Security Services for the IoT: Introduction

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Teaching team

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(teacher)

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Online house rules

- Mute your mic!
- Put a “?” in the chat if you’d like to ask a question and we’ll give you the floor (*or write your question directly in the chat*)
- Unmute your mic (and optionally turn on your cam) if you want to speak :-)
- Roles: chair (Cristian), moderator (Elmer), attendees (you guys)

Today's goal

- Provide an overview of Security Services for the IoT (SSI)
- Answer any questions you may have on assessment, deliverables, etc.
- Result: understanding of SSI, the work you'll need to carry out, and some IoT inspiration

Agenda

- Five-slide high-level introduction to IoT security
- Course overview
- (Brief introduction of SIDN Labs)
- Guest lecture by Marco Davids (SIDN Labs) on “How the core of the Internet is organized”

Security issues in the IoT?

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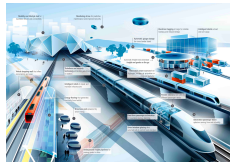
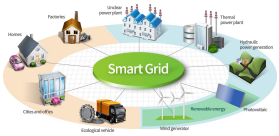
Internet of Things (IoT)

- 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



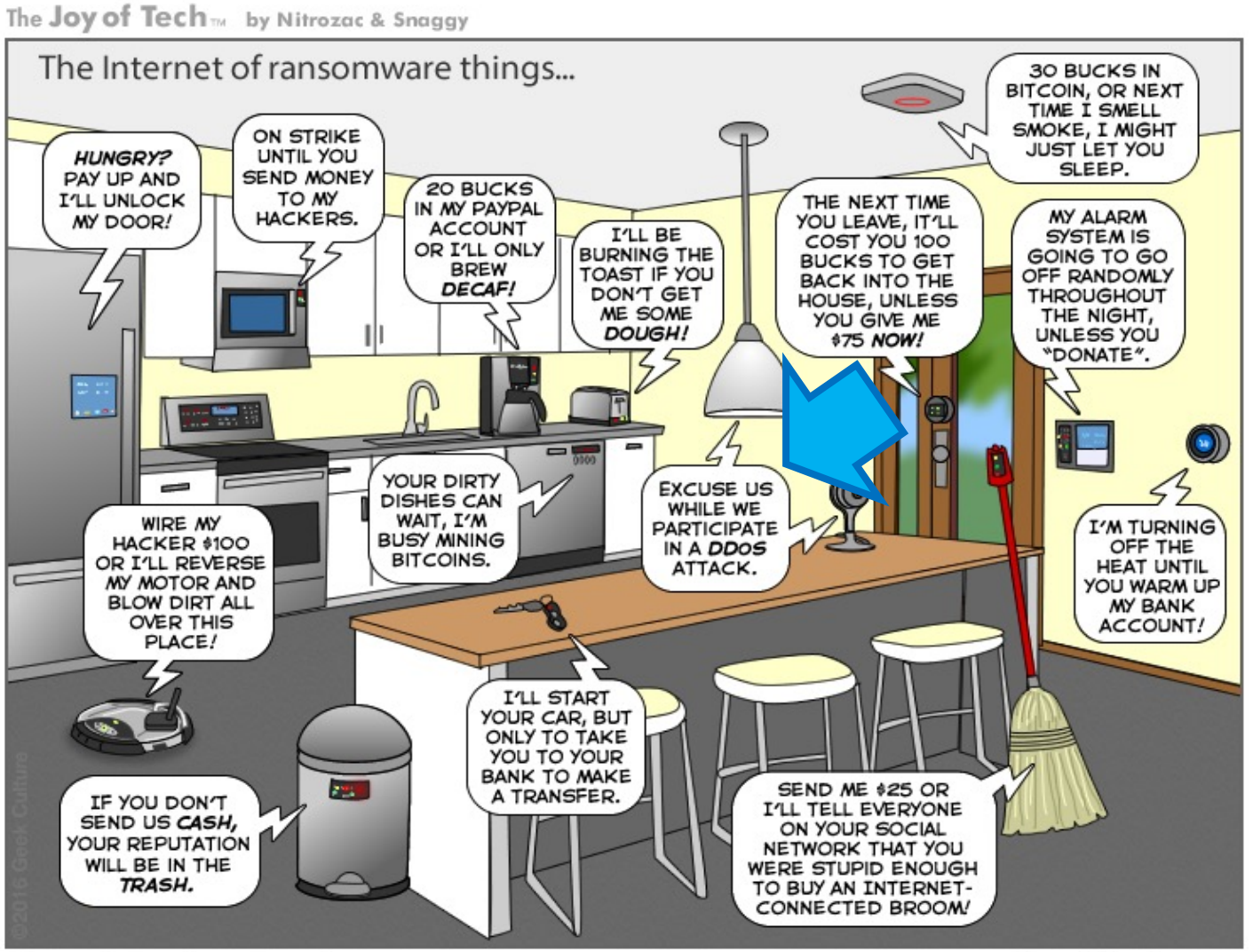
Smart energy grids

Smart homes and cities

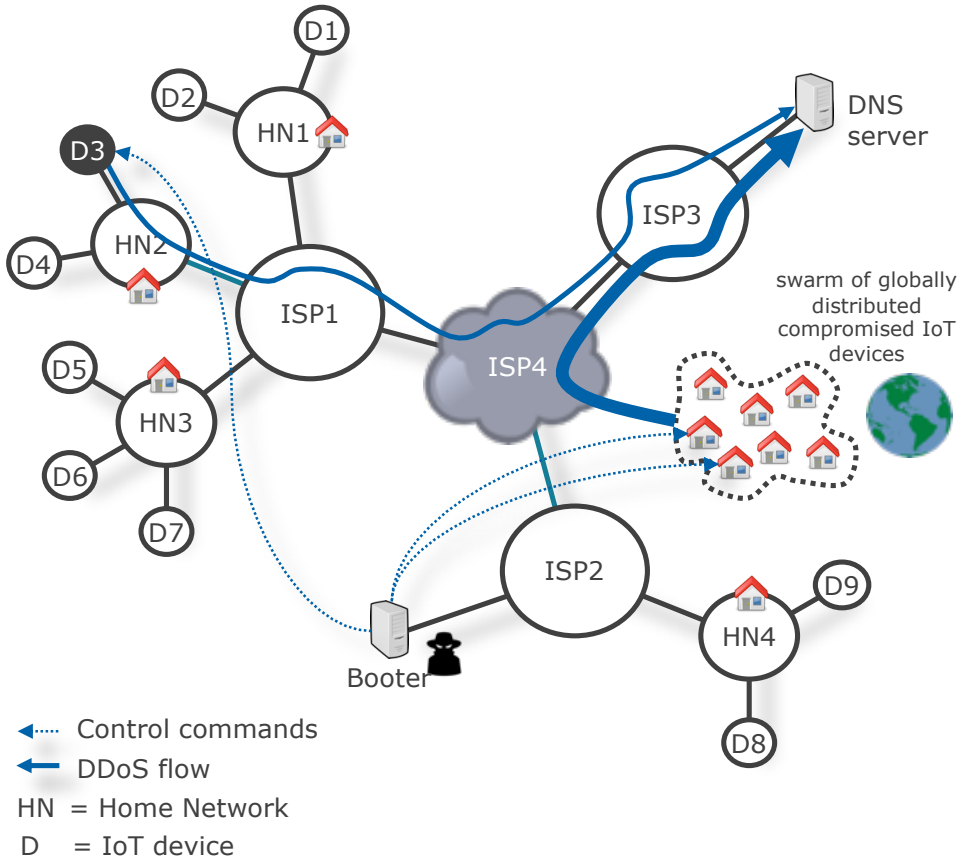
- Promises safer, smarter, more sustainable society, **but IoT security is a major challenge**

