Security Services for the IoT: Introduction

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

University of Twente | April 22, 2020

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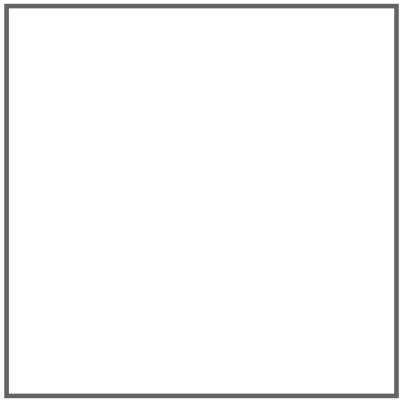
Teaching team

Cristian Hesselman
(teacher)

Elmer Lastdrager
(teacher)

Ramin Yazdani
(teaching assistant)



Etienne Khan
(teaching assistant)

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Online house rules

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

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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

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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”

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Security issues in the IoT?

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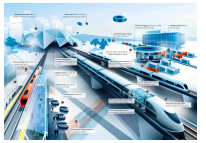
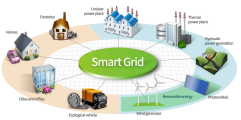
Internet of Things (IoT)

- 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

- 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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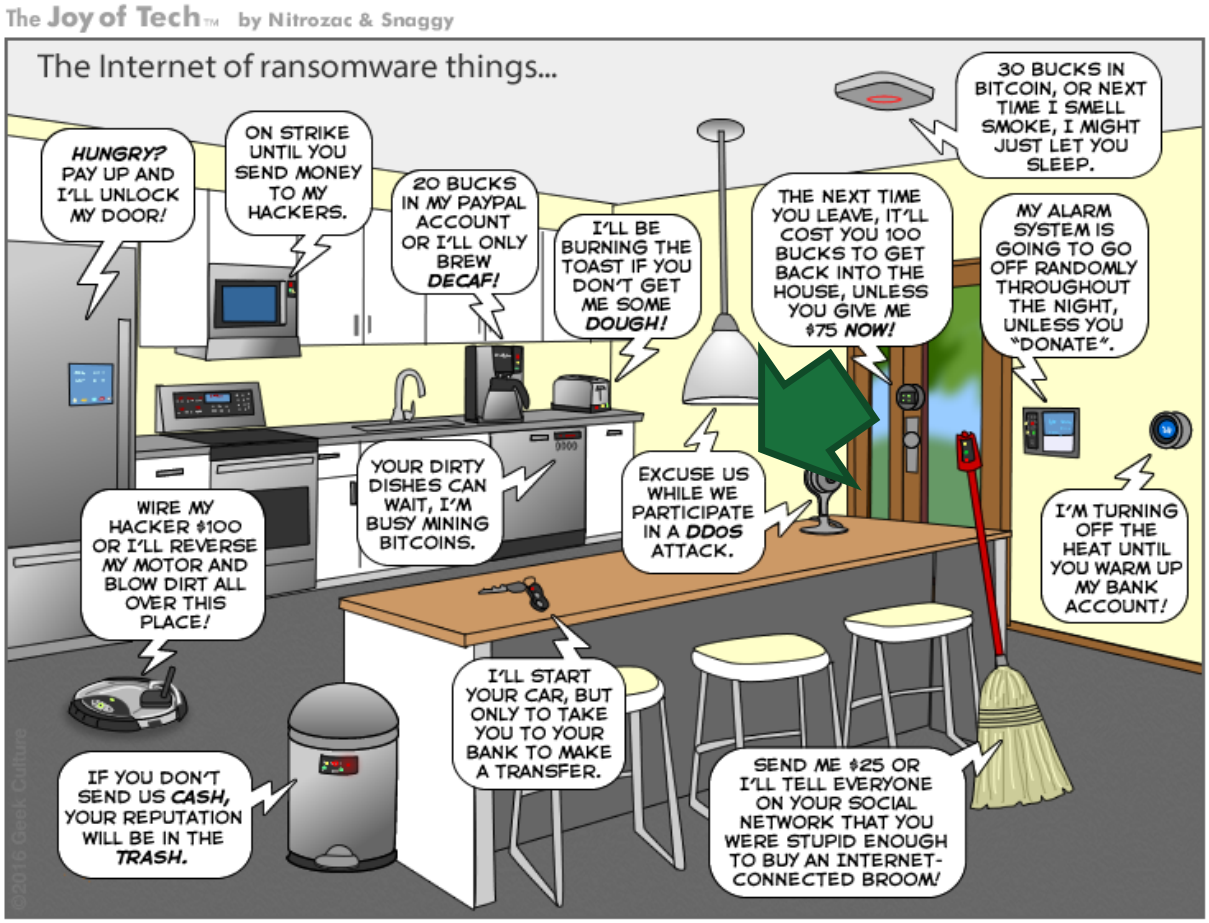
“Nightmare on connected home street”



