UNIK4750 - Measurable Security for the Internet of Things

L12 - System Security and Privacy analysis

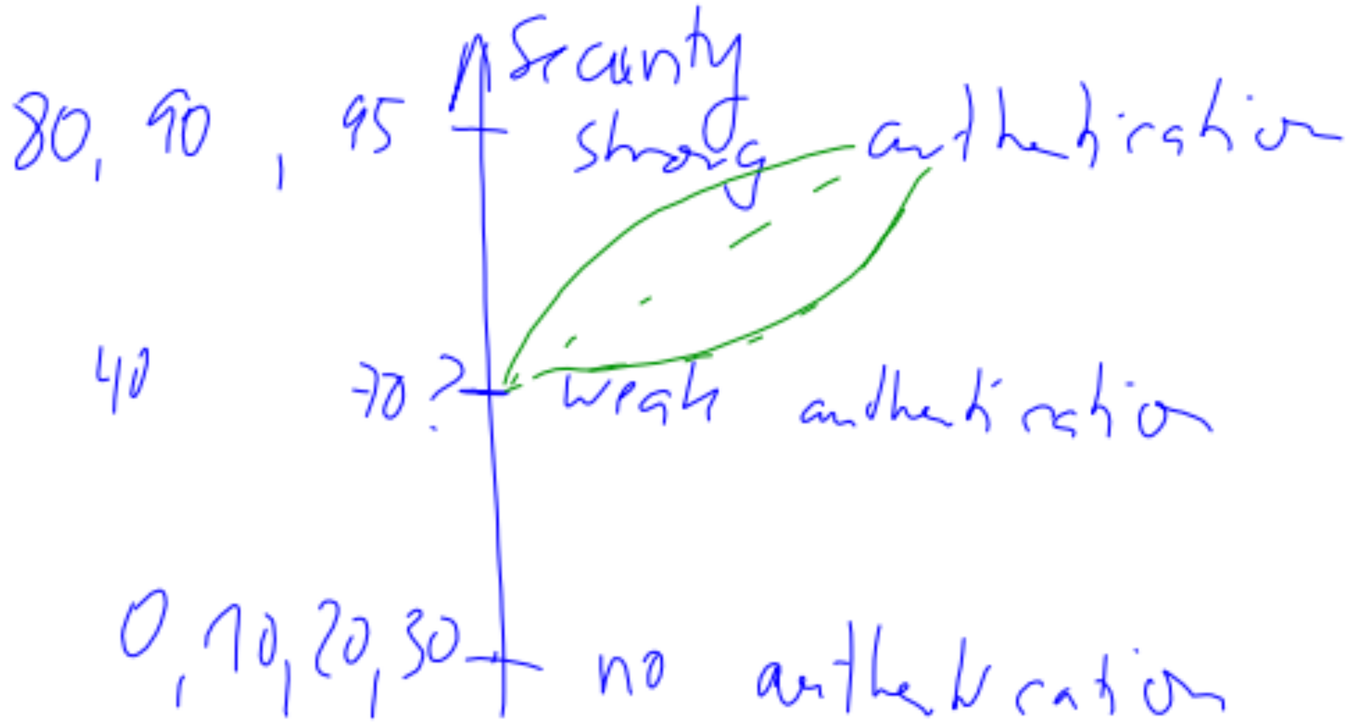
György Kálmán,
Mnemonic/CCIS/UNIK
gyorgy@unik.no

Josef Noll
UiO/UNIK
josef@unik.no

Overview

- expected learning outcomes L12
- Recap L11 - security and privacy application goals
- terminology of “classes”
- examples of security classification
  - example domains
- privacy classification
- match between application goals and security/privacy classification
- Future work

- how to we relate numbers to security/privacy functionalities?



L12 - Expected Learning outcomes

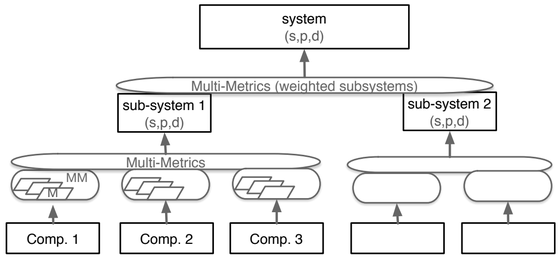
Having followed the lecture, you can

- explain terminology for security and privacy
- provide examples of security classes
- provide examples of privacy data
- reason over relation between System$_{SPD}$ and security/privacy goals of applications

goal

versus

System$_{SPD}$



system of systems

Terminology

- Information System Security based on ISO 27000 standards, often named cyber security
- Industrial Control Systems (ICS) - designates a set of human and material resources designed to control or operate technical installations
- Control Command System (CCS) - technical parameters to talk to sensors and actuators
- Sector - here used as industrial areas, e.g. energy, transport, water supply, industry, as well as Building Management System (BMS)
- Data Breach - loss, unauthorised access to or disclosure of personal data as a result of a failure of the organisation to effectively safeguard the data
- Privacy by Design (PbD) - creating methods to protect privacy in the design of systems, a.o. *measurable* and *proven* privacy results

