The IoT and the DNS

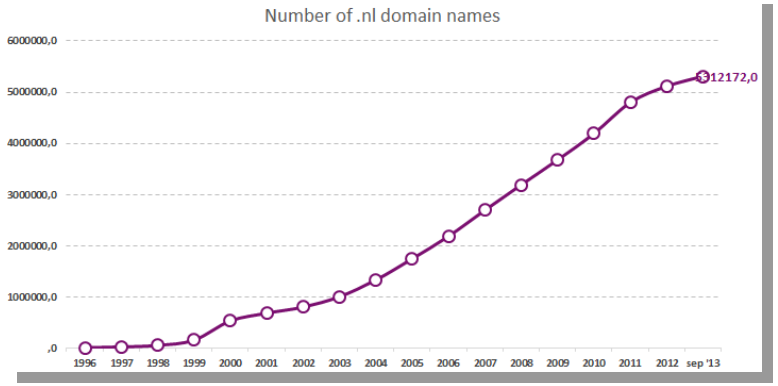
Jelte Jansen (SIDN)

ETNO wg meeting

Wed Feb 19, 2020

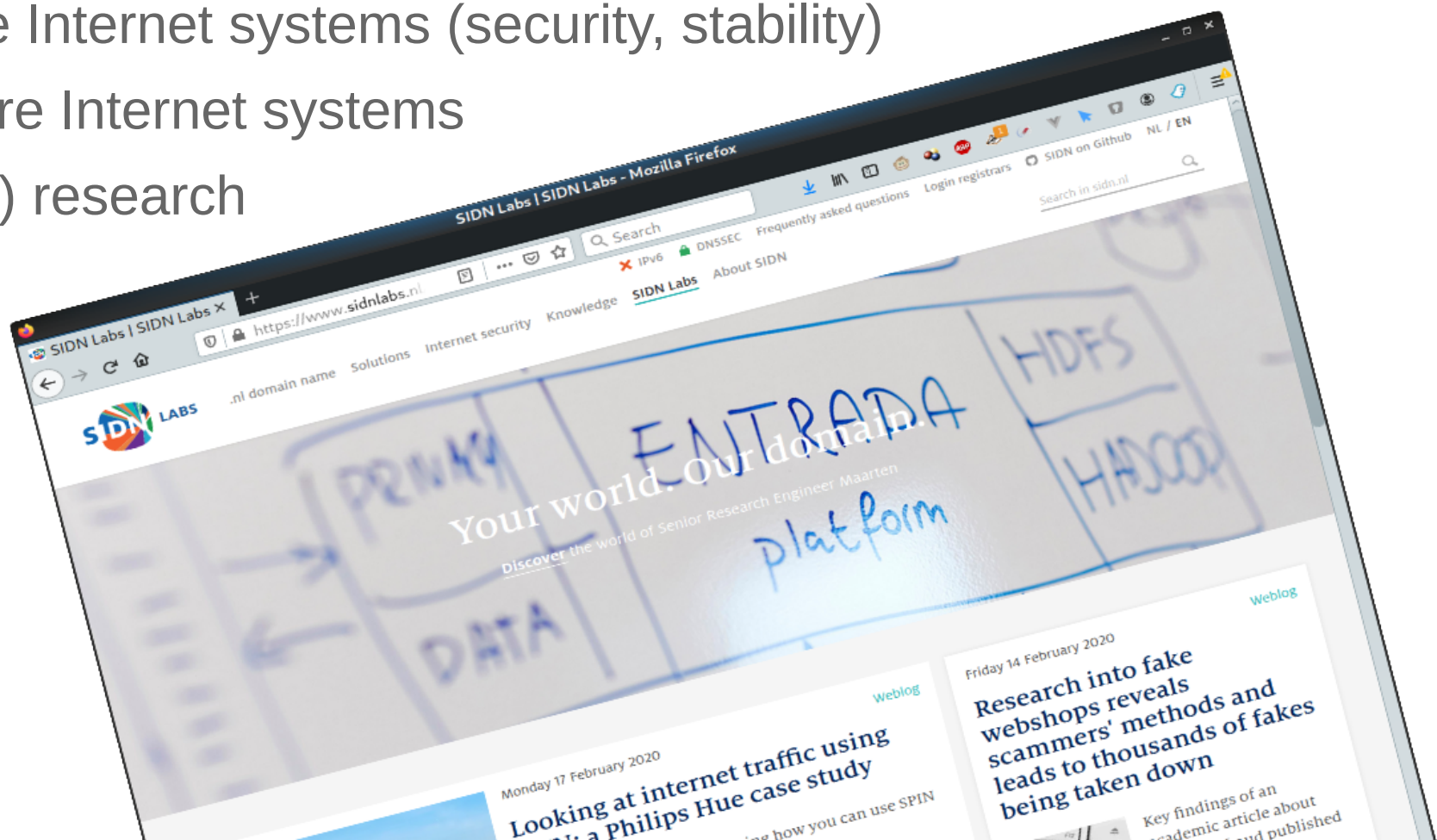
Introduction: Me & SIDN

- Research Engineer at SIDN
- Domain name registry for the .nl ccTLD
- 5.9 million domain names
- 3.2 million domain names signed with DNSSEC



Introduction: SIDN Labs

- https://www.sidnlabs.nl/en/about-sidnlabs
- R&D team of SIDN
- Research into core Internet systems (security, stability)
- Research into future Internet systems
- Facilitate (external) research



So, about that IoT

So, about that IoT

Home > Data Protection > Internet of Things

SLIDESHOW

The internet of insecure things: Thousands of internet-connected devices are a security disaster in the making

By Josh Fruhlinger, CSO | Oct 12, 2016 4:00 AM PT

Attributed to @tkadlec

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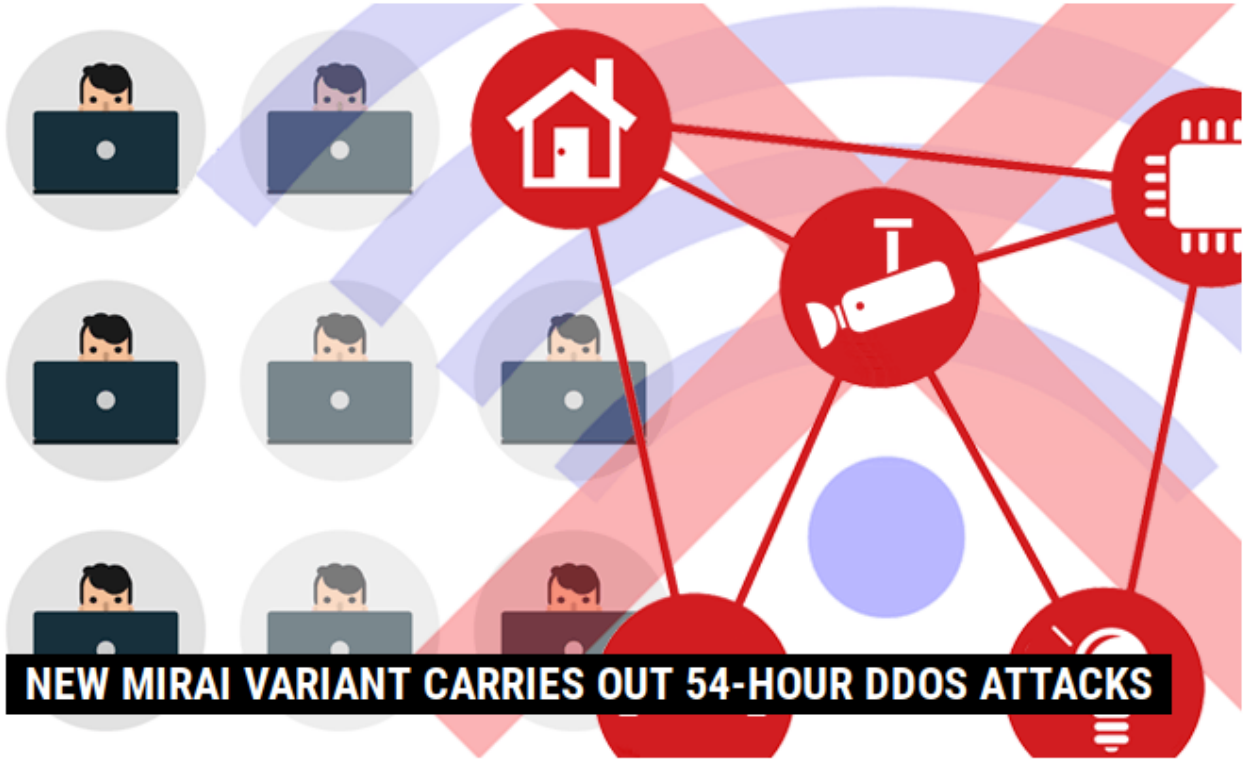
So, about that IoT