MAT HONAN GEAR 06.13.14 06:30 AM

THE NIGHTMARE ON CONNECTED HOME STREET

https://www.wired.com/2014/06/the-nightmare-on-connected-home-street/

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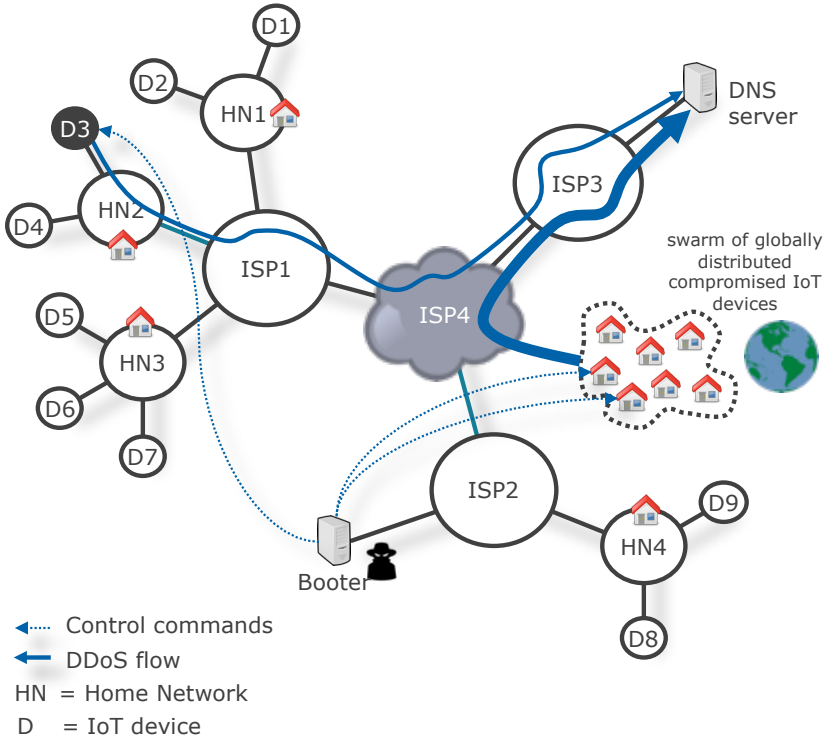
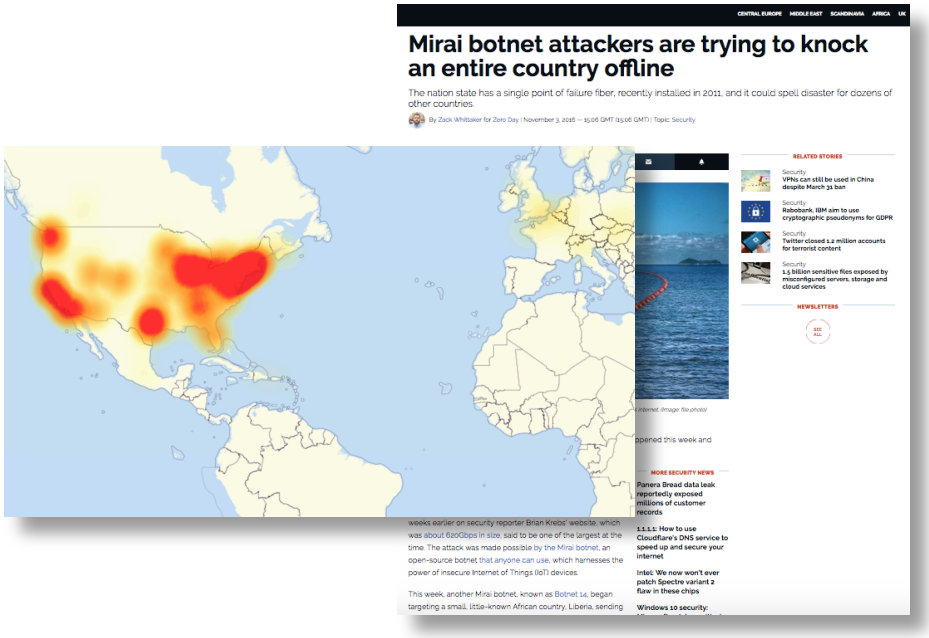
IoT wakeup call: Mirai-powered DDoS attacks (2016)