References:
http://www.ssi.gouv.fr/uploads/2014/01/industrial_security_WG_Classification_Method.pdf

Applicability of security and privacy classes

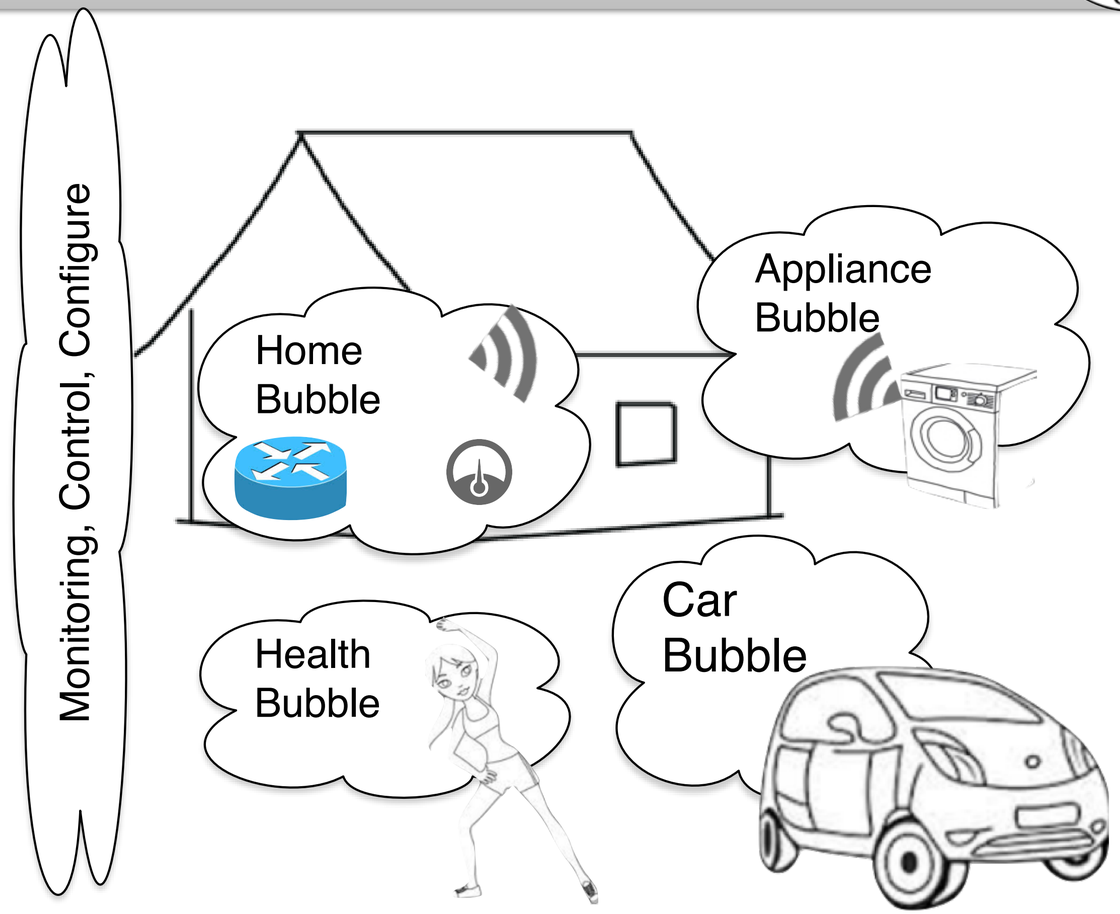
- Applications & application information

Privacy

- abstract principles, rights-based argumentation
- Privacy laws “identifiable information”
- Privacy by design, enforceable privacy
- privacy-invasive services

