# Lecture #3: IoT Concepts and Applications

Cristian Hesselman, Elmer Lastdrager, Ramin Yazdani, and Etienne Khan

University of Twente | May 6, 2020

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# Lab assignment

- Reshuffle groups because we now have 2 groups of 4 and one group of a single person
- Equally sized groups much preferred for fairness
- We'll contact the groups of 4 and 1 after the lecture

# Paper summaries

- You must have handed in your two summaries BEFORE this lecture
- You can use the summaries during the oral exam (“open book”)
- You **cannot** complete SSI without submitting 12 paper summaries!
- If you didn’t submit in time, do it today (deadline 23:59 CET today)
- We will only allow this **once** because this is the first lecture

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# Interactive Lecture

- Goal: enable you to learn from each other and further increase your understanding of the papers (contributes to preparing yourself for the oral exam)

- Format:
  1. We'll ask someone to provide their verbal summary of the paper
  2. 5-slide(-ish) summary by teachers (put any questions in the chat)
  3. Questions: discussion starters and fact questions
  4. Discussion (use your mic)
  5. We may ask someone specific to start the discussion

- Experimental format resulting from Corona pandemic, please provide feedback!

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# Today's papers

- Are about "setting the scene": not very technical, but important for the other papers

- [ISOC] K. Rose, S. Eldridge, L. Chapin, "The Internet of Things: An Overview – Understanding the Issues and Challenges of a More Connected World", ISOC Whitepaper, October 2015

- [WEIS] E. Leverett, R. Clayton, and R. Anderson, "Standardisation and Certification of the `Internet of Things'", 16th Annual Workshop on the Economics of Information Security (WEIS2017), USA, June 2017

Karen Rose, Scott Eldridge, Lyman Chapin,
"The Internet of Things: An Overview",
ISOC Report, October 2015

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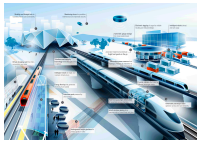
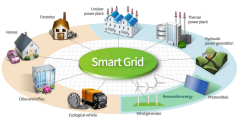
# Internet of Things (IoT)

- Internet application that extends “network connectivity and computing capability to objects, devices, sensors, and items not ordinarily considered to be computers” (ISOC)

- Differences with “traditional” applications
  - IoT continually senses, interprets, acts upon physical world
  - Without user awareness or involvement (passive interaction)
  - 20-30B devices “in the background” of people’s daily lives
  - Widely heterogeneous (hardware, OS, network connections)
  - Longer lifetimes (perhaps decades) and unattended operation



Intelligent Transport Systems




Smart energy grids

Smart homes and cities

- IoT promises a safer, smarter, and more sustainable society, but IoT security is a major challenge

[SAC105] T. April, L. Chapin, kc claffy, C. Hesselman, M. Kaeo, J. Latour, D. McPherson, D. Piscitello, R. Rasmussen, and M. Seiden, “The DNS and the Internet of Things: Opportunities, Risks, and Challenges”, SSAC report SAC105, June 2019

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# IoT quiz

Is the IoT specific for the Internet?

A. Yes, it can only work on the Internet

B. No, it's a broad concept that also works for other types of internets

# Communication patterns

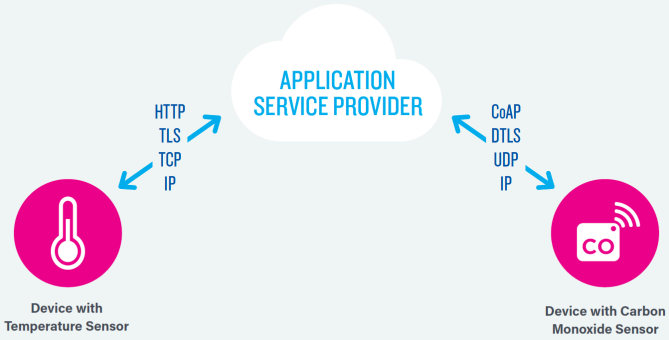
FIGURE 1

Example Of Device-To-Device Communication Model


SOURCE: Tschofenig, H., et.al., Architectural Considerations in Smart Object Networking. Tech. no. RFC 7452. Internet Architecture Board, Mar. 2015. Web. https://www.rfc-editor.org/rfc/rfc7452.txt.