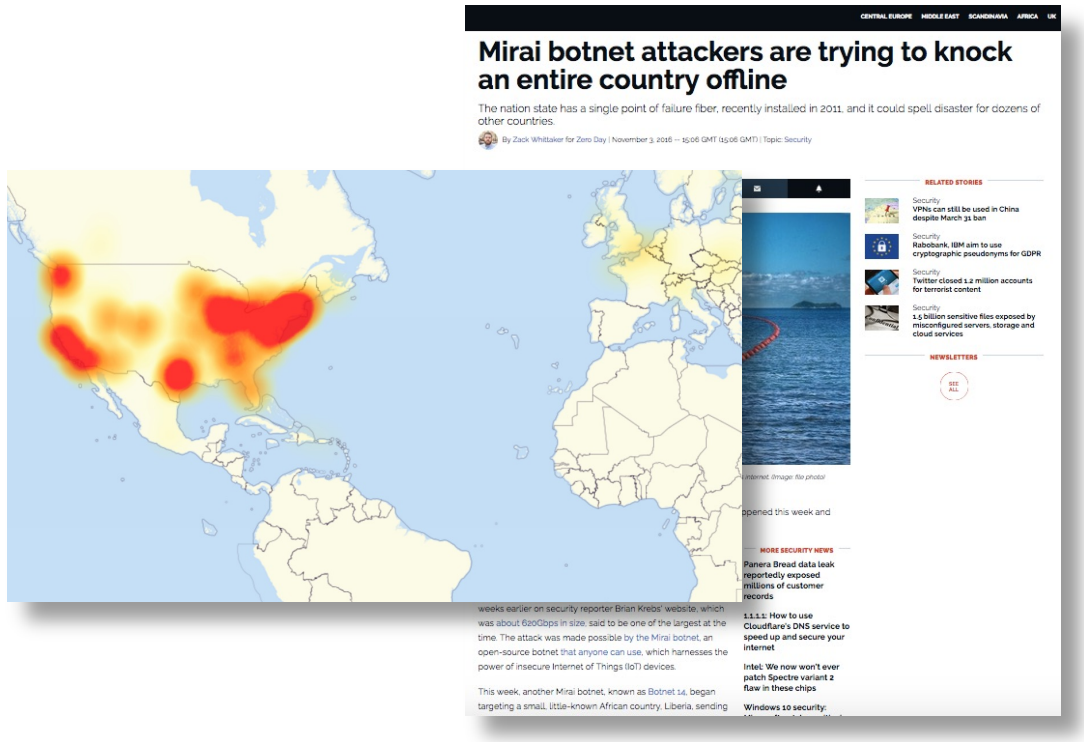
Further reading: [WEIS] [DNSIoT]

“The Internet of Insure Things”



IoT wakeup call: Mirai-powered DDoS attacks (2016)





Other targets: OVH (hosting provider), Krebs On Security (website), Deutsche Telecom (ISP)

Further reading: [Mirai], [Hajime], [DNSIoT]

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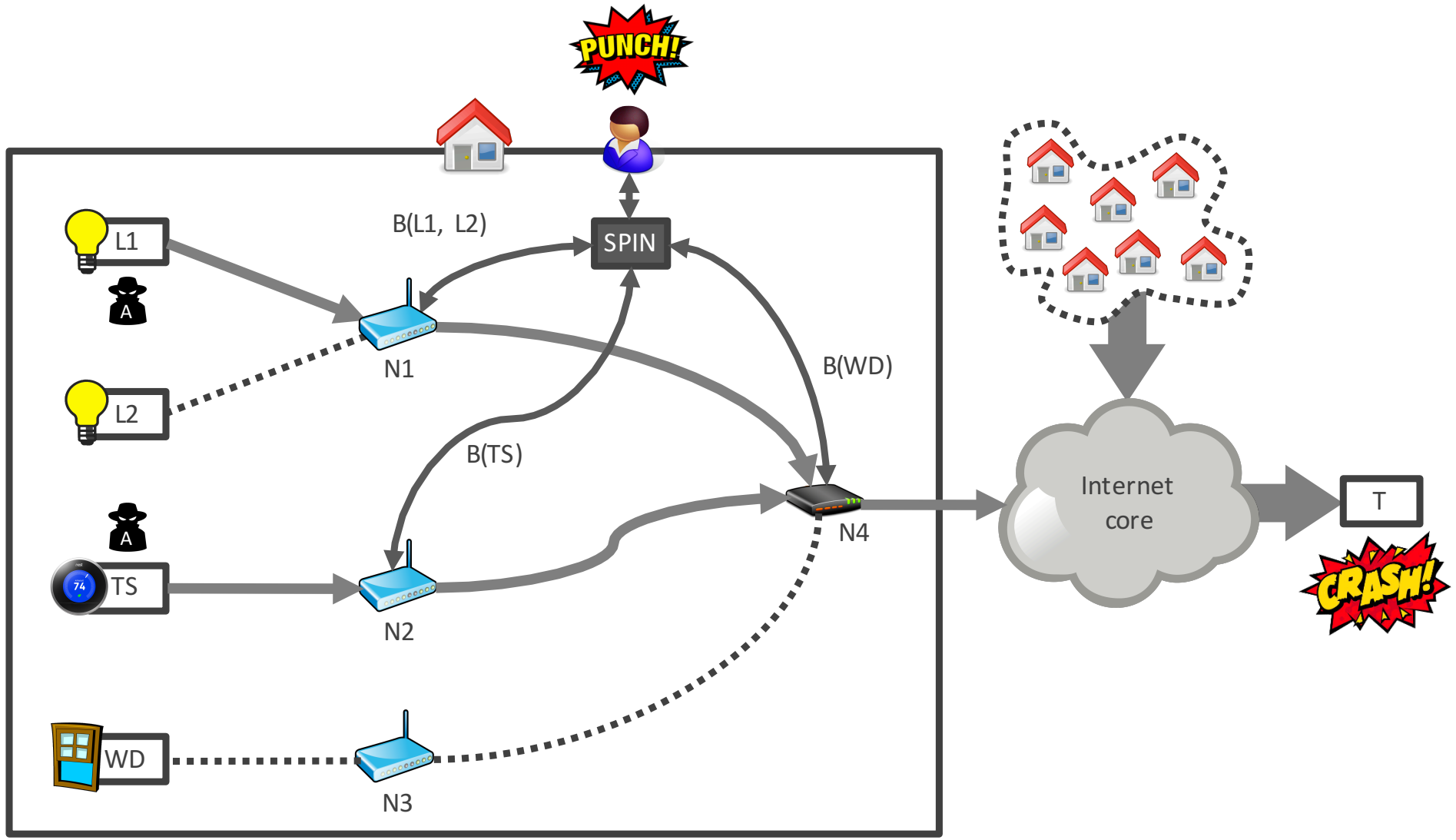
Example of an IoT security system: SPIN