Security

- System classifications
  - code: red, yellow, green

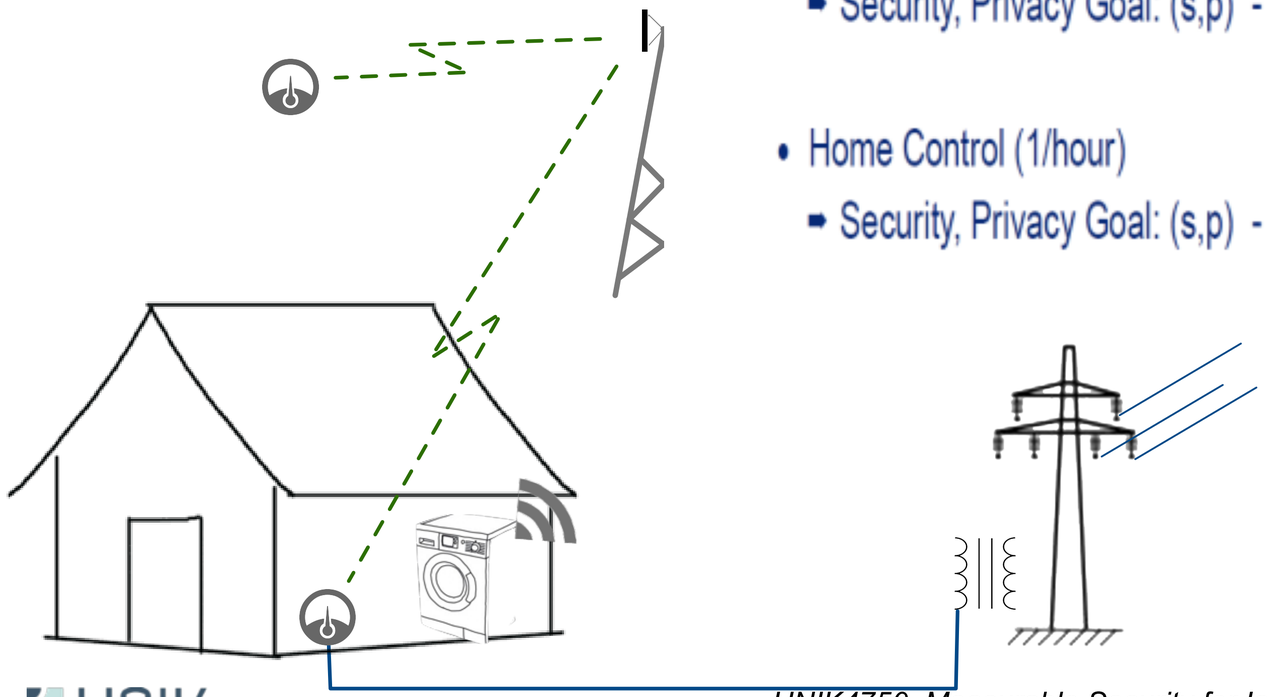


note: Bubble means both applications and system,
e.g. car bubble address
- applications: charging, software update, …
- sub-system: communication, control/identify

L11 - recall - and discussion

your take on application goals

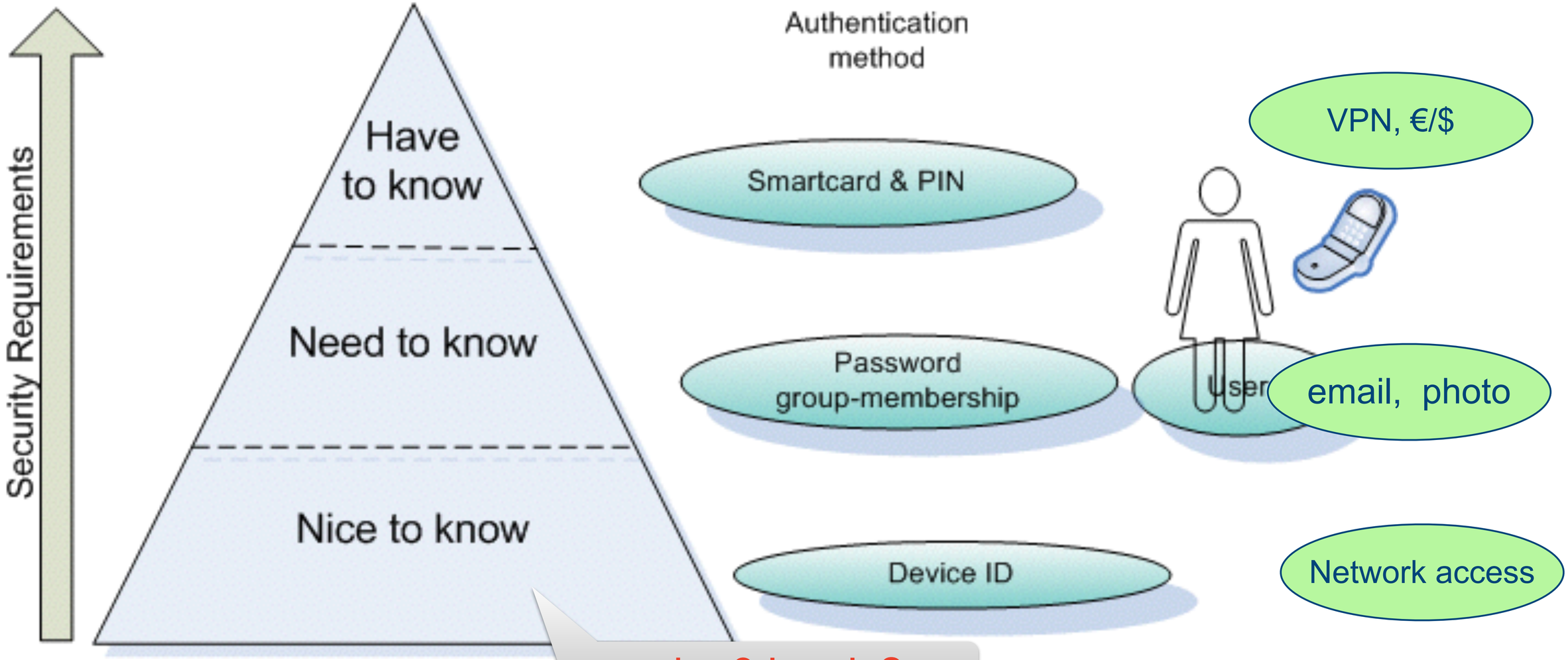
- Billing (1/hour)
  - Security, Privacy Goal: (s,p) - Range [0...100]
- Fire alarm
  - Security, Privacy Goal: (s,p) - Range [0...100]
- Home Control (1/hour)
  - Security, Privacy Goal: (s,p) - Range [0...100]