threatpost CATEGORIES FEATURED PODCASTS VIDEOS

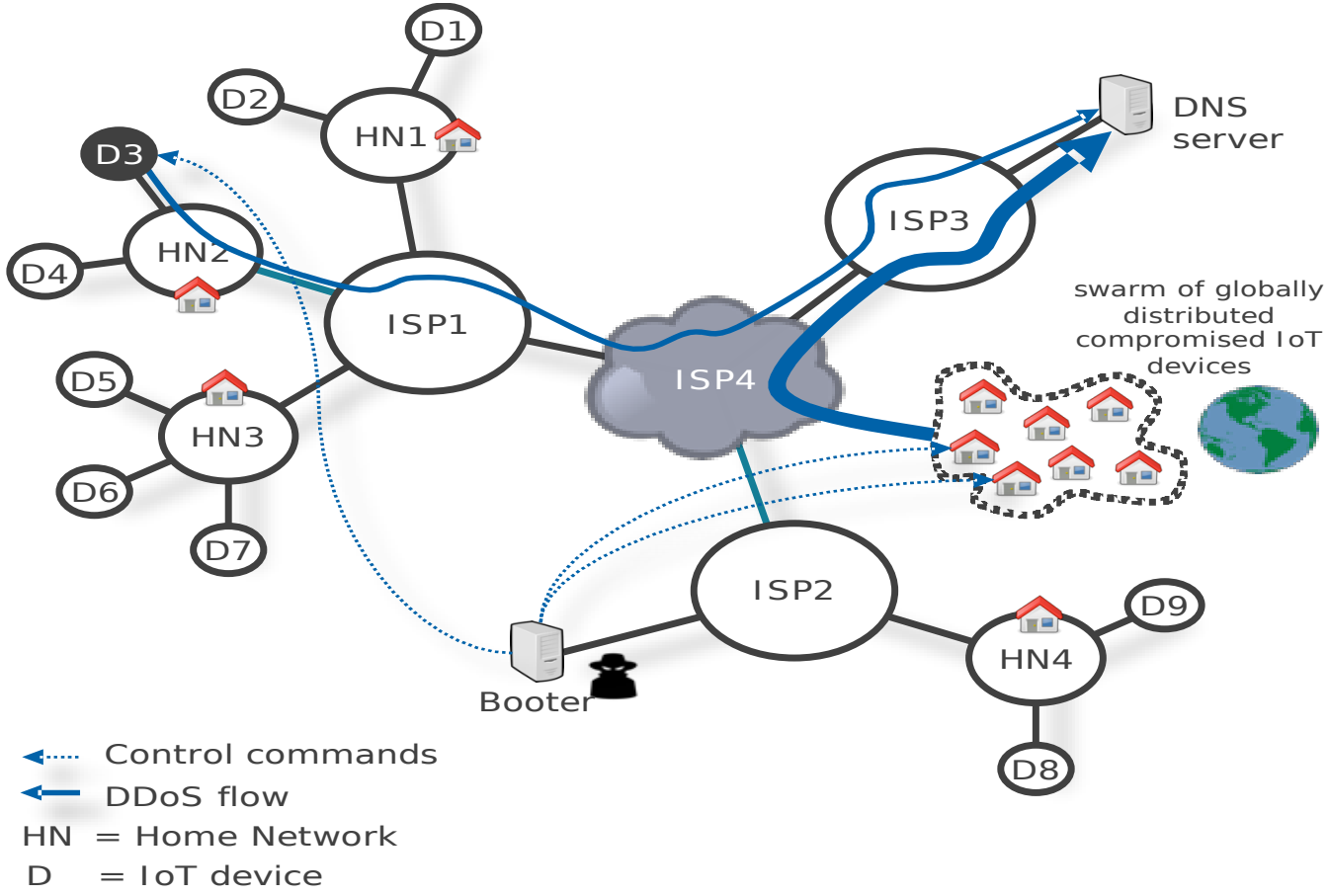
Welcome > Blog Home > Hacks > New Mirai Variant Carries Out 54-Hour DDoS Attacks



by Tom Spring

March 30, 2017 , 2:50 pm

IoT wakeup call for ccTLDs and other operators: Mirai-powered DDoS attacks



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

Sources:
[Mirai17], [Hajime19], [SAC105]
https://en.wikipedia.org/wiki/2016_Dyn_cyberattack
https://www.zdnet.com/article/mirai-botnet-attack-briefly-knocked-an-entire-country-offline/

What should we (the world) do?

- Better practices for manufacturers?
- Free **secure** software stacks?
- International policy, regulation, certificiation?
- Clear up accountability issues?
- Generate market demand for secure products?
- Quarantine bad actors (e.g. at ISP)?
- Educate users?
- Empower users?

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“Yes”

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"Yes"

We need to do it all

ICANN Security and Stability Advisory board publication:

The DNS and the Internet of Things: Opportunities, Risks, and Challenges (SAC105)

https://www.icann.org/en/system/files/files/sac-105-en.pdf

Excerpt from SAC105: issues

- DNS-unfriendly programming at IoT scale
  - TuneIn app example: 700 iPhones generating random queries filled resolver cache of mobile operator, took weeks to update
  - Imagine millions of unsupported devices that operate unattended for decades
- Larger and more complex DDoS attacks by IoT botnets
  - IoT botnets currently around 400-600K bots (Mirai, Hajime), may increase in the future
  - Higher propagation rates (e.g., Hajime exploited vulnerability in 10 days and increased by 50K bots in 24 hours)
  - Vulnerabilities more difficult to fix quickly at scale, botnet infections go unnoticed
- DDoS amplification
  - 23-25 million open resolvers
  - Amplification factors in the range 29-64

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Excerpt from SAC105: challenges

- Develop a DNS security library for IoT devices
  - Such as DNSSEC validation, DoH/DoT support
  - User control over DNS security settings and services used
- Train IoT and DNS professionals
  - IoT folks: understand IoT botnets, open resolvers, “DNS friendly” programming and security (e.g., DNSSEC)
  - DNS folks: understand IoT changes domain registration model and security
- Collaboratively handle IoT-powered DDoS attacks
  - Share DDoS “fingerprints” across operators
  - DDoS mitigation broker to flexibly share mitigation capacity
  - Security systems in edge networks, such as home routers
- Develop a system to measure the evolution of the IoT
  - Device-to-domain name database
  - DNS operators provide coarse grained stats