Further reading: [NOMS] and https://spin.sidnlabs.nl/en/

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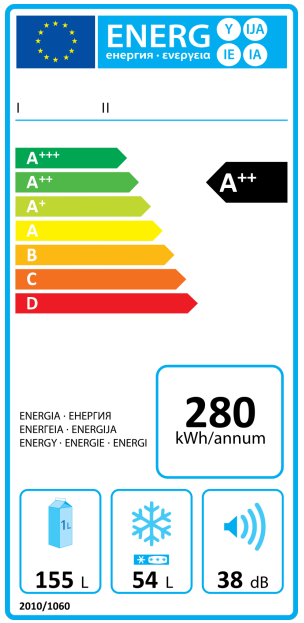
Key challenges

- **Topline:** enable safer, smarter, and more sustainable society through the IoT, **while** protecting the Internet and its users (at home and elsewhere)

- Specific challenges, such as
  - Deployment of IoT security solutions
  - Interoperability between IoT devices and security services
  - More transparent IoT (data autonomy)
  - Continuous measurements and analysis of the IoT
  - Explainable security, legal and regulatory (e.g., a cybersecurity label)



- We'll be discussing papers that address these issues

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Course overview

Learning goals

- Understand IoT concepts and applications, security threats, technical solutions, and a few relevant standardization efforts in the IETF

- Be able to analyze network traffic of IoT devices and create device profiles that describe this behavior

- Understand the operational business of DNS operators and the impact the IoT may have on them (industry perspective)

Assessment

- Goal: evaluate to what extent you attained SSI's learning goals

- Total score = [(score of oral exam) × 50% + (score of the lab assignment) × 50%] × (all paper summaries submitted 0=no or 1=yes)

- Deliverables
  - 12 **summaries** of papers (2 per lecture) => your input for oral exam
  - A five-page report on your **lab assignment**

Make sure to **browse** a few of the SSI papers this week to verify that SSI matches your interests, study plan, prerequisites, etc.

Deliverable #1: 12 paper summaries

- One summary for each of the papers we'll discuss during the lectures
- Each summary can be at most 250 words, at most 1 single-sided A4 page
- You can add figures and graphs from the paper or add your own if you like
- Due **before 7AM** on the **day of the lecture** in which the papers will be discussed

- Submit through CANVAS

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Deliverable #2: lab report

- Outcome of your lab assignment (see next slide)
- Discuss results of your measurements of **2+ IoT devices**, analysis and observations
- Your proposal on novel usages of MUD or extensions of MUD profiles
- Five-page lab report in two-column IEEE format, MUD spec, PCAP file, README file
- Evaluation: introduction, methodology, results, discussion, clarity (detail on SSI homepage)
- Firm deadline: **Sunday June 20, 2021, 23:59 CEST**