*1 depends on application: fire, water, …

Security Requirements

Examples of Services



Information Security Classification

- Class 1: ICSs for which the risk or impact of an attack is low. The measures recommended for this class must be able to be applied in complete autonomy. This class mainly corresponds to rules provided in the ANSSI Healthy Network Guide.
- Class 2: ICSs for which the risk or impact of an attack is significant. There is no state control over this class of ICS, but in the event of inspection or incident, the responsible entity must be able to provide evidence that adequate measures have been implemented.
- Class 3: ICSs for which the risk or impact of an attack is critical. In this class, the obligations are heightened and the conformity of ICSs is verified by the state authority or an accredited body.

Consequences/measures for

- roles and responsibilities
- risk analysis
- inventory (rapid assessment of system)
- user training, control, certification
- audits
- monitoring process
- business resumption and continuity plan
- emergency modes
- alert and crisis management
- network segmentation and segregation
- remote diagnosis, maintenance and management
- surveillance and intrusion detection methods
- security approval

http://www.ssi.gouv.fr/uploads/2014/01/industrial_security_WG_Classification_Method.pdf

Classification example – OpenSSL ciphers

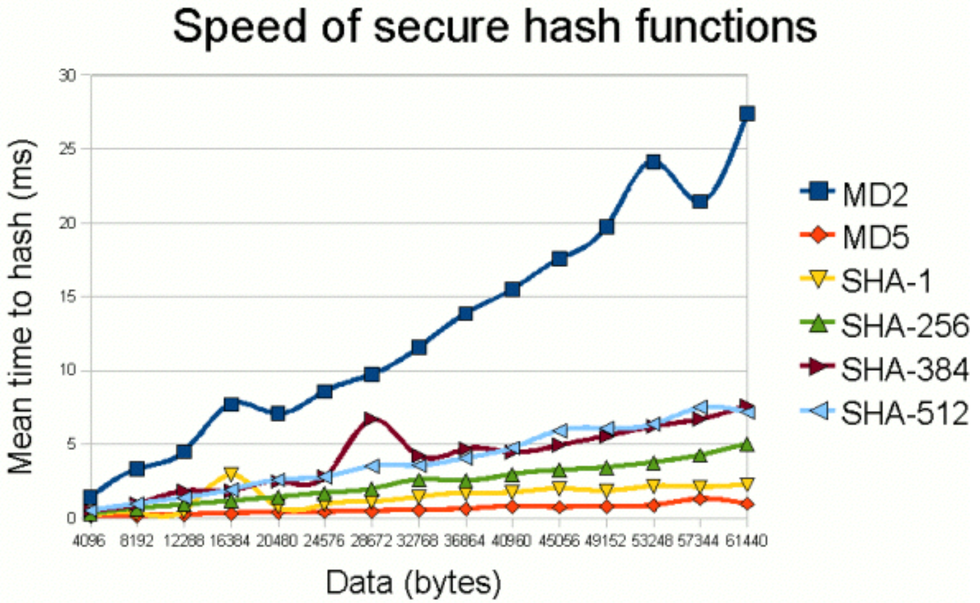
- Nmap: ssl-enum-ciphers script
- Enumerates all the supported cipher suites in the actual openssl installation
- Guides attacks to the weakest supported set – but also administrators to switch off forgotten old or even NULL ciphers (testing)
- In the multi-metric approach, can classes mean certain «goodness» values
- One dimension of a multi-dimensional problem:
  especially in IoT, on board resources can limit the choice of cipher.

```
PORT    STATE SERVICE REASON
443/tcp open  https   syn-ack
| ssl-enum-ciphers:
|   SSLv3:
|     ciphers:
|       TLS_RSA_WITH_RC4_128_MD5 (rsa 2048) - A
|       TLS_RSA_WITH_RC4_128_SHA (rsa 2048) - A
|       TLS_RSA_WITH_3DES_EDE_CBC_SHA (rsa 2048) - C
|     compressors:
|       NULL
|     cipher preference: server
|   TLSv1.0:
|     ciphers:
|       TLS_RSA_WITH_RC4_128_MD5 (rsa 2048) - A
|       TLS_RSA_WITH_RC4_128_SHA (rsa 2048) - A
|       TLS_RSA_WITH_3DES_EDE_CBC_SHA (rsa 2048) - C
|       TLS_DHE_RSA_WITH_AES_256_CBC_SHA (dh 256) - A
|       TLS_DHE_RSA_WITH_AES_128_CBC_SHA (dh 256) - A
|     compressors:
|       NULL
|     cipher preference: server
|_  least strength: C
```

Classification example – time

- Required strength security/integrity protection depends on the data protected – classify with resurce need, typically cycle time
- This is a tradeoff between resource usage and importanc/life time
- See hash example: delay vs security, in IoT a ms can be long time
- Some benchmark examples: https://www.wolfssl.com/wolfSSL/benchmarks-wolfssl.html