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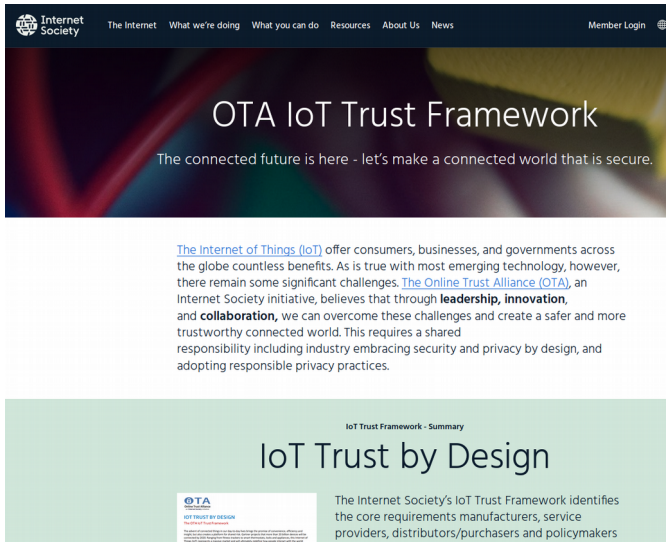
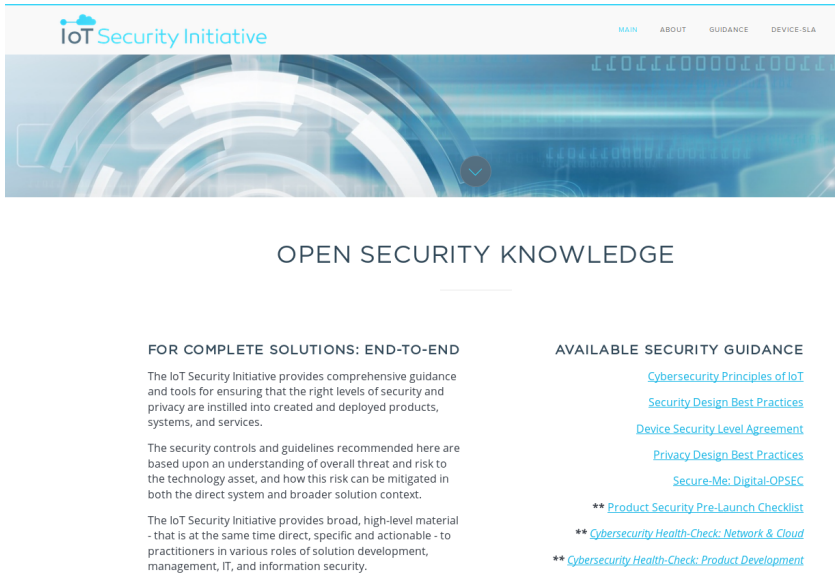
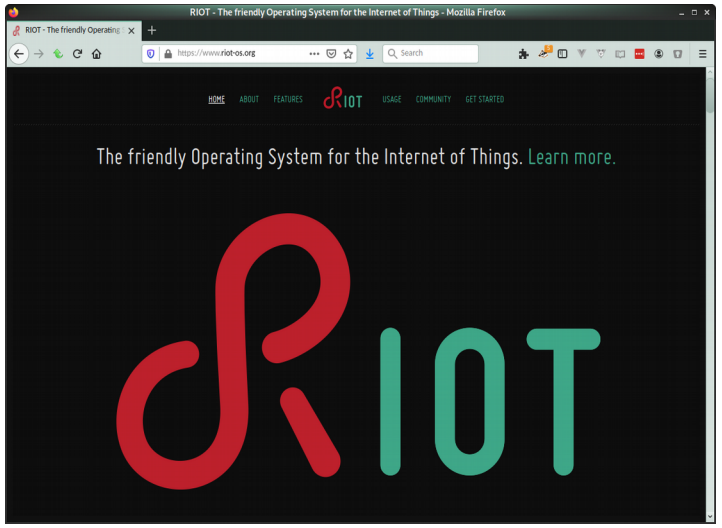
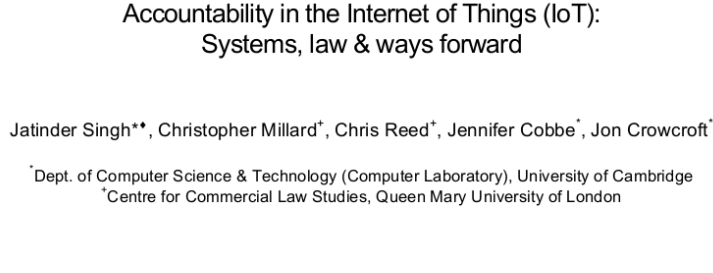
(Other) Initiatives around the world, on many levels









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Paper: Cleaning up the Internet of Evil things

https://www.ndss-symposium.org/wp-content/uploads/2019/02/ndss2019_02B-2_Cetin_paper.pdf

Paper by TUD, YNU, and NICT into the effectiveness of remediation strategies, such as notification and quarantining infected networks.

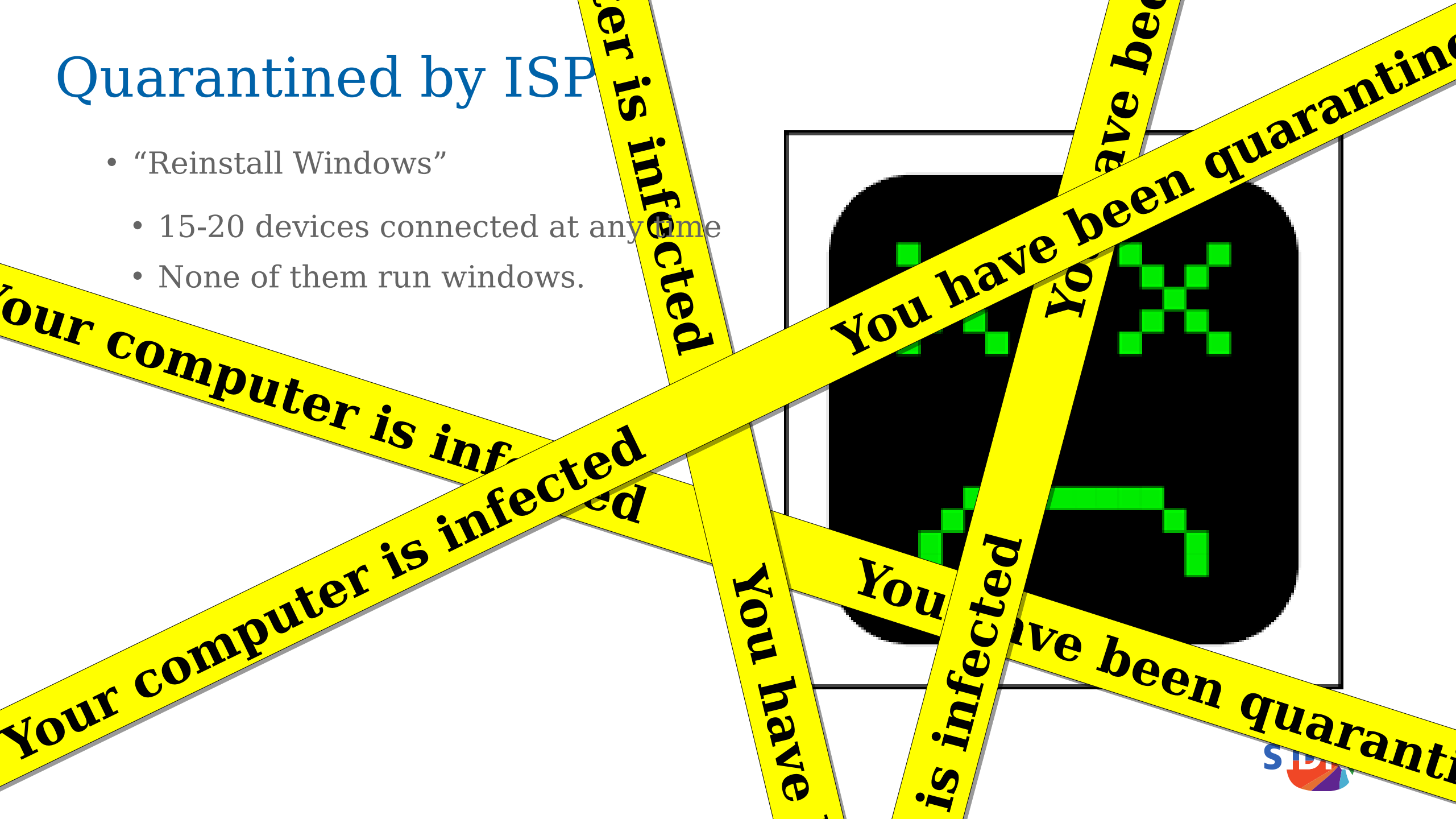
Tracked Mirai infections through several sources, and the rate of cleanup for several methods.