Lab experiment

- Measure network traffic of **2+** IoT devices in groups of **two or three***, **one** report per team
- Use IoT devices **without a browser-like interface**
- Examples: camera, audio speaker, light bulb, thermostat, doorbell
- We have a couple of devices if you really can't find an IoT device
- Do not use multi-purpose devices like tablets, phones, laptops
- Use WireShark, TCPdump, or (for example) a SPIN device.
- Etienne Khan available for assistance

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Writing your lab report

- **Group effort:** write together, everybody is equally responsible for the final report

- How to write a paper (30 mins): https://www.youtube.com/watch?v=5zthkvzyTfk

- We **evaluate** your report in a **double-blind** way, similar to how many academic conferences review papers (details on the SSI site)

- Examples of reviewers' questions:
  - What are their key findings? Did they sufficiently discuss background and cite papers?
  - Would I be able to **reproduce** their experiments based on their methodology?
  - How well did they analyze their measurements? To what extent did they explain the limitations of their methodology?

Plagiarism

- As per the university's policy, no forms of plagiarism are tolerated

- We configured Canvas such that it will automatically check your report for plagiarism

Style		Example
Citing	✓	In our lab experiment, we use Manufacturer Usage Descriptions (MUDs) [RFC8250] to describe the network behavior of IoT devices.
Quoting	✓	MUD was designed to "provide a means for end devices to signal to the network what sort of access and network functionality they require to properly function" [RFC8250]
Copying	✗	MUD was designed to provide a means for end devices to signal to the network what sort of access and network functionality they require to properly function [RFC8250]

- Also cite and quote sources where you are a co-author

Oral exam

- Q&A with an SSI teacher and a teaching assistant
- Covers the 12 papers you studied; you may use the summaries you wrote
- Takes about 45 minutes and will take place from June 21 through July 2
- You can pick a timeslot in the week before the oral exams
- We'll take your oral exam through a video call using Canvas (instructions on the SSI site)

Important dates

- Two summaries per lecture: before the lecture in which the papers will be discussed
- Lab report (PDF) and required files: **Sun June 20, 2021, 23:59 CEST**
- All to be submitted through CANVAS

Lectures

- Three **guest lectures** to provide you with non-academic perspectives

- Six **technical lectures**:
  - Teachers discuss two papers per lecture
  - Interactive discussion
  - We ask at least one of you to share their thoughts on each paper (pros, cons)
  - Enables you to learn from each other, so mandatory to participate

- A 7th “re-sit” lecture in case you miss a lecture (optional for everybody else), same format

Schedule

No.	Date	Contents
1	Apr 21	Course introduction Guest lecture #1: how the core of the internet is organized, Marco Davids (SIDN Labs)
2	Apr 28	Guest lecture #2: the relationship between regulation & IoT security, Eelco Vriezekolk, Agentschap Telecom (Dutch telecoms regulator)
3	May 6*	Lecture: IoT Concepts and Applications
4	May 12	Lecture: IoT Botnet Measurements
5	May 18	Lecture: IoT Honeypots
6	May 25*	Guest lecture #3: The Life Of An IoT Device, Eliot Lear, Cisco Systems
7	May 26	Lecture: IoT Edge Security Systems
8	Jun 2	Lecture: IoT Device Behavior
9	Jun 9	Lecture: IoT in Non-Carpeted Areas
10	Jun 16	Lecture: IoT Edge Security Systems (re-sit)

* Different lecture times/days. Default slot: Wednesdays 11:00 - 12:45

Staying up to date

- SSI homepage at https://courses.sidnlabs.nl/ssi
- Authoritative source for information about SSI
- Recommend visiting it every now and then

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Common pitfalls

- Forgetting to submit summaries or submitting the wrong ones ;-)

- Starting too late with the lab report

> *"I love deadlines. I love the whooshing noise they make as they go by."*
>
> *-- Douglas Adams*

- Properly test your measurement setup. Consider reproducability early on.