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

[Mirai], [Hajime], [SAC105]
https://en.wikipedia.org/wiki/2016_Dyn_cyberattack
https://www.zdnet.com/article/mirai-botnet-attack-briefly-knocked-an-entire-country-offline/

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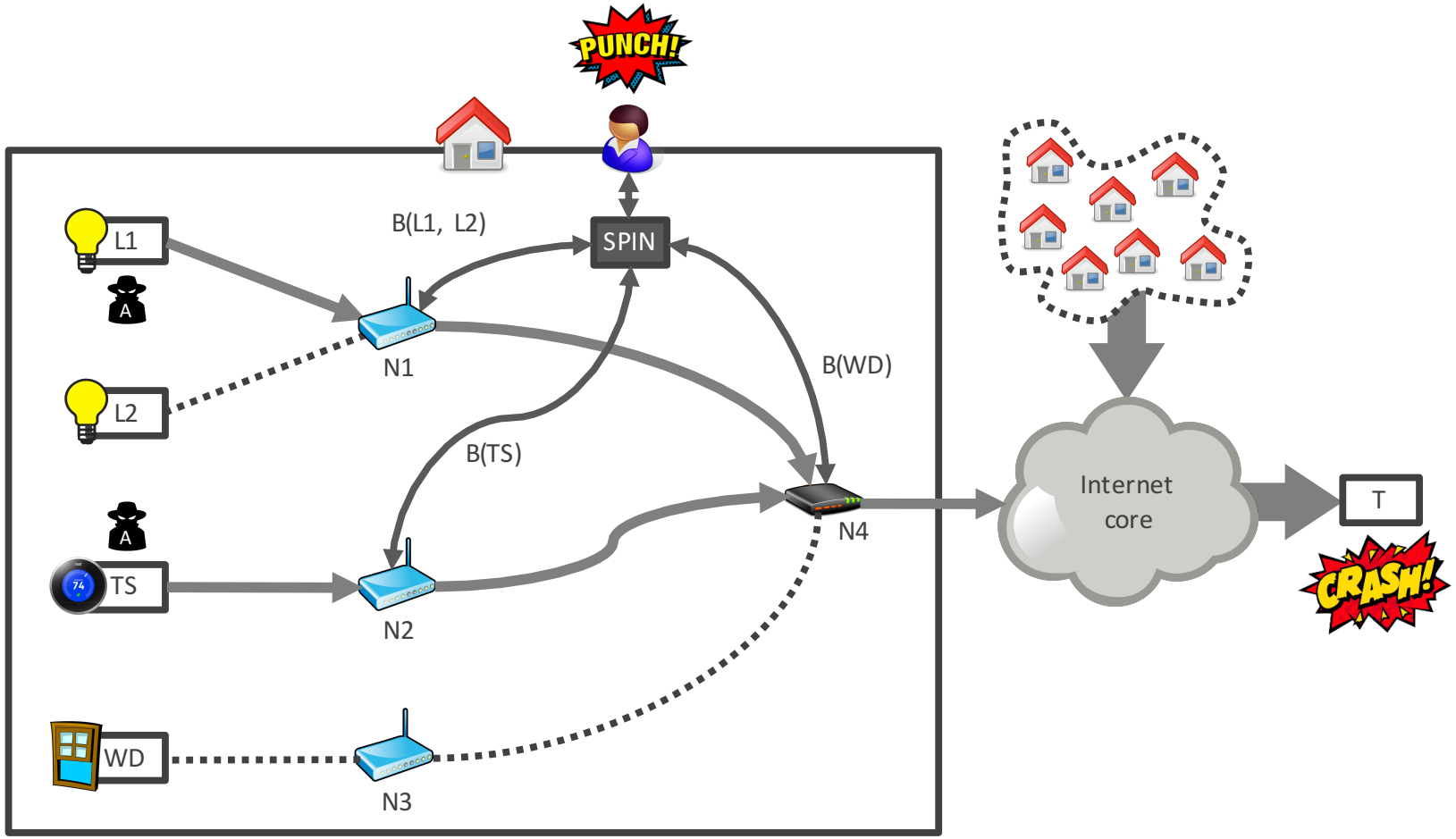
Example of an IoT security system: SPIN