Cleaning up the Internet of Evil things: Mirai

- 87% of infections in broadband access networks
- 58-74% natural cleanup rate (no action taken) over several control groups
- 77% cleanup on email notification
- 92% cleanup on quarantine
- Only 5% reinfection rate after 5 months

Quarantined by ISP

- “Reinstall Windows”
  - 15-20 devices connected at anytime
  - None of them run windows.



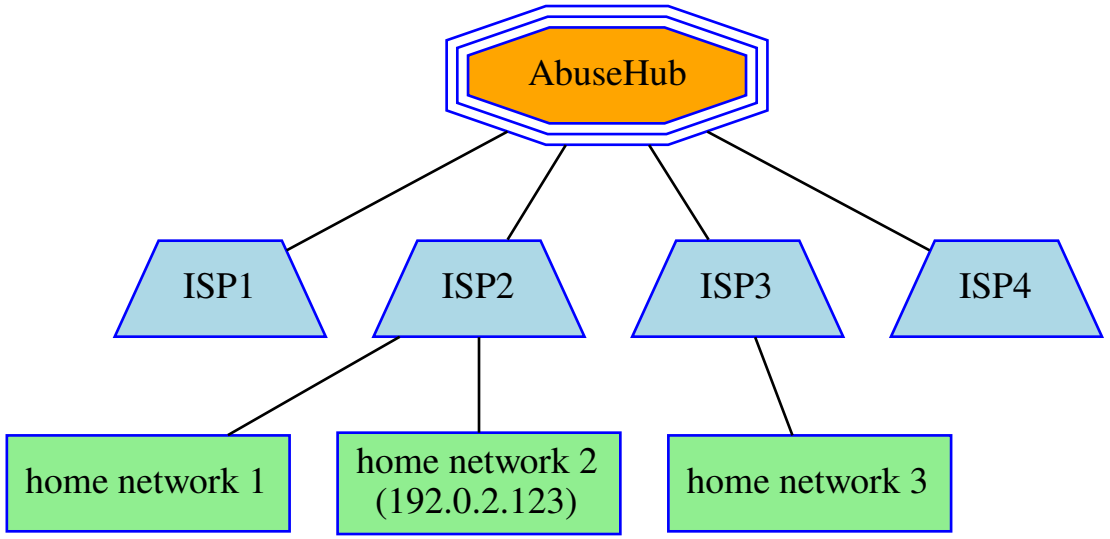
Conclusion:

- Quarantines work!

- But please, do it right:
  - Specify issue and reason
  - Specify date and time
  - Specify what to do

Can we do even better?

Incident report system



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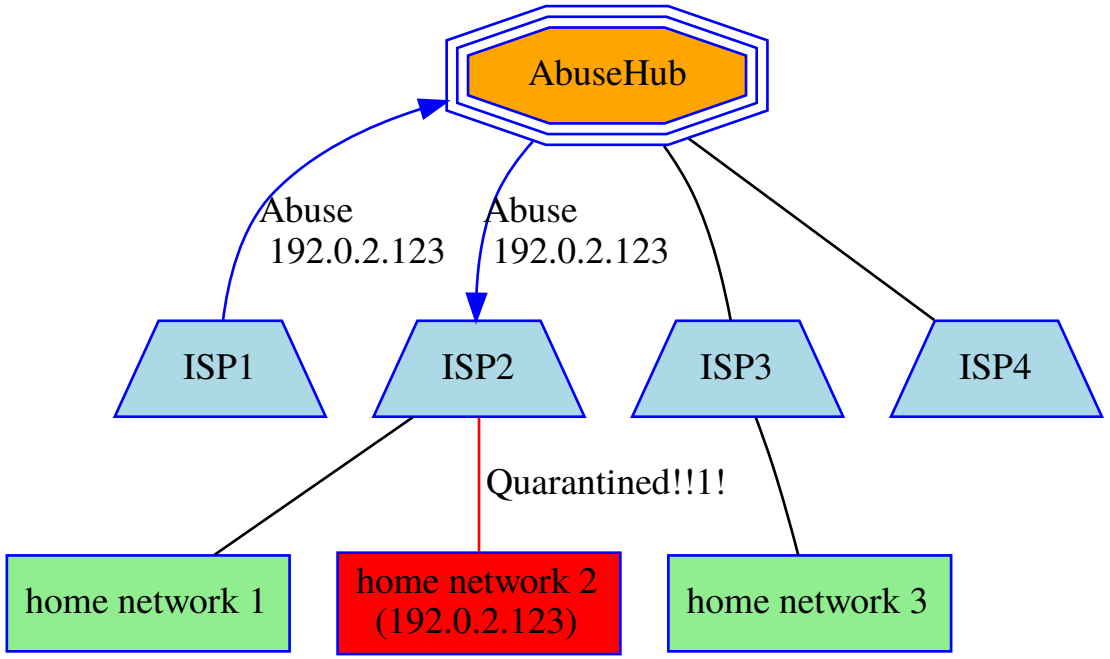