MD5 25 kB took 0.003 seconds, 8.138 MB/s
POLY1305 25 kB took 0.004 seconds, 6.104 MB/s
SHA 25 kB took 0.006 seconds, 4.069 MB/s
SHA-256 25 kB took 0.014 seconds, 1.744 MB/s
SHA-512 25 kB took 0.042 seconds, 0.581 MB/s



http://www.javamex.com/tutorials/cryptography/HashTime.png

Example: Server Rating (SSL Labs)

Numerical Score	Grade
80 <= score	A
65 <= score < 80	B
50 <= score < 65	C
35 <= score < 50	D
20 <= score < 35	E
score < 20	F

Note: continuous updates over time

Changes in 2009h (30 October 2014)
- Don't award A+ to servers that don't support TLS_FALLBACK_SCSV.
- Cap to B if SSL 3 is supported.

Changes in 2009i (8 December 2014)
- Cap to B if RC4 is supported.
- Cap to B if the chain is incomplete.
- Fail servers that have SSL3 as their best protocol.

Changes in 2009j (20 May 2015)
- Cap to B if using weak DH parameters (less than 2048 bits).
- Increase CRIME penalty to C (was B).
- Cap to C if RC4 is used with TLS 1.1+.
- Cap to C if not supporting TLS 1.2.

Changes in 2009k (14 October 2015)
- Fail servers that support only RC4 suites.

Table 2. Criteria categories

Category	Score
Protocol support	30%
Key exchange	30%
Cipher strength	40%

Table 4. Key exchange rating guide

Key exchange aspect	Score
Weak key (Debian OpenSSL flaw)	0%
Anonymous key exchange (no authentication)	0%
Key or DH parameter strength < 512 bits	20%
Exportable key exchange (limited to 512 bits)	40%
Key or DH parameter strength < 1024 bits (e.g., 512)	40%
Key or DH parameter strength < 2048 bits (e.g., 1024)	80%
Key or DH parameter strength < 4096 bits (e.g., 2048)	90%
Key or DH parameter strength >= 4096 bits (e.g., 4096)	100%

Table 3. Protocol support rating guide

Protocol	Score
SSL 2.0	0%
SSL 3.0	80%
TLS 1.0	90%
TLS 1.1	95%
TLS 1.2	100%

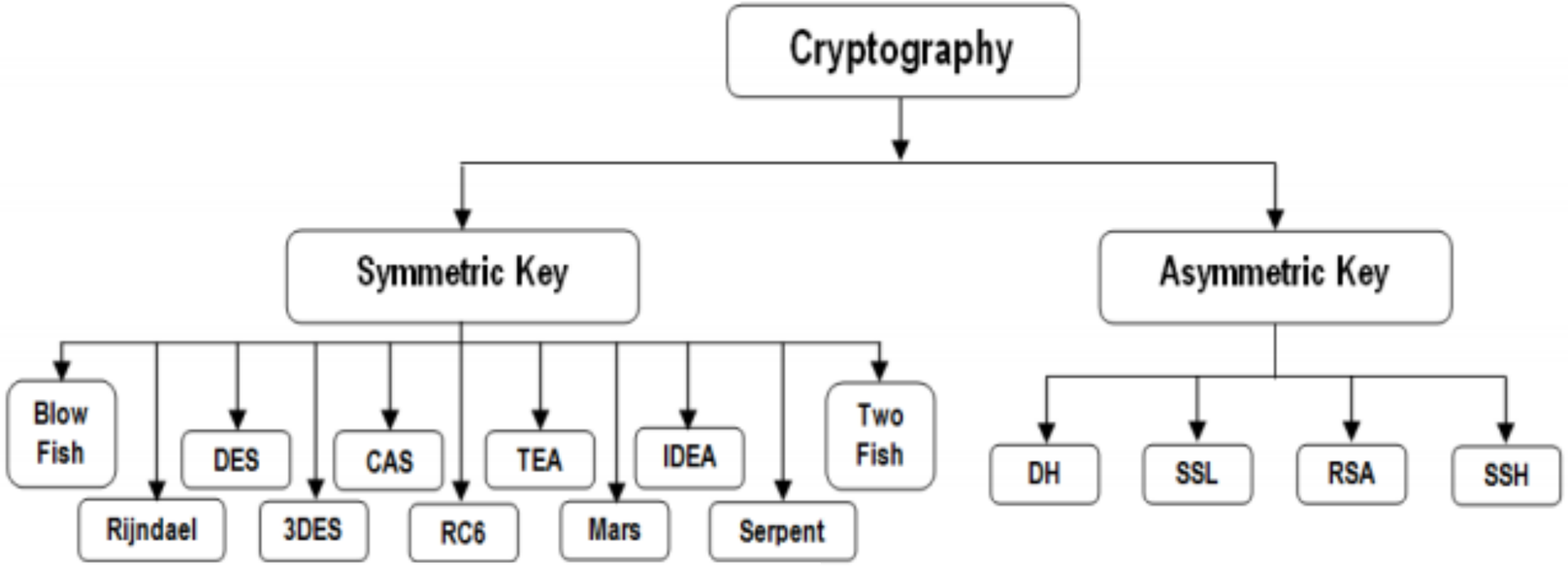
Table 5. Cipher strength rating guide

Cipher strength	Score
0 bits (no encryption)	0%
< 128 bits (e.g., 40, 56)	20%
< 256 bits (e.g., 128, 168)	80%
>= 256 bits (e.g., 256)	100%