FIGURE 2

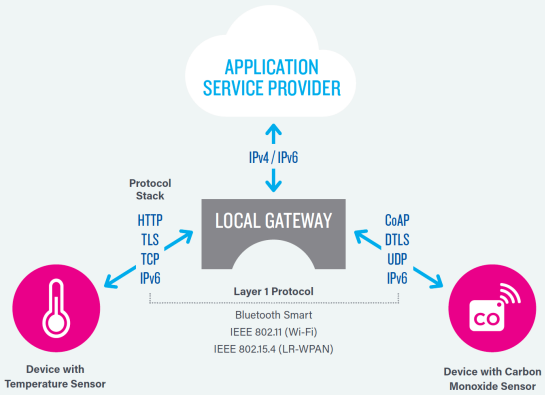
Example Of Device-To-Cloud Communication Model




SOURCE: Tschofenig, H., et.al., Architectural Considerations in Smart Object Networking. Tech. no. RFC 7452. Internet Architecture Board, Mar. 2015. Web. https://www.rfc-editor.org/rfc/rfc7452.txt.

FIGURE 3

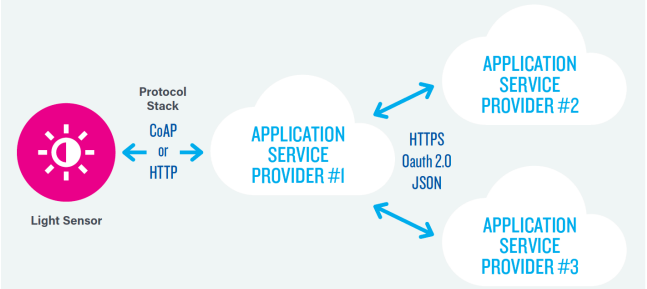
Example Of Device-To-Gateway Communication Model




SOURCE: Tschofenig, H., et.al., Architectural Considerations in Smart Object Networking. Tech. no. RFC 7452. Internet Architecture Board, Mar. 2015. Web. https://www.rfc-editor.org/rfc/rfc7452.txt.

FIGURE 4

Back-End Data-Sharing Model




SOURCE: Tschofenig, H., et.al., Architectural Considerations in Smart Object Networking. Tech. no. RFC 7452. Internet Architecture Board, Mar. 2015. Web. https://www.rfc-editor.org/rfc/rfc7452.txt.

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# Communication patterns quiz

Which model typically results in more brittle end-to-end connections?

A. Device-to-device

B. Device-to-cloud

C. Device-to-gateway

D. Back-end data sharing

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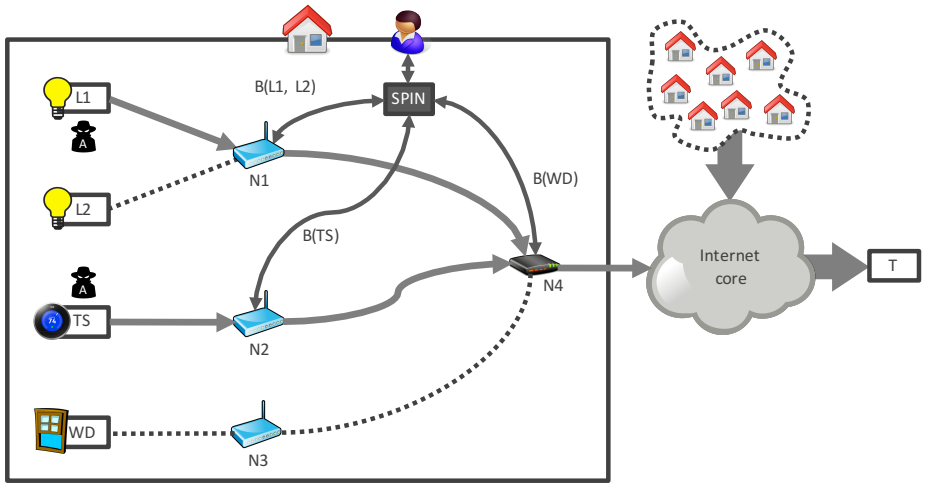
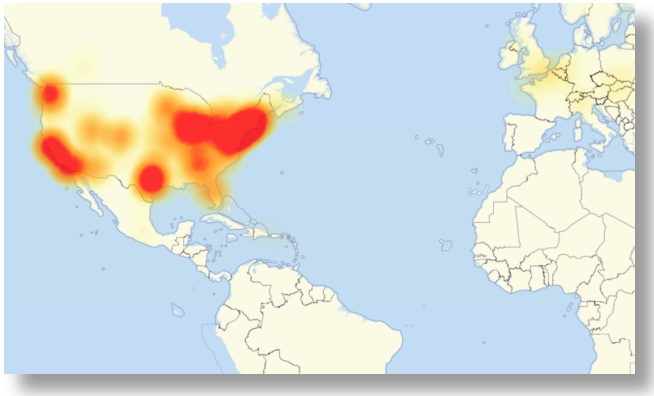
# Challenge #1: security