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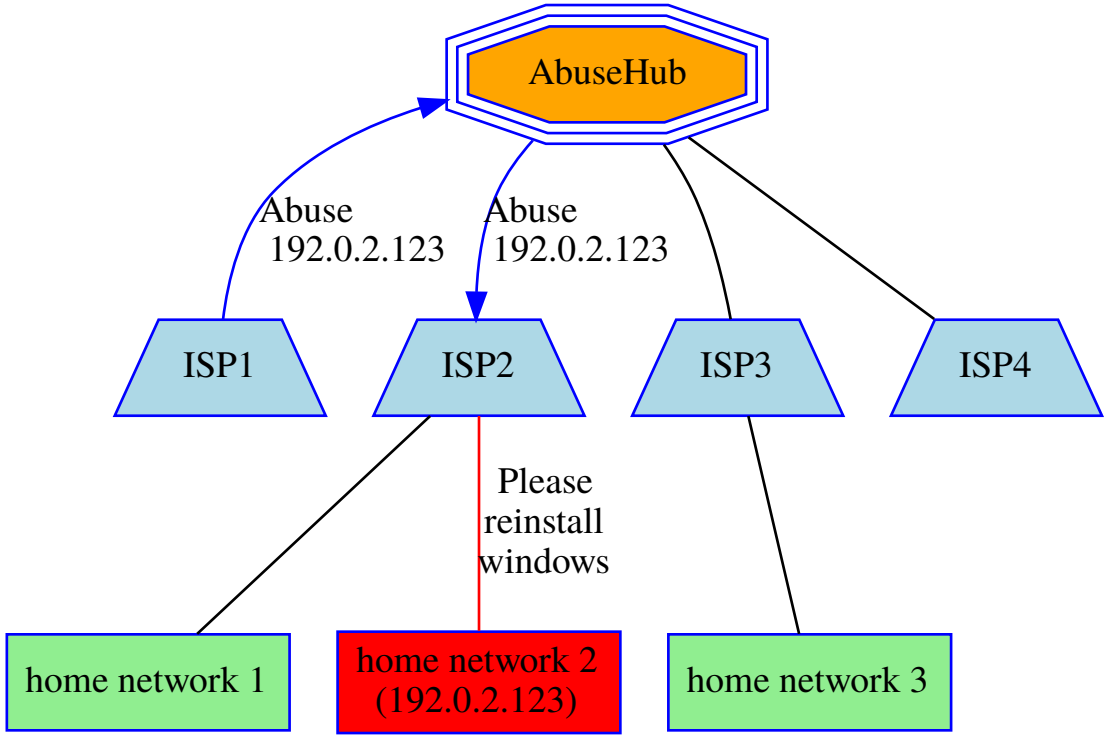

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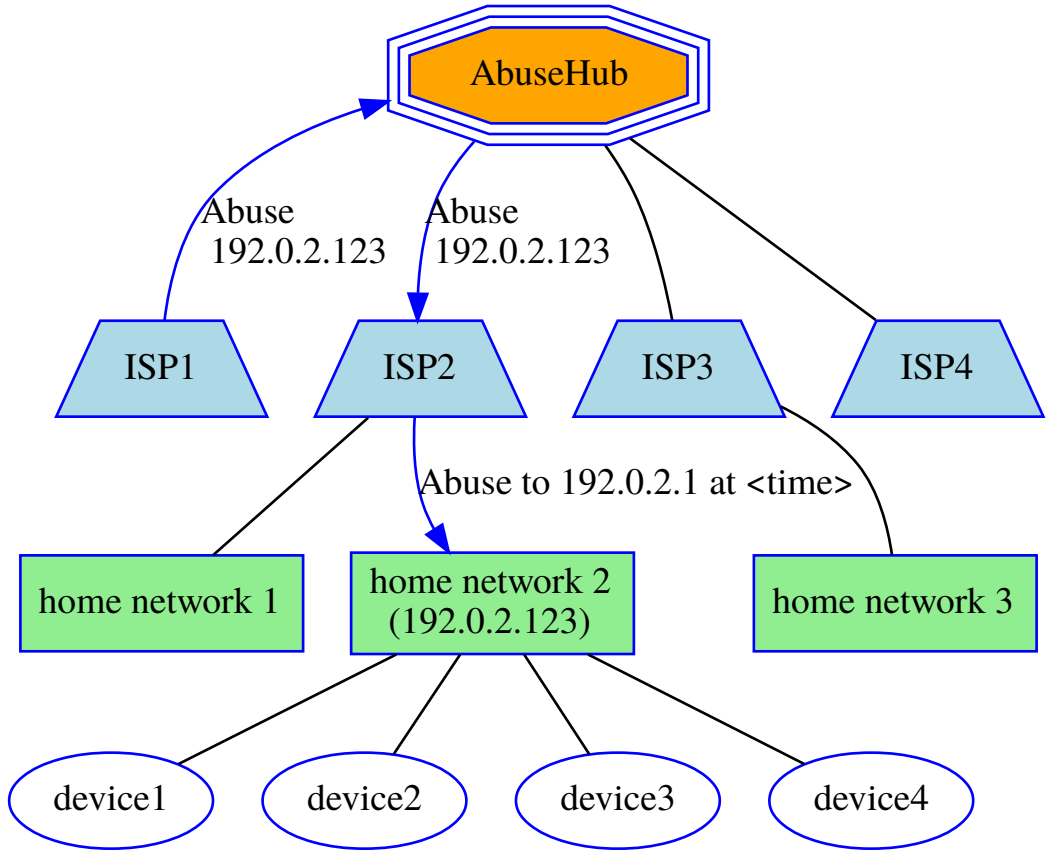

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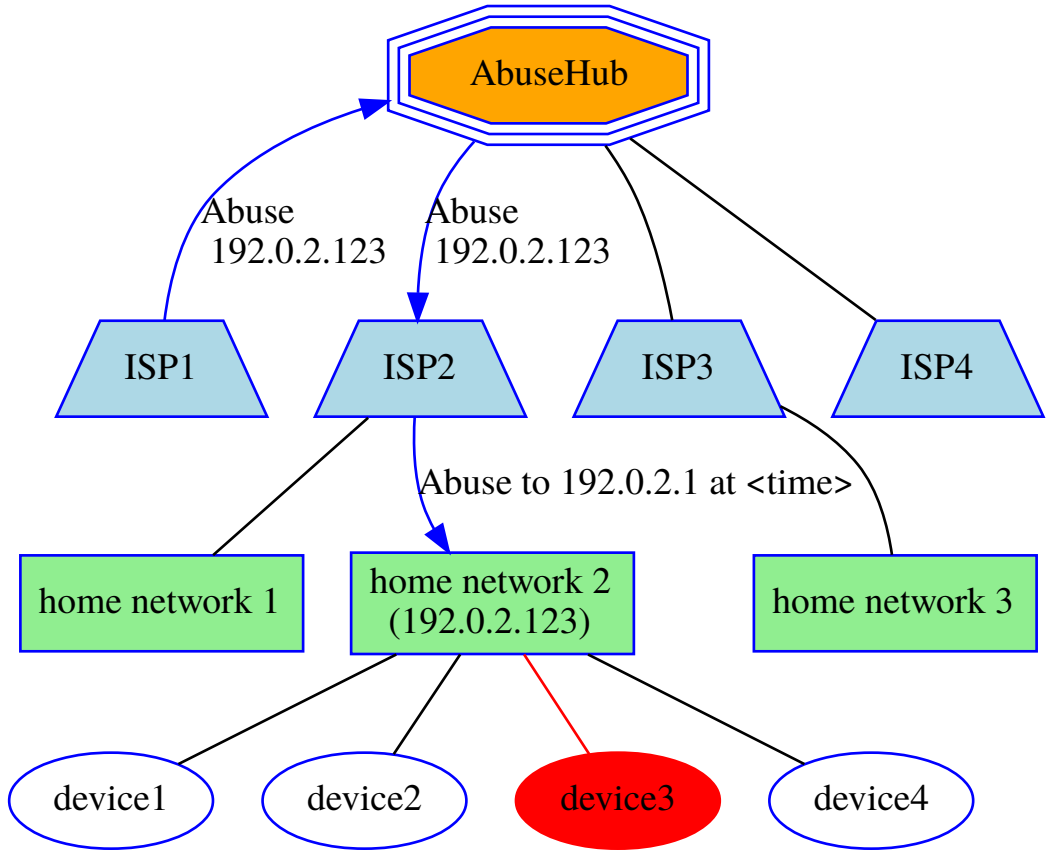