calculate using mean:
*0.5 * (best + worse)*

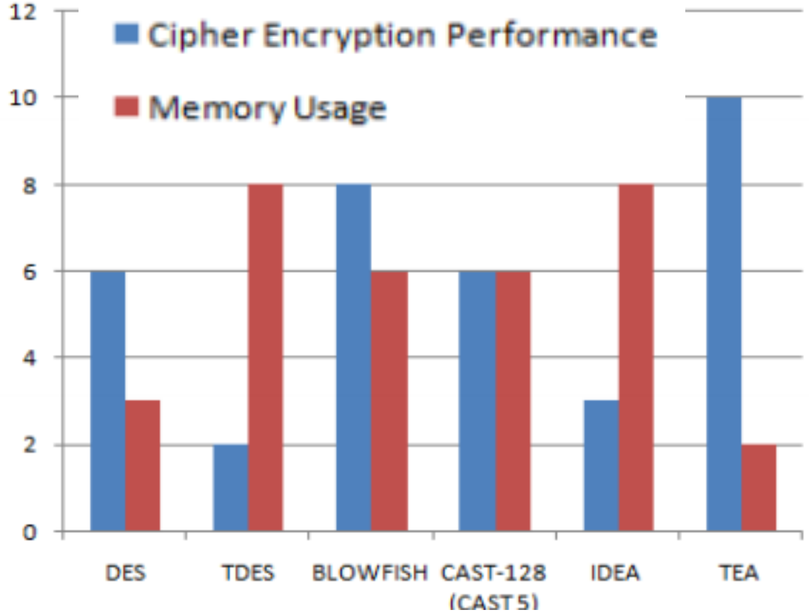
https://www.ssllabs.com/downloads/SSL_Server_Rating_Guide.pdf

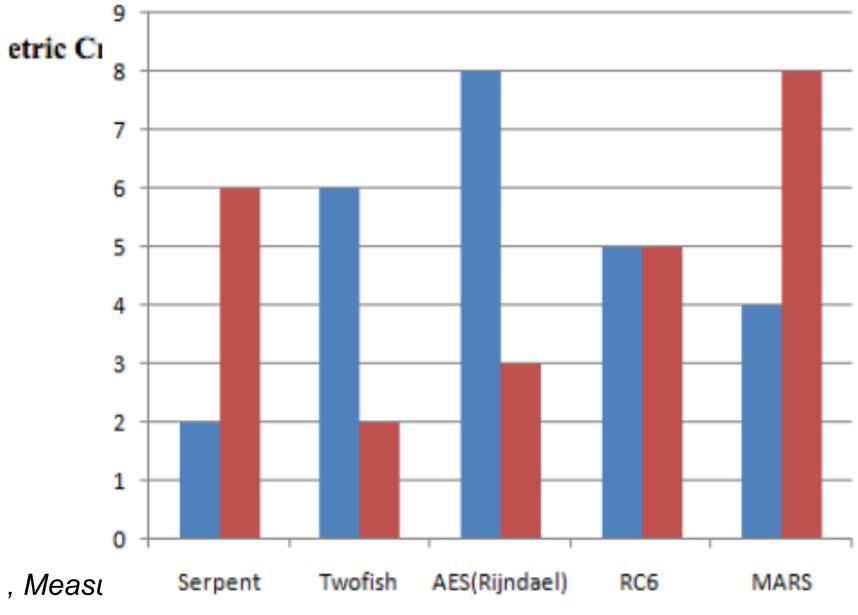
Example
Symmetric and Asymetric Key Cryptography



some flaws in symmetric algorithms such as
- weak keys
- insecure transmission of secret key,
- speed,
- flexibility,
- authentication and reliability

i.e. in DES, four keys for which encryption is exactly the same as decryption





Translate into security measures?

https://arxiv.org/ftp/arxiv/papers/1405/1405.0398.pdf

How to define security?

- We looked at cipher strengths, hash speeds, have defined an interval of acceptable quality of service
- What forms the baseline: in IoT: regulations. We use frameworks to create a security baseline, which fulfills the regulator's minimal set of requirements
- Several frameworks exist: kind of all the same: provides a structured approach for defining the baseline and also achieving it.
- The choice of framework can depend on industry, the actual contract or personal preference
- Examples are: COBIT, ISA99 (IEC 62443), NERC 1300 (critical infrastructure protection)

Your take?