- Poorly secured devices (“by design” or configuration)
- DDoS attacks on remote services or Internet infrastructure [Mirai] [Hajime]
- Leaking privacy-sensitive data
- Proximity connectivity and botnet spreading [Mirai] [Hajime]
- Global impact [Mirai] [Hajime] [IoTPOT] [Honware]



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# Security quiz

What's an externality in the context of IoT security?

A. A human adversary in an IoT device's local operating environment

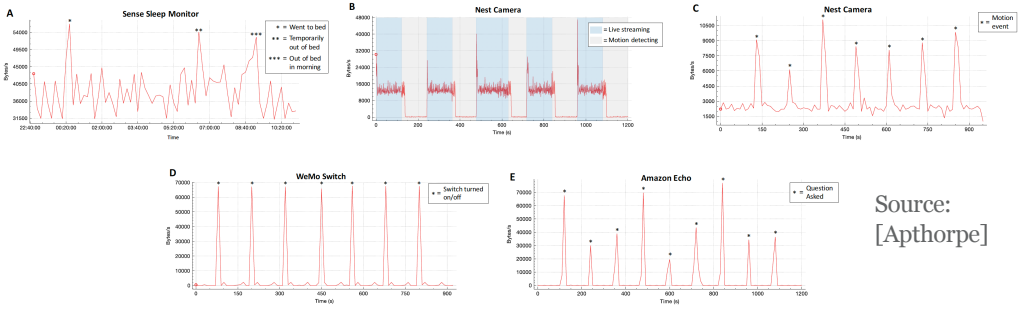
B. An external organization that regulates a specific IoT ecosystem (e.g., medical or automotive)

C. A sudden spike in RF bit error rate as a result of a solar flare

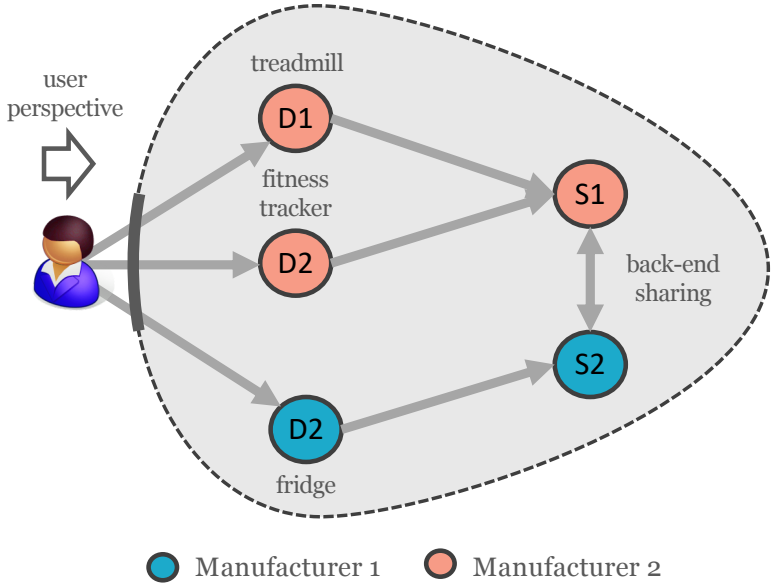
D. A device vendor not bearing the costs caused by an insecurity