More granular quarantining:

- Specify the bad behaviour (time, target, ports, etc.)
- Router should figure out how to mitigate:
  - Preventative firewall rules (dots-signal-call-home)
  - Active response to behaviour (SPIN approach)

dots: DDoS Open Threat Signaling (dots) work at IETF:

- https://datatracker.ietf.org/wg/dots/charter/
- https://datatracker.ietf.org/doc/draft-ietf-dots-signal-call-home/

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The IoT and the DNS @ .nl

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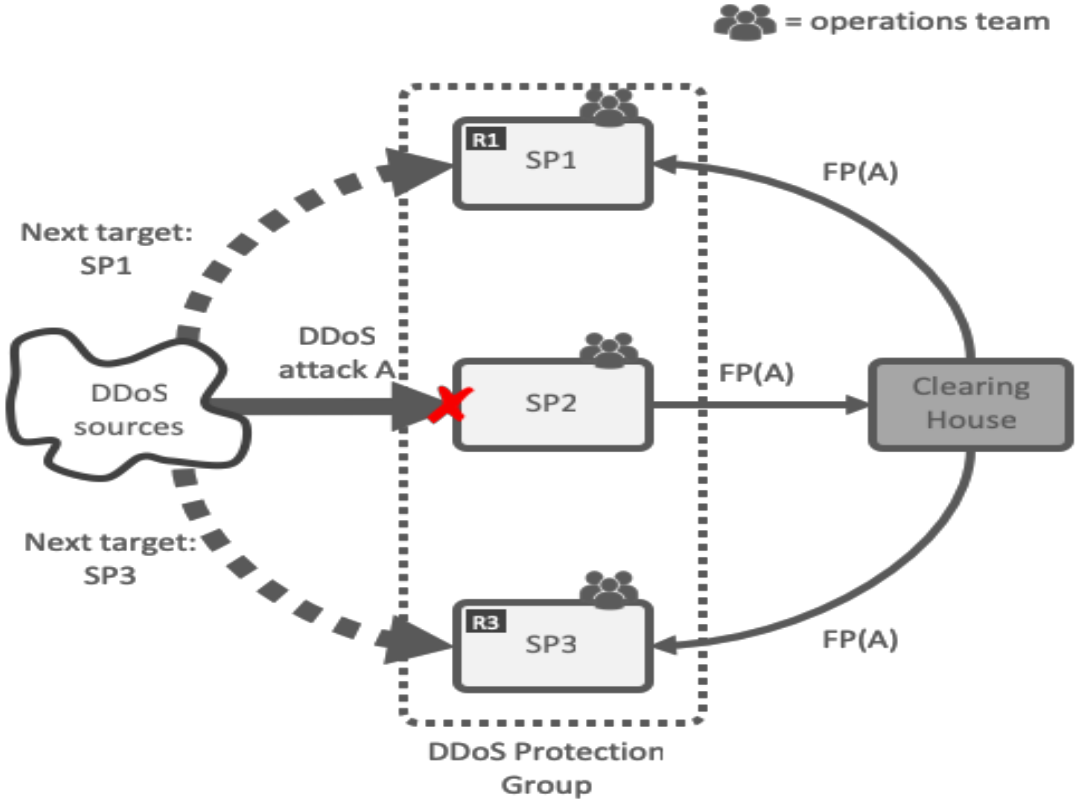
National DDoS clearing house

- Continuous and automatic sharing of “fingerprints” of (IoT-powered) DDoS attacks buys providers time (proactive)
- Extends DDoS protection services of critical service providers, not a replacement
- Pilot with 10 NL partners, then scale up to EU-level as part of CONCORDIA project [DDoS19]



The work of SIDN, SURFnet, and the University of Twente on the DDoS clearing house was partly funded by the European Union’s Horizon 2020 Research and Innovation program under Grant Agreement No 830927.

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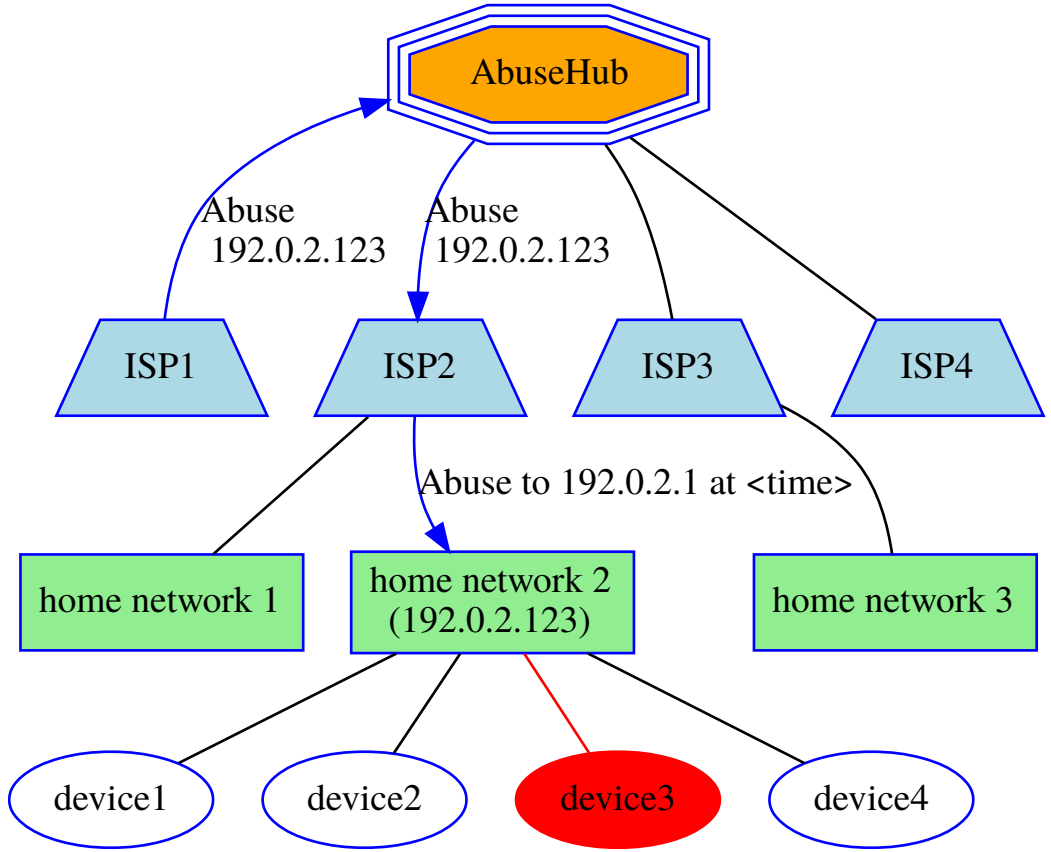
The SPIN project at SIDN Labs

- Security and Privacy for In-home Networks
- Research and prototype of SPIN functionality:
  - Visualise network traffic
  - Signal problems based on traffic patterns
  - Perform measurements on (IoT) devices
- Goal: Protect the Internet by protecting the home
- Get functionality like this into deployed routers