- "Oh, I just copy this paragraph from this website"

SSI fact sheet

Security Services for the IoT (SSI)	
EC	5 (140 hours)
Coordinator	Cristian Hesselman (SIDN Labs, University of Twente)
E-mail	c.e.w.hesselman@utwente.nl
Lecturers	dr. Elmer Lastdrager (SIDN Labs) dr. Cristian Hesselman (SIDN Labs)
Fourth quartile	April 19 – July 4, 2021
Academic year	2020/2021

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Operator of the .nl TLD

- *Stichting Internet Domeinregistratie Nederland* (SIDN)

- Critical infrastructure services
  - Lookup IP address of a domain name (almost every interaction)
  - Registration of all .nl domain names
  - Manage fault-tolerant and distributed infrastructure

- Increase the value of the Internet in the Netherlands and elsewhere
  - Enable safe and novel use of the Internet
  - Improve the security and resilience of the Internet itself

.nl = the Netherlands
17M inhabitants
6.2M domain names
3.4M DNSSEC-signed
2.5B DNS queries/day
8.6B NTP queries/day

SIDNfonds

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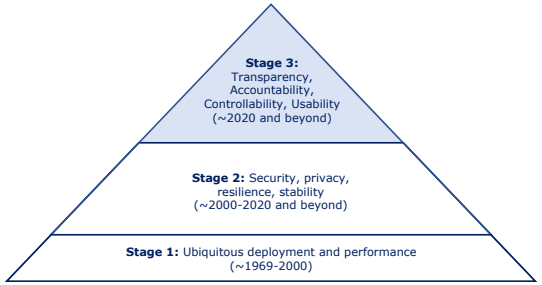
SIDN Labs = research team

- Goal: increase the trustworthiness (security, stability, resilience, and transparency) of our society's internet infrastructure, for .nl and the Netherlands in particular



- Strategies:
  - Applied research (measurements, prototyping, evaluation)
  - Make results publicly available and useful for various target groups
  - Work with universities, infrastructure operators, and other labs

- 3 research areas: network security (DNS, NTP, BGP), domain name & IoT security, trusted future internet infrastructures

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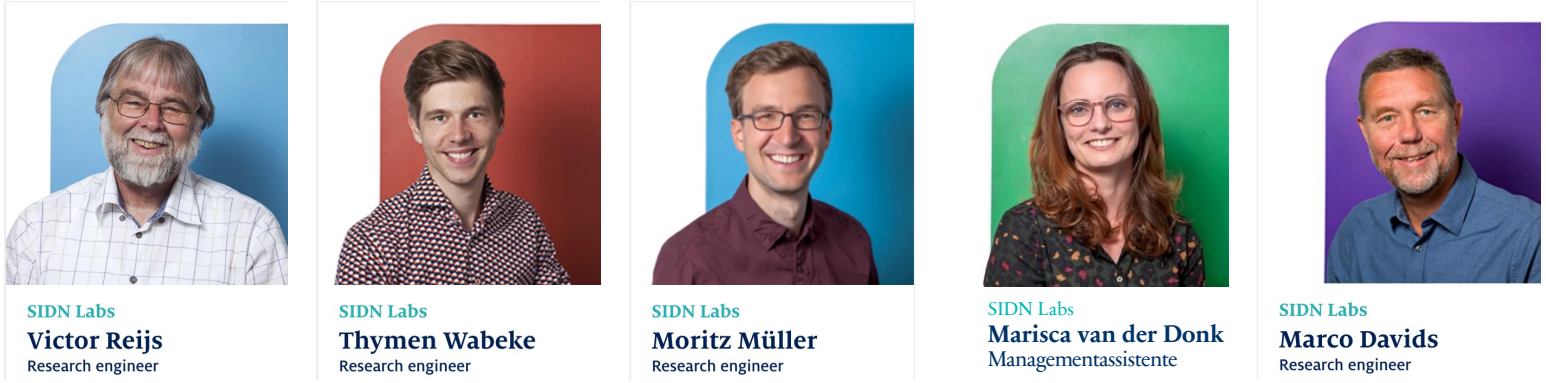
SIDN Labs team



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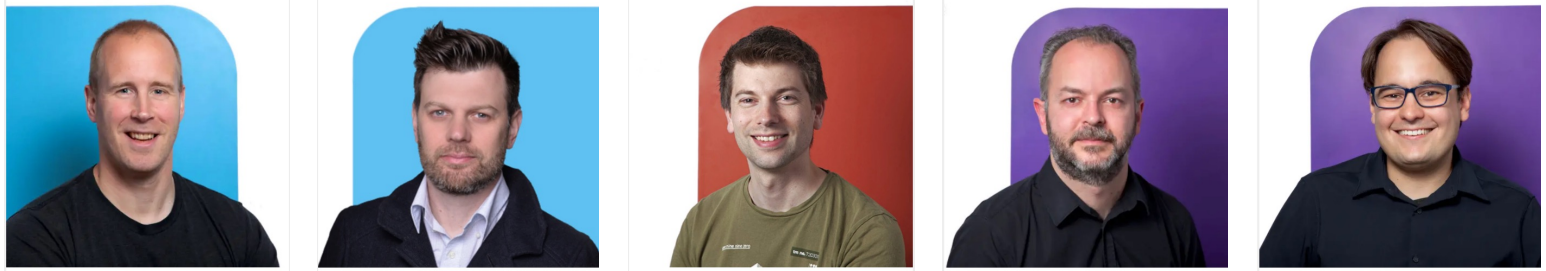
Marisca van der Donk
Managementassistente