# Challenge #2: privacy

- Transparency of user sensor flows [SAC105]
  - Sharing with/among third parties [IMC] [SPIN]
  - Data leak-related vulnerabilities
  - Applicable jurisdictions [WEIS]
- Control of privacy across IoT devices
  - Interact with thousands of devices a day
  - New types of user consent
- Different privacy expectations in different parts of the world




Source: [Apthorpe]




[Apthorpe] N. Apthorpe, D. Reisman, N. Feamster, "A Smart Home is No Castle: Privacy Vulnerabilities of Encrypted IoT Traffic", Workshop on Data and Algorithmic Transparency (DAT '16), New York University Law School, Nov 2016
[SPIN] SPIN homepage, spin.sidnlabs.nl

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# Privacy quiz

Why does the traditional notice and consent model work not work in the IoT?

A. IoT devices encrypt the sensor data they share, so the model is not needed

B. IoT devices often do not explicitly interact with users

C. IoT devices share data across jurisdictions, so you'll get a lot of notifications

D. There will be so many IoT devices, tracking what user data goes where will be impossible

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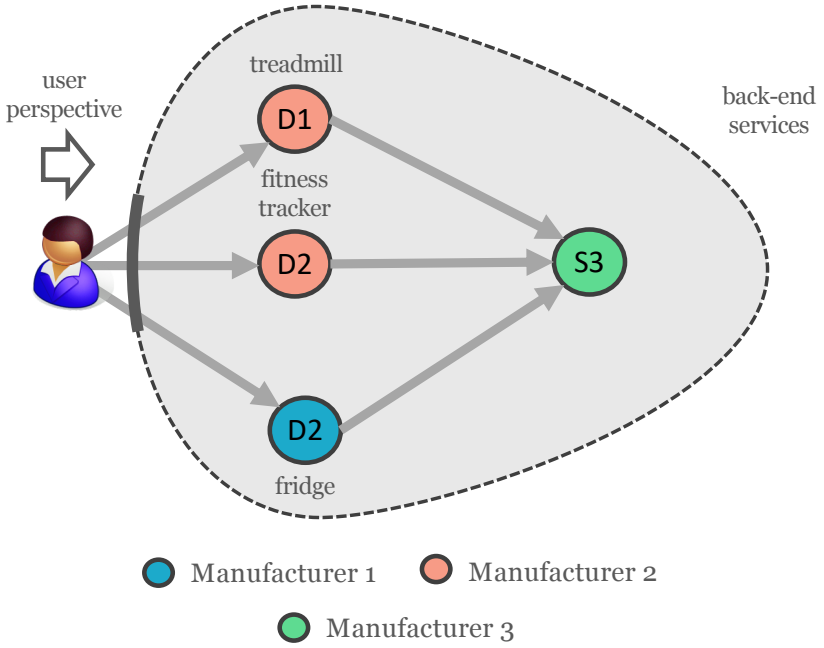
# Challenge #3: interoperability

- Standardized open protocols and data formats
- Enables data mobility, user choice, innovation
- Access to larger pool of technical experts
- Eases configuring large numbers of devices (100s, 1.000s)

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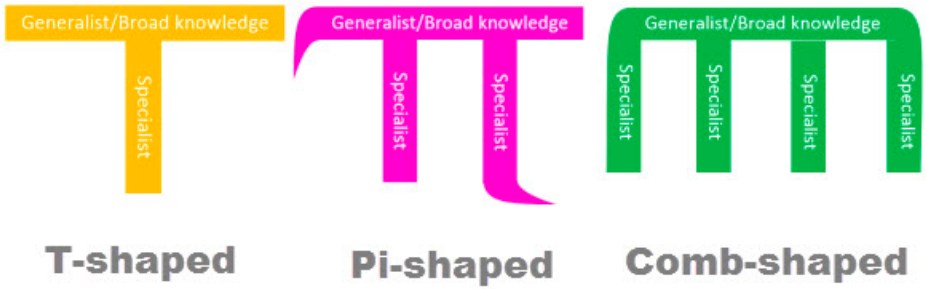
# Interoperability quiz

What do some consider an advantage of proprietary IoT protocols?