The SPIN project at SIDN Labs

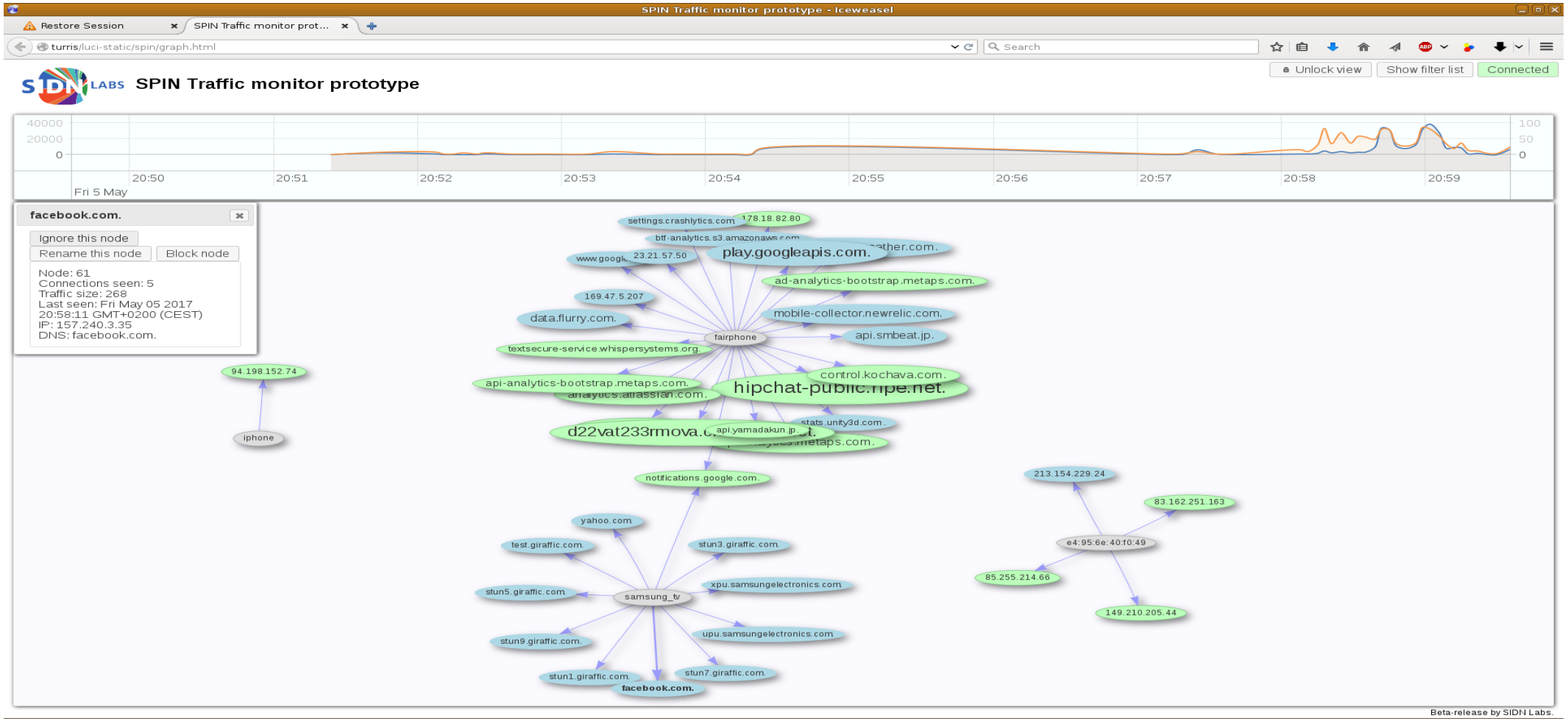
- Open source in-home router/AP software that
- Provides insight into device activity on the Internet
- Serves as platform for research and experimentation

Fine-grained blocking of vulnerable IoT devices through SPIN

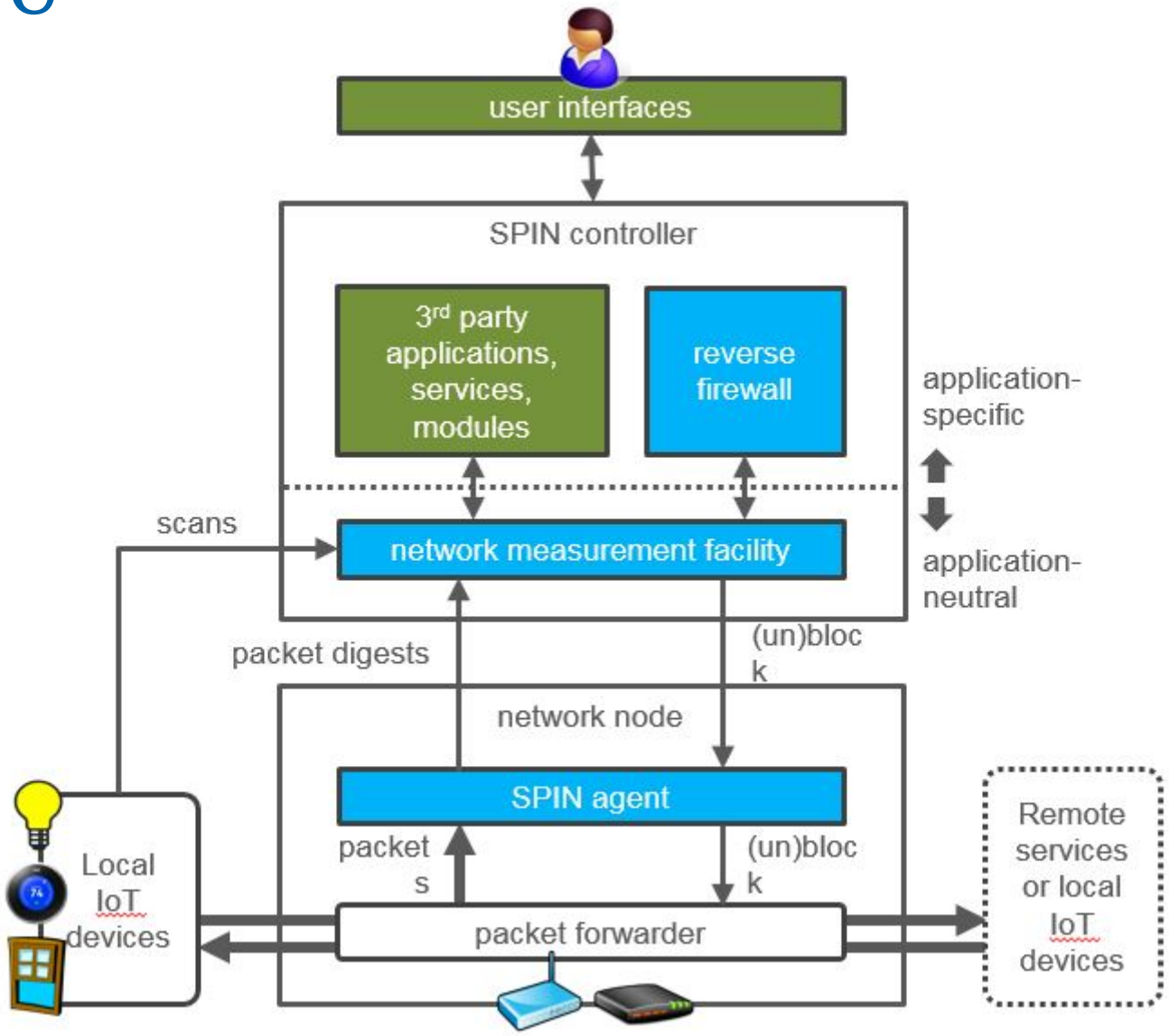


https://www.sidnlabs.nl/a/weblog/redesigning-spin-to-a-reference-platform-for-secure-and-privacy-enabled-iot-home-networks?language_id=2