SIDN Labs
Marco Davids
Research engineer



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Maarten Wullink
Research engineer

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João Ceron
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Joeri de Ruiter
Research engineer

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Data Scientist

SIDN Labs
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Research engineer

SIDN Labs
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Afstudeerder (UT)

SIDN Labs
Caspar Schutijser
Research engineer

SIDN Labs
Cristian Hesselman
Directeur SIDN Labs

- Technical experts, divers in seniority and nationality
- Help SIDN teams, write open-source software, analyze large amounts of data, conduct experiments, write articles, collaborate with universities
- M.Sc students help us advance specific areas

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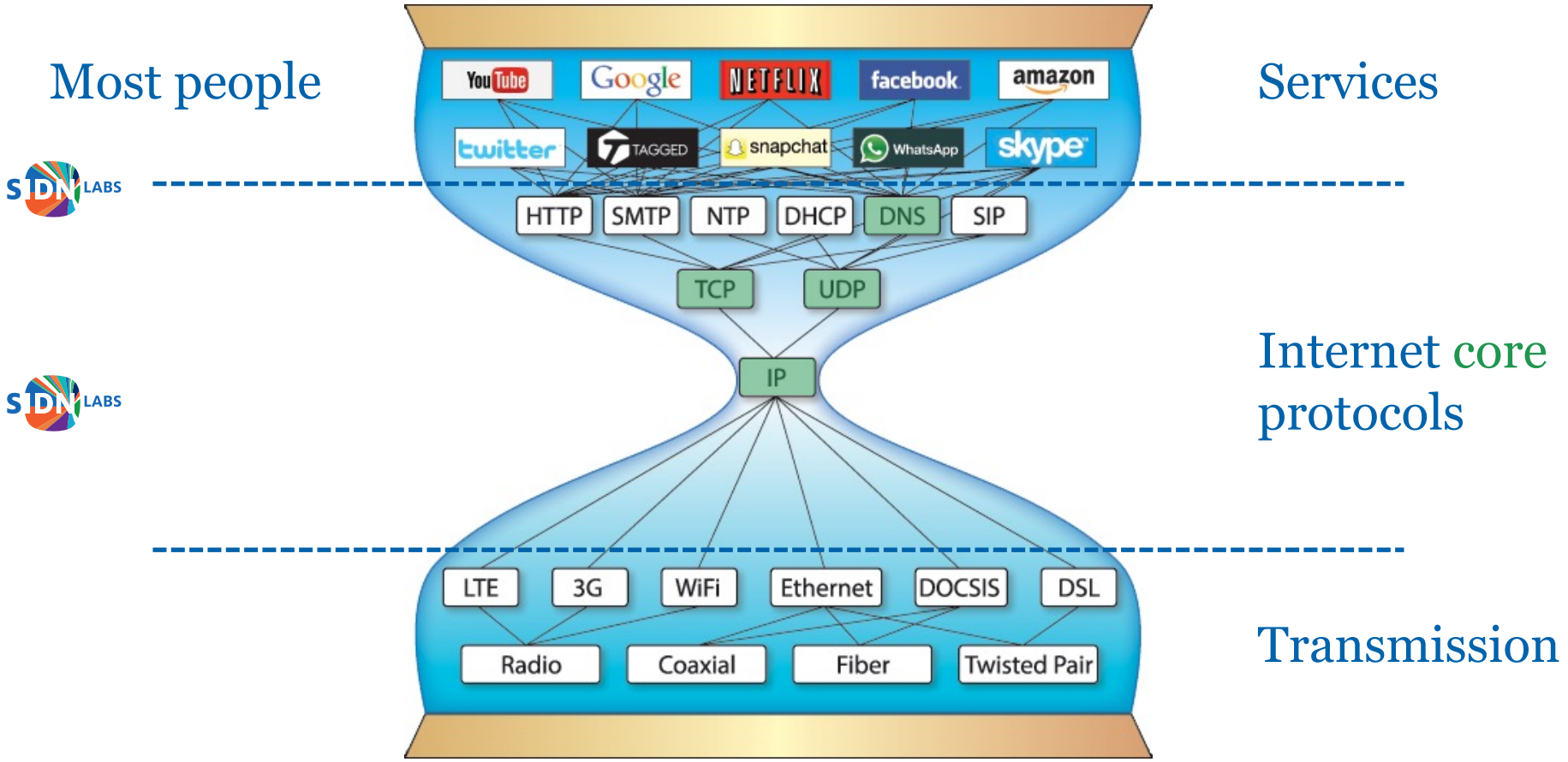
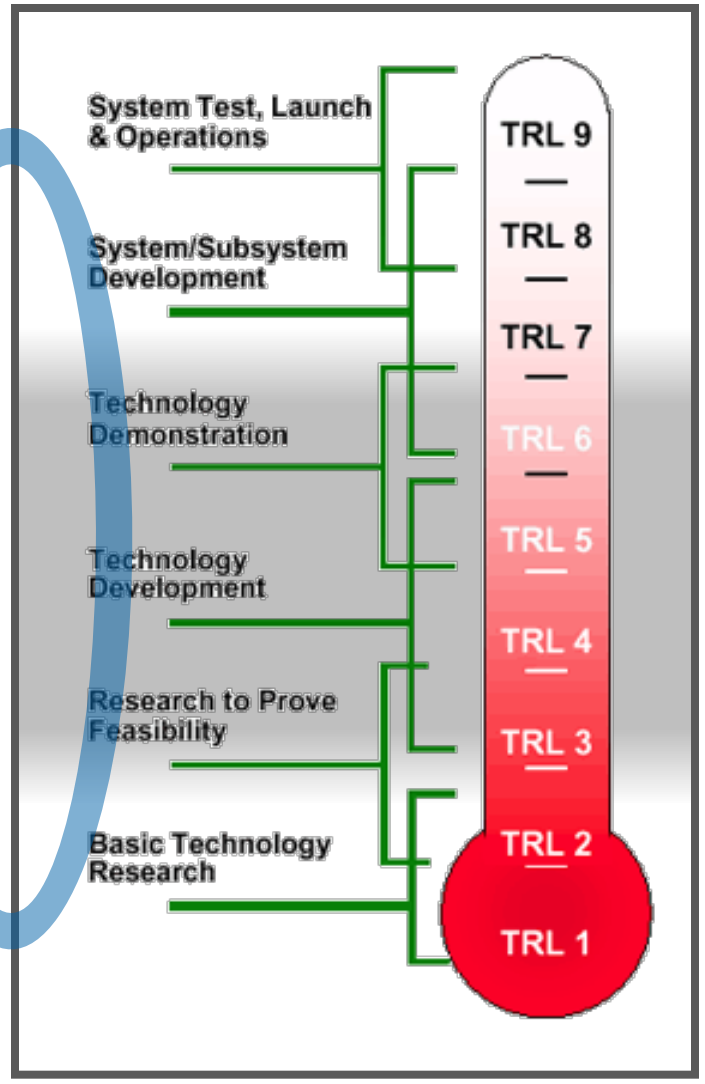
The Internet under the hood



SIDN Labs and Technology Readiness Levels

SIDN Labs focuses on the **R** in R&D



Operations

Experimental

Fundamental research

https://en.wikipedia.org/wiki/Technology_readiness_level

O'Reilly, C. A., & Tushman, M. L. (2013). Organizational ambidexterity: Past, present, and future. Academy of Management Perspectives, 27(4), 324-338

Examples of our research partners

SSI is a collaborative course

- Motivation for SIDN Labs
  - Help educating the next generation of Internet security engineers and researchers
  - Highlight societal impact of the Internet (e.g., concentration, interaction w/ physical world)
  - Aligns with our work on IoT security (SPIN project, RAPID project, and others)
  - Perhaps interest some of you to check out our work for an M.Sc. Project :-)

- Extends ongoing academic-industry research collaboration
  - SIDN Labs: improve security and resilience of SIDN's services and wider Internet using university's latest academic insights, methodologies, network, and creative thinking
  - University: further improved research and education using SIDN's operational experience, unique datasets, and industry network

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Guest lecture

Marco Davids (SIDN Labs)

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Q&A

Next lecture: **Wed Apr 28, 11:00-12:45**

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