A. They're more secure, because the protocol is not public
B. They're faster to update because they bypass lengthy standardization cycles
C. They can be installed more easily through an app
D. Proprietary protocols can be claimed as a patent whereas open standards can't

# Challenge #4: legal and regulatory

- Silent cross-border data exchange
- High data specificity because of single-purpose devices and third-party sensors
- Who's responsible for actions of an IoT device that cause harm? [WEIS]
- Regulation of classes of IoT devices [WEIS]
- Ethical considerations (fitness tracker and insurer example)

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# Legal and regulatory quiz

Open question: what do you consider the major legal and regulatory challenge in the IoT?

- Algorithms?
- Transparency?
- Accountability?
- …
- (There's no right or wrong :-)

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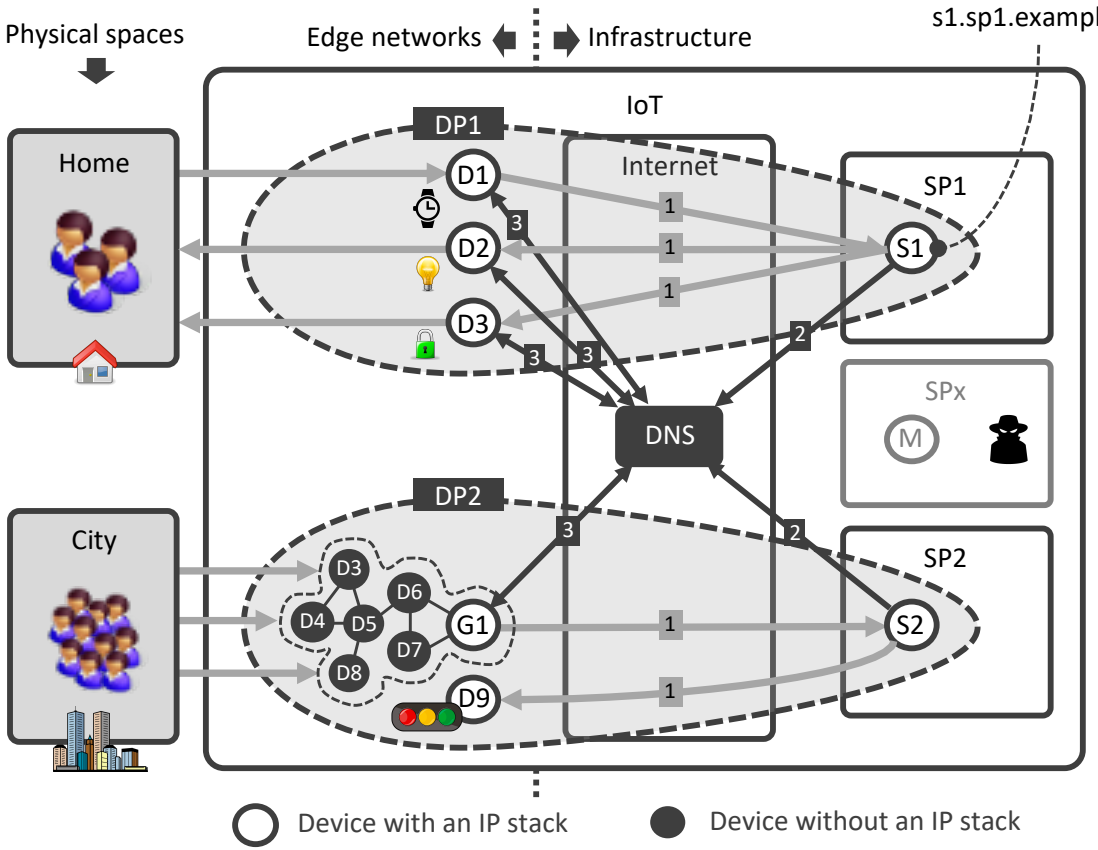
# If time permits: where would you put security, privacy, and transparency functions and why?