SPIN DNS traffic monitor for IoT users



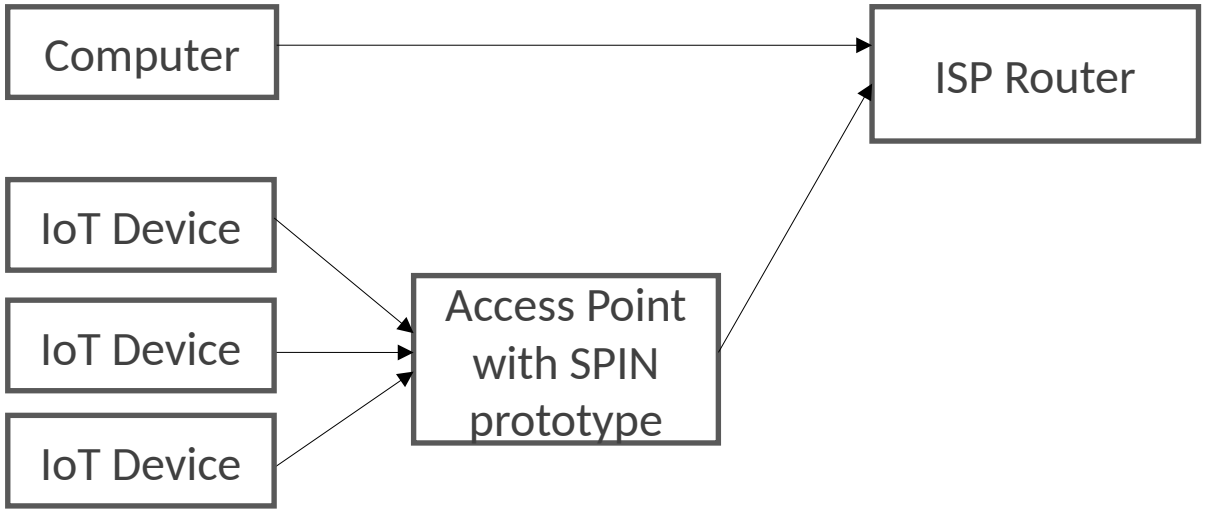
Architecture



Prototype built on OpenWRT

- Currently bundled with Valibox: http://valibox.sidnlabs.nl
- Source at https://github.com/SIDN/spin
- Also runs on Debian and Raspberry Pi (with some hammering)

prototype 2, GL-Inet hardware

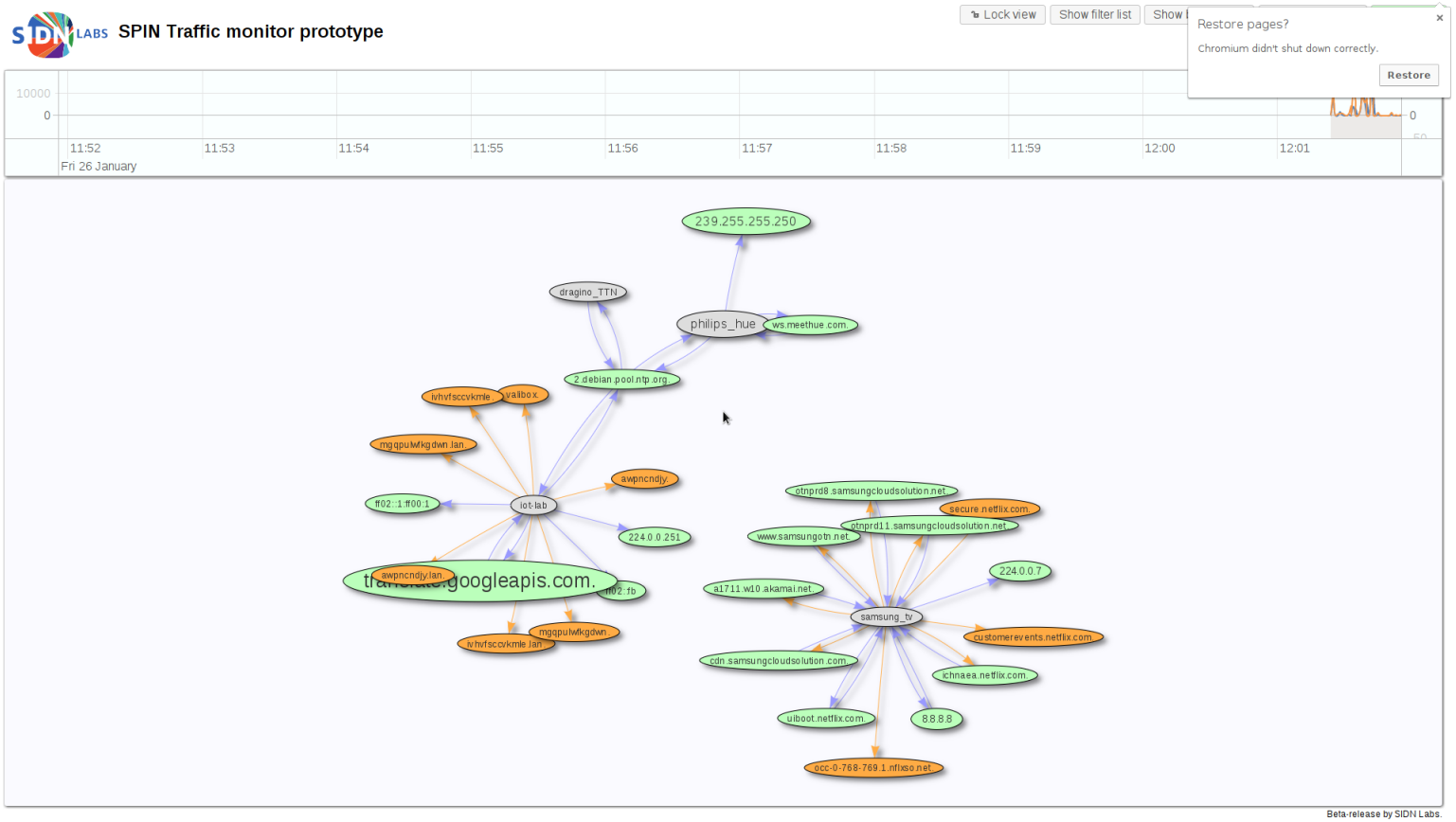


Running prototype: visualiser

- Shows DNS queries
- Shows data traffic
- User can block traffic based on source or destination
- Download traffic from specific devices

Next research topics:

- In-depth device traffic analysis
- Time-series based analysis



If time permits,
show SPIN in action here

Thank you for your attention!

Any questions?

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Fora to discuss approaches on technical level

- IETF
  - IETF dots working group

- RIPE: https://www.ripe.net
  - RIPE IoT Working group
  - RIPE Abuse working group
  - RIPE Routing working group

  Next RIPE meeting: May 11-15, Berlin
  https://ripe80.ripe.net

References and related reading

- SAC-105 - The DNS and the Internet of Things: Opportunities, Risks, and Challenges
  https://www.icann.org/en/system/files/files/sac-105-en.pdf

- SPIN website:
  https://spin.sidnlabs.nl

- RIPE IoT working group
  https://www.ripe.net/participate/ripe/wg/iot

- ISOC IoT information
  https://www.internetsociety.org/iot/getiotsmart/