Example
Federal Information Processing Standards

- SC information type = {(confidentiality, impact), (integrity, impact), (availability, impact)},
- where the acceptable values for potential impact are LOW, MODERATE, HIGH, or NOT APPLICABLE.

http://csrc.nist.gov/publications/fips/fips199/FIPS-PUB-199-final.pdf

About privacy

- 1980: OECD guidelines (oecdprivacy.org) Guidelines Governing The Protection of Privacy and Transborder Flows of Personal Data.
- 2005: Kim Cameron - 7 laws of identity
- 2011 OECD update on privacy guidelines
- 2012 EU Data Protection Reform
  - ➡ “Right to be forgotten”
  - ➡ Easier access to one’s data; right to data portability
  - ➡ Data protection **by design** and **by default**
  - ➡ Stronger enforcement of the rules - up to 4% of annual turnover

1. Collection Limitation Principle - “limits to the collection of personal data…”
2. Data Quality Principle - “relevant and necessary for the purpose of usage”
3. Purpose Specification Principle - “specified prior to collection - change of purpose”
4. Use Limitation Principle - “non disclosure, not for others than those” - “need consent”
5. Security Safeguards Principle - “protection by reasonable security safeguards”
6. Openness Principle - “about developments, practices and policies”
7. Individual Participation Principle - “individual to have insight, answers in reasonable time…”
8. Accountability Principle - “data controller should be accountable”

http://www.oecd.org/sti/ieconomy/49710223.pdf

http://europa.eu/rapid/press-release_MEMO-15-6385_en.htm

Ten Commandments to protect Privacy in the Internet World

- **International Separation of Powers**
- **Telecommunications Secrecy**
- **Data Austerity**
- **Right to Anonymity**
- **Virtual Right to be Alone**
- **Right to Security**
- **Restriction on Secondary Use**
- **Transparency**
- **Access to one‘s personal data**
- **International Complaints Resolution**

Discussion

- Telecom companies collaborate with Facebook on “free basic”
  - zero-rated (“no pay”)
  - low capacity content
- Facebook uses connectivity data for analysis
  - conversion from zero-rated to payed customer
  - profiling of users
- *Example*:
- Telenor Pakistan
  - 100% Telenor owned
  - Telenor: 53% state owned

Kim Cameron - 7 Laws of Identity

1. Technical identity systems must only reveal information identifying a user with the user's consent.
2. The solution that discloses the least amount of identifying information and best limits its use is the most stable long-term solution.
3. Digital identity systems must be designed so the disclosure of identifying information is limited to parties having a necessary and justifiable place in a given identity relationship.
4. A universal identity system must support both "omnidirectional" identifiers for use by public entities and "unidirectional" identifiers for use by private entities, thus facilitating discovery while preventing unnecessary release of correlation handles.
5. A universal identity system must channel and enable the inter-working of multiple identity technologies run by multiple identity providers.
6. The universal identity metasystem must define the human user to be a component of the distributed system integrated through unambiguous human/machine communication mechanisms, offering protection against identity attacks.
7. The unifying identity metasystem must guarantee its users a simple, consistent experience while enabling separation of contexts through multiple operators and technologies.

Kim Cameron's influence on Microsoft

Kim Cameron, a Microsoft distinguished engineer and outspoken advocate of Internet privacy, left the company last week.

In a video interview yesterday, he says that Microsoft is on the right track, but he's worried that user privacy will get lost in the shuffle as big Internet companies like Microsoft, Google, and Facebook fight for market share.

13May2011

- „All of our information will be on the Internet. Our health records."
- „Historically, we've essentially relied on... incompetence to protect our privacy."
- It „would be a strong milestone...to have an all-inclusive uniform privacy law...that would give consumers control over their personal information. This would increase their confidence in providing information to legitimate businesses and other organizations."

(Bill Gates, 2007)

http://www.businessinsider.com/top-microsoft-privacy-guru-leaves-blasts-current-state-of-net-advertising-2011-5?IR=T

Privacy assessment

- Medical App Checker: a Guide to assessing Mobile Medical Apps
  - Medical App Checker: Evaluation of Mobile Medical Apps (.pdf)
    - (1) focussed search, (2) reliability and quality, (3) privacy of personal data
  - Draft Code of Conduct on privacy for mobile health applications (pdf)
- 2015: more than 120.000 mobile medical apps

Ease of use

The extent to which an app is easy to use.

Questions	*Yes / No / Don't know*
10 Is the use of the app clearly explained?	☐ ☐ ☐
11 Is a website available with additional information?	☐ ☐ ☐
12 Is the app simple to use?	☐ ☐ ☐
13 Are the app's functionalities available for offline use?	☐ ☐ ☐
14 Can problems with use of the app be reported to the app provider (phone number, email address, help function)?	☐ ☐ ☐

If two answers are *No*, use of the app is not advisable.

Privacy

Questions	*Yes / No / Don't know*
1 Does the app include a clear, easy-to-read privacy statement?	☐ ☐ ☐

If the answer = *No*, use of the app is not advisable.