[SAC105] T. April, L. Chapin, kc claffy, C. Hesselman, M. Kaeo, J. Latour, D. McPherson, D. Piscitello, R. Rasmussen, and M. Seiden, "The DNS and the Internet of Things: Opportunities, Risks, and Challenges", SSAC report SAC105, June 2019

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# Discussion

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# Standardisation and Certification of the ‘Internet of Things’

Eireann Leverett, Richard Clayton, Ross Anderson

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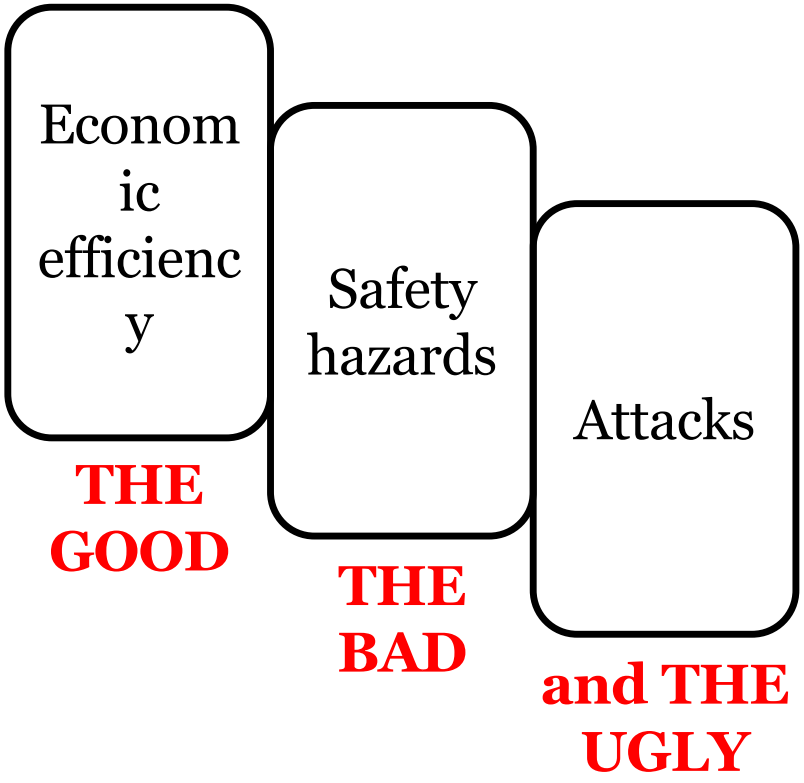
# Paper #2: Standardisation and Certification of the 'Internet of Things'

Eireann Leverett, Richard Clayton, Ross Anderson

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# Paper #2: Standardisation and Certification of the 'Internet of Things'

Eireann Leverett, Richard Clayton, Ross Anderson

**Core question:** What should the EU's regulatory framework look like?

Social welfare goals of a cybersecurity regulator (a mix of **safety** and **privacy**):

1. Ascertaining, agreeing, and harmonizing protection goals
2. Setting standards
3. Certifying standards achievement and enforcing compliance
4. Reducing vulnerabilities
5. Reducing compromises
6. Reducing system externalities

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# Paper #2: Standardisation and Certification of the 'Internet of Things'

Eireann Leverett, Richard Clayton, Ross Anderson

Safety in three contexts:

Road transport, Medical devices, Energy sector

Generic approaches:

- Liability
- Transparency
- Data protection
- Attack and vulnerability testing
- Security standards

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# Paper #2: Standardisation and Certification of the 'Internet of Things'

Eireann Leverett, Richard Clayton, Ross Anderson

Creation of a European Safety and Security Engineering Agency is proposed:

Missions:

- support the European Commission's policy work
- support sectoral regulators in the EU institutions and at the Member State level
- develop cross-sectoral policy and standards
- act as a clearing house for data
- work to promote best practice and harmonization
- act as a counterweight to the national security authorities

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# Quiz: question 1

How should the EU Cybersecurity regulation look like?

**A**: A single regulator covering all industry sectors

**B**: Expertise embedded in each sector

**C**: Separate regulators for privacy, safety, consumer protection, …

**D**: A matrix of functional and sectoral regulators

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# Quiz: question 2

Who should investigate the IoT incidents?

**A**: Vendors

**B**: Regional authorities

**C**: A mix of stakeholders

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# Quiz: question 3

Which sector currently implements a practice closer to the goals of the IoT regulation?

**A**: Transport

**B**: Healthcare

**C**: Energy

**D:** Other

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# Discussion & feedback

Next lecture: **Wed May 13, 10:45-12:30**

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