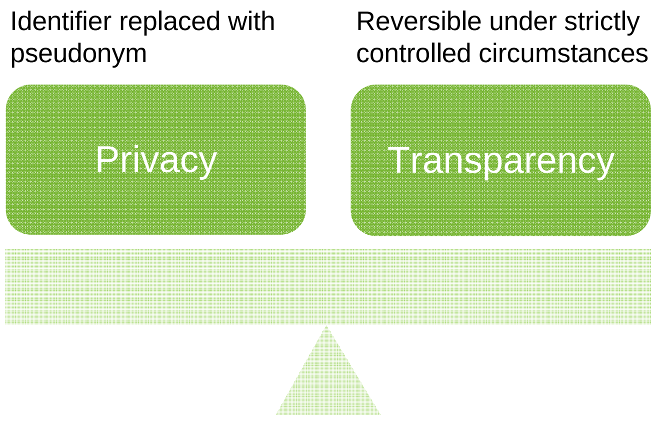
Health data fully encrypted

Reversible, but only by patient

Privacy

Transparency

Encryption



Identifier replaced with pseudonym

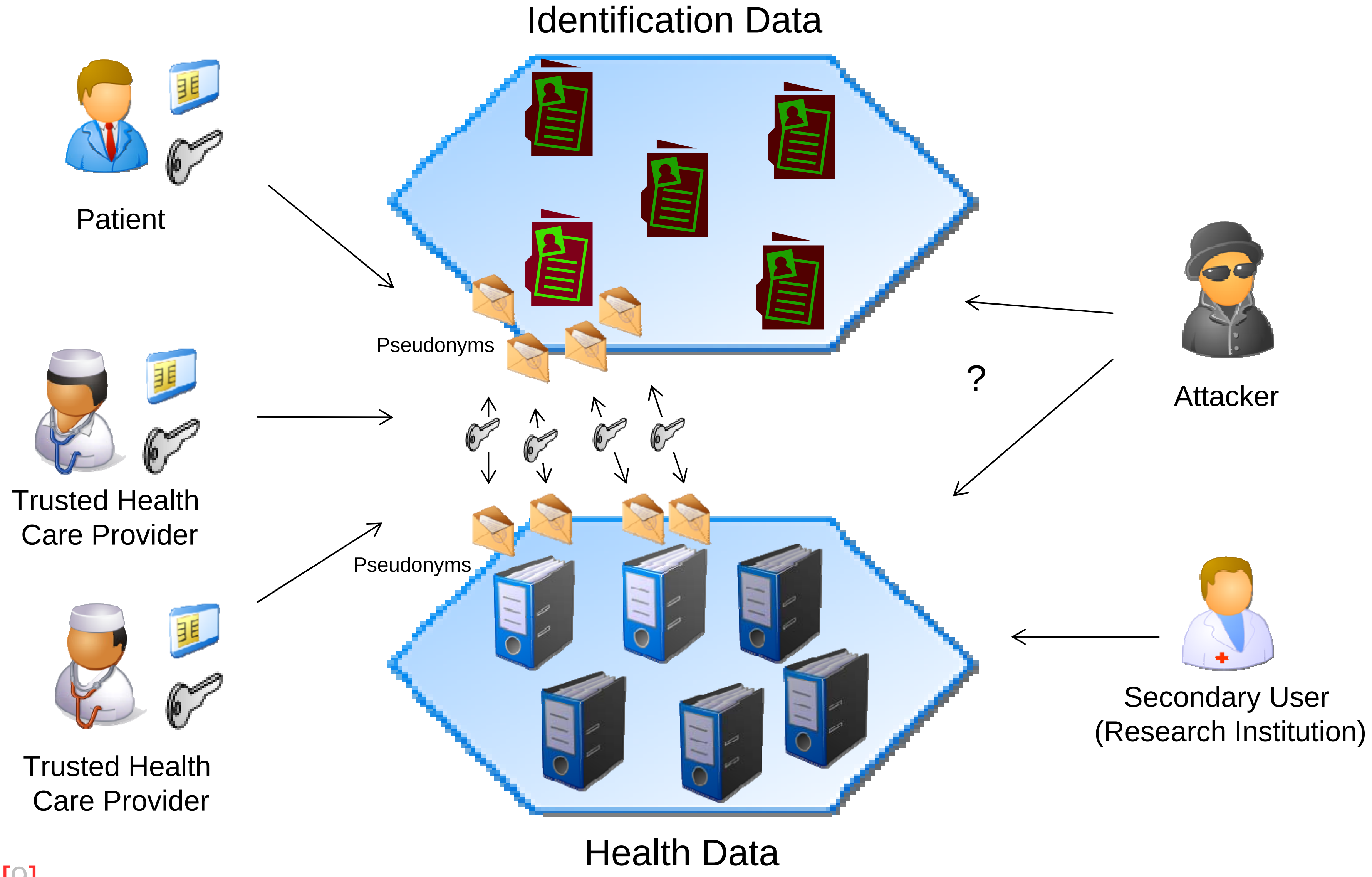
Reversible under strictly controlled circumstances

Privacy

Transparency

Pseudonymization

PIPE - Pseudonymization of Information for Privacy in e-Health


Identification Data
Patient
Pseudonyms
?
Attacker
Trusted Health Care Provider
Pseudonyms
Trusted Health Care Provider
Secondary User (Research Institution)
Health Data

PIPE Benefits and Ongoing Research

- Hull-based security architecture
  - Combination of symmetric and asymmetric cryptography
  - Multiple roles supported
- Patient as data owner
  - Grants data access authorizations to trusted relatives and health care providers
- Secondary use supported
  - Secondary users gain access to health data without the ability to reconnect the pseudonymized data to the corresponding patients
- Ongoing research
  - Extension with advanced privacy-preserving query and retrieval techniques
  - Development of configurable pseudonymization workflows for different domains
  - Service-based centralized design