2 Does the privacy statement do any of the following:	
- ask permission to collect data?	☐ ☐ ☐
- ask to access data on your mobile device?	☐ ☐ ☐
- use any data (entered or released)?	☐ ☐ ☐
- modify the data entered?	☐ ☐ ☐
- delete the data entered, including account data?	☐ ☐ ☐

http://www.knmg.nl/Over-KNMG/About-KNMG/News-English/152830/Medical-App-Checker-a-Guide-to-assessing-Mobile-Medical-Apps.htm

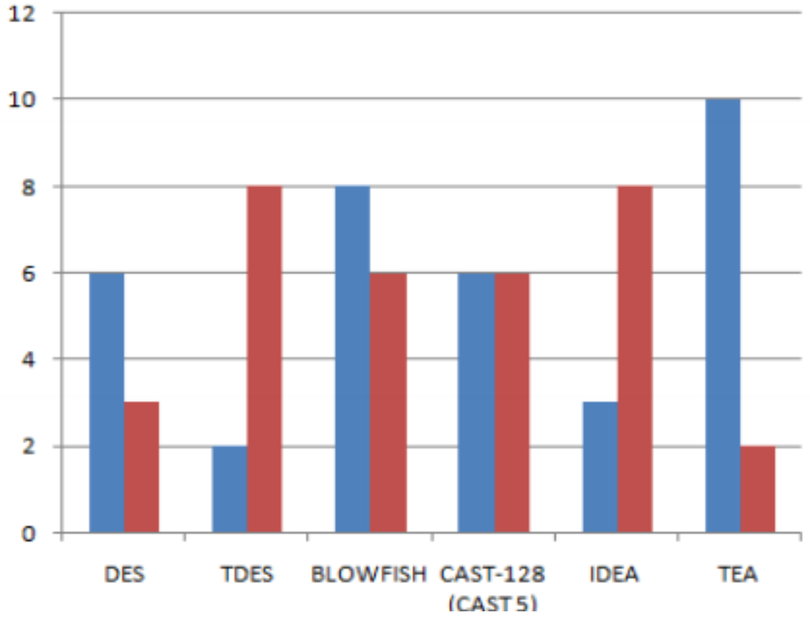
http://www.knmg.nl/web/file?uuid=21e68dda-abe7-455f-a003-e5e45f561831&owner=a8a9ce0e-f42b-47a5-960e-be08025b7b04&contentid=152825

http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=12378

Conclusions

- Performed a review on security and security classes
  - Examples: server rating, ssh security
- Privacy and identity
  - ongoing discussion on privacy enforcement

- can we really draw conclusions?

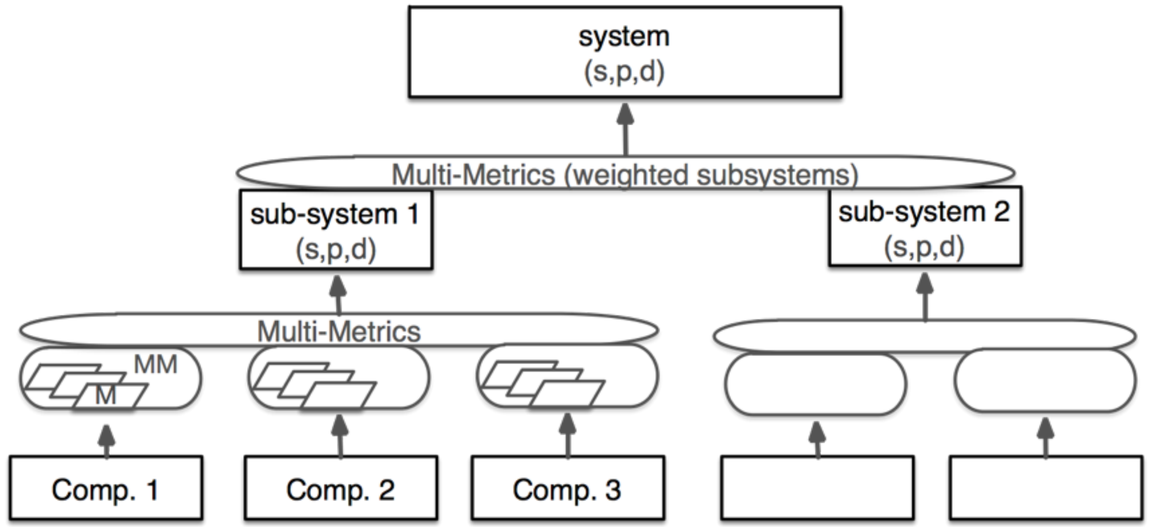


$|\text{SPD}_{Goal} - \text{SPD level}| = \leq 10$, green.
$|\text{SPD}_{Goal} - \text{SPD level}| = > 10, \leq 20$, yellow.
$|\text{SPD}_{Goal} - \text{SPD level}| = > 20$, red.

Upcoming lectures

- L13: Intrusion detection

- …. applying Multi-Metrics on your own



References

- Cybersecurity classes: http://www.ssi.gouv.fr/uploads/2014/01/industrial_security_WG_Classification_Method.pdf
- IAEA: Computer Security at Nuclear Facilities: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1527_web.pdf
- Red Tiger Security: mapping security controls to standards: http://isacahouston.org/documents/RedTigerSecurity-NERCCIPandotherframeworks.pdf
- Standards for Security Categorization of Federal Information and Information Systems, http://csrc.nist.gov/publications/fips/fips199/FIPS-PUB-199-final.pdf