https://spin.sidnlabs.nl/en/

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Key challenges

- Enable safer, smarter, and more sustainable society through the IoT
- Protect the Internet and its users (at home and elsewhere)
- Deployment of IoT security solutions
- Interoperability between IoT devices and security services
- We'll be discussing papers that address these issues

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Course overview

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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%

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

- We'll announce the papers that will be discussed in the oral exam one week beforehand

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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 A4 page
- You can add figures and graphs from the paper or add your own if you like
- Submit through CANVAS on the **Tuesday** before the lecture in which the papers will be discussed

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

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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 the MUD specification
- Five-page lab report in two-column IEEE format, MUD spec, PCAP file, README file
- Evaluation: clarity and soundness of the methodology, analysis, writing, quality of PCAPs/MUDs
- Firm deadline: **Sunday June 21, 2020, 23:59 CEST**

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Lab assignment

- Measure network traffic of **2+** IoT devices in groups of **three**, **one** report per team
- Use IoT devices **without a browser-like interface**
- Examples: camera, audio speaker, light bulb, thermostat, doorbell
- Do not use multi-purpose devices like tablets, phones, laptops
- No SPIN devices this year: use WireShark, TCPdump, or other
- Etienne Khan available for assistance

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Oral exam

- Q&A with an SSI teacher and a teaching assistant
- Covers a **subset** of the 12 papers you studied, use the summaries you wrote
- We'll announce your subset of papers in the week before the exams
- Takes about 30 minutes and will take place from June 22 through July 3
- We'll likely need take your oral exam through a video call (instructions on the SSI site)

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Important dates

- Two summaries per lecture: before the lecture in which the papers will be discussed
- Lab report, PCAPs, MUD files, README file: Sun June 21, 2020, 23:59 CEST
- All to be submitted through CANVAS

Schedule

No.	Date	Contents
1	Apr 22	Course introduction Guest lecture #1: how the core of the internet is organized
2	Apr 29	Guest lecture #2: Security in The Things Network
3	May 6	Lecture: IoT Concepts and Applications
4	May 13	Lecture: IoT Botnet Measurements
5	May 20	Lecture: IoT Honeypots
6	May 27	Lecture: IoT Edge Security Systems
7	Jun 3	Lecture: IoT Device Behavior
8	Jun 10	Lecture: IoT Network Security
9	Jun 17	Lecture: IoT Edge Security Systems (re-sit)

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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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Learning outcomes

- 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)

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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 20 – July 5, 2020
Academic year	2019/2020

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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 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 DACS' latest academic insights, methodologies, network, and creative thinking
  - DACS group: further improved research and education using SIDN's operational experience, unique datasets, and industry network

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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
5.9M domain names
3.2M DNSSEC-signed
1.3B DNS queries/day

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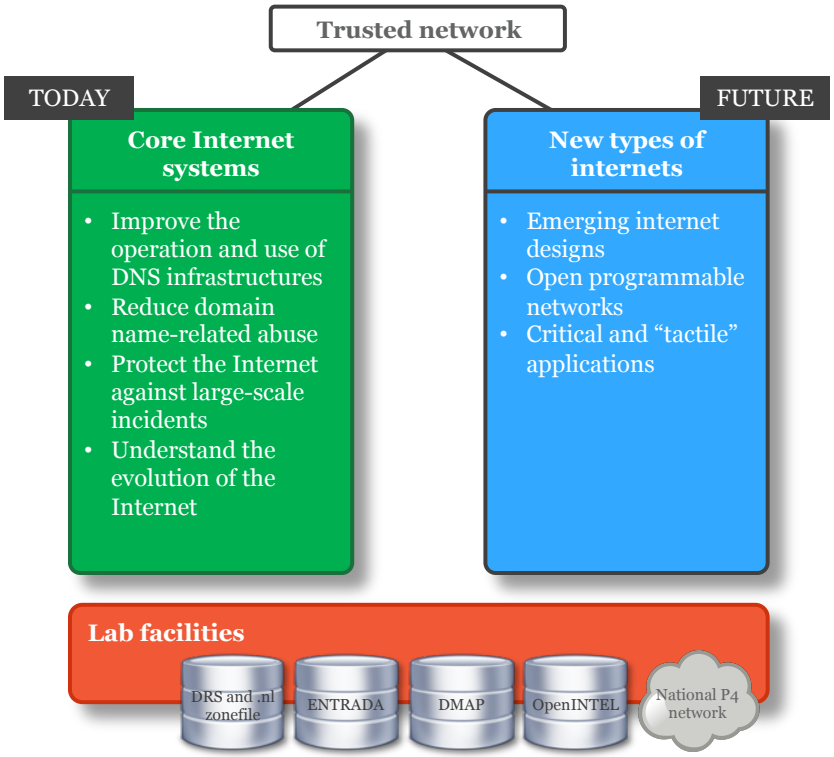
SIDN Labs objective: to increase the trustworthiness of our society's internet infrastructure

- Trusted = secure, stable, resilient, and transparent, for .nl and NL in particular

- Strategies to get there
  - Measure, prototype, evaluate mechanisms that increase the trustworthiness of the Internet
  - The same, but for new internet infrastructures that complement the Internet
  - Reinforce the Dutch, European, and global research and operational communities



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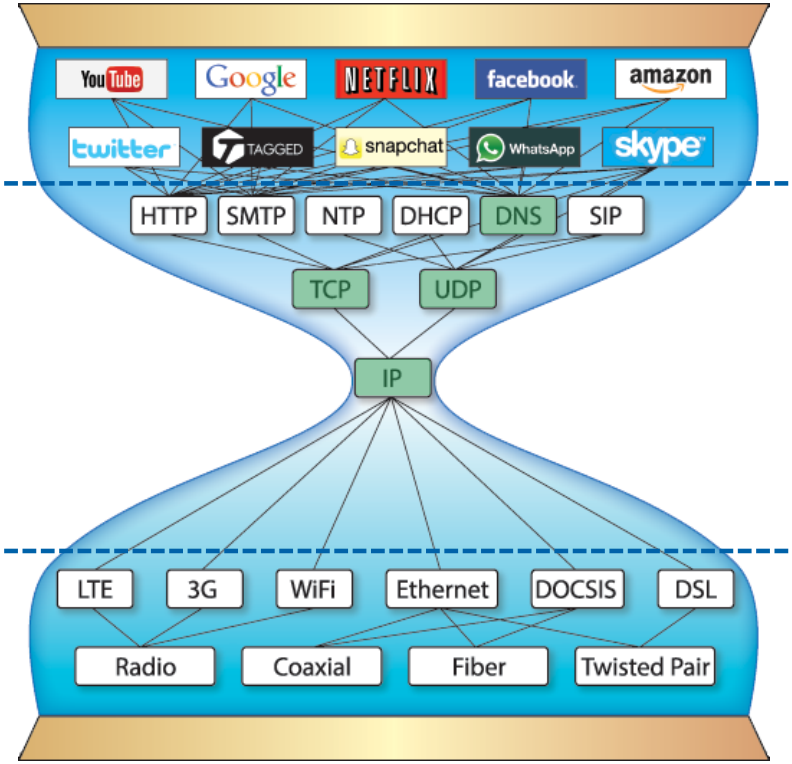
The Internet under the hood

Most people



Services

Internet core protocols

Transmission

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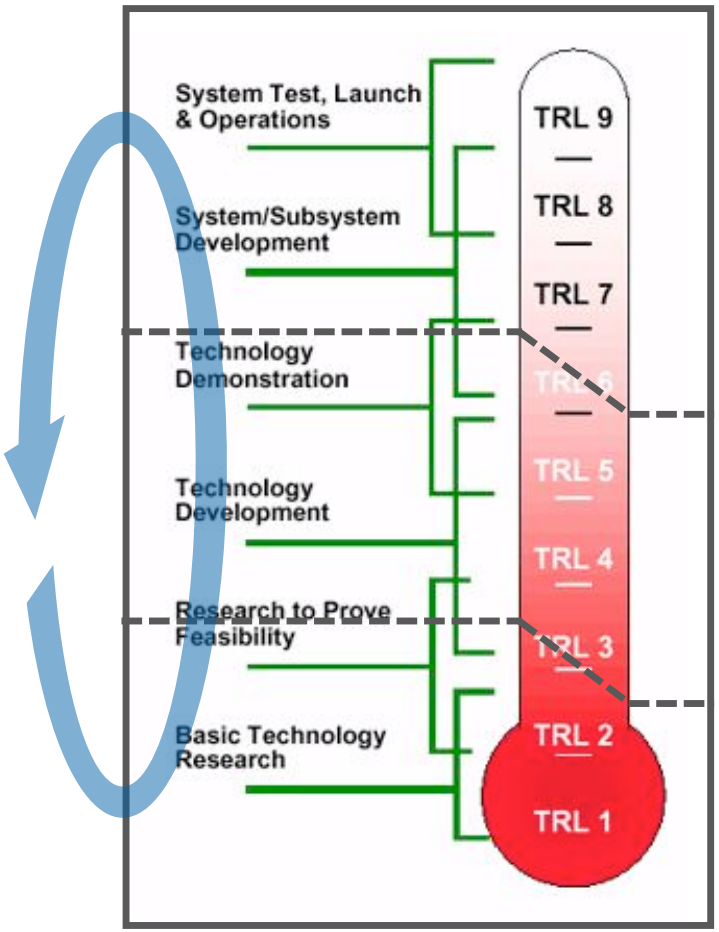
Technology Readiness Levels

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



Operations

Experimental

Basic research

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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

Daily work

- Help operational teams
- Write open source software
- Analyze vast amounts of data
- Run experiments
- Write academic papers and tech reports
- Work with universities

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Examples of research partners

Guest lecture

Marco Davids (SIDN Labs)

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Volg ons

SIDN.nl

@SIDN

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Q&A

Next lecture: **Wed Apr 29, 10:45-12:30**

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