WORK IN PROGRESS

Mitigating DDoS attacks from botnets through a national DDoS clearing house

BotLeg Workshop
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Botnets: swiss army knife of cybercrime

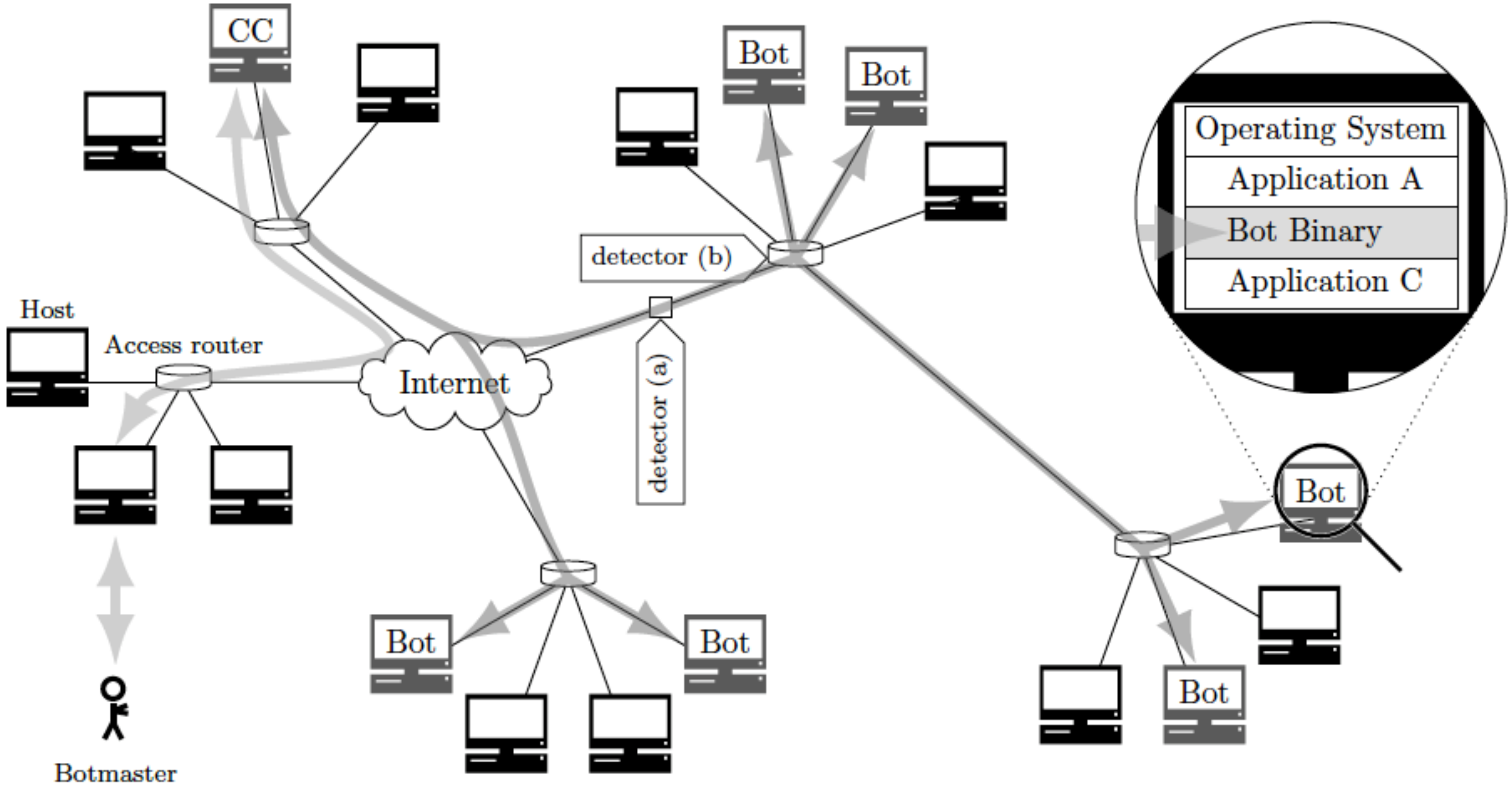
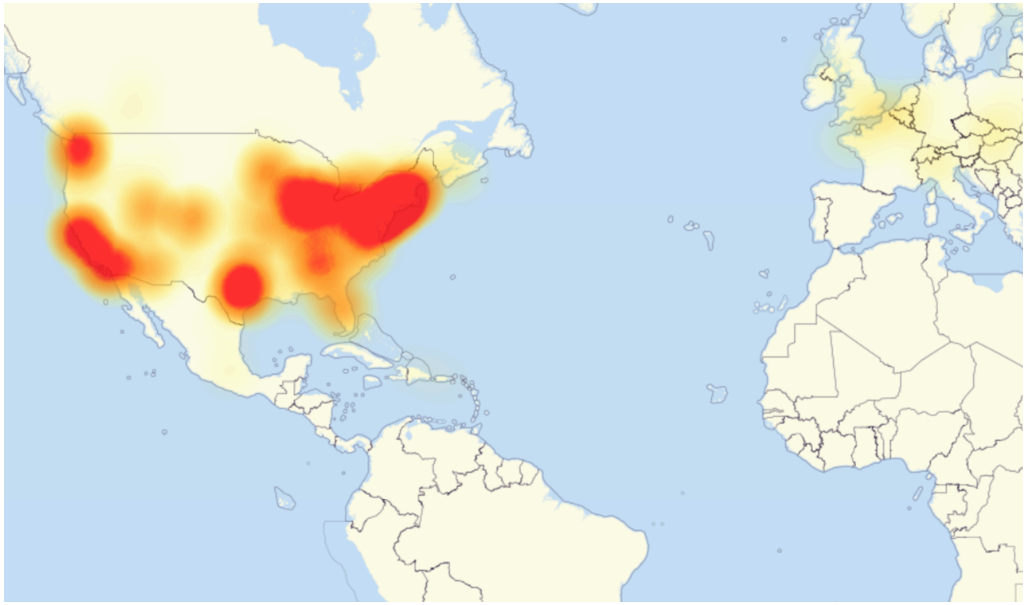
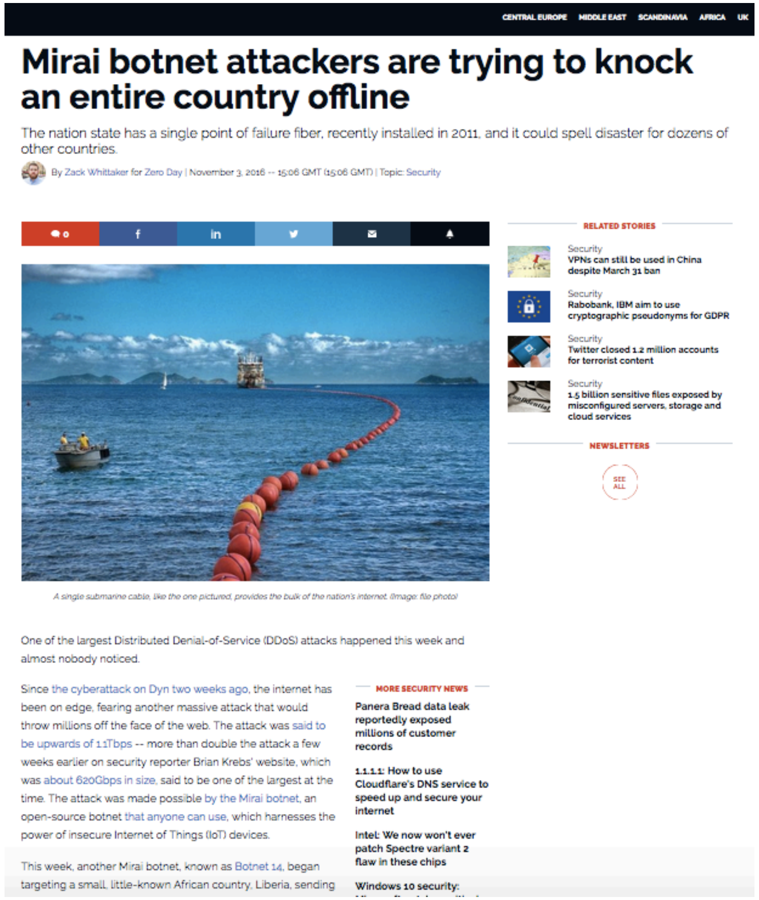


Fig. 1. Botnet overview example consisting of a centralized botnet including botmaster, C&C server, communication channels, bots, and bot binary. Additionally, example network-based detector positions (a) and (b) are depicted. Detector (a) acts as an intermediate node while (b) is included in a router.

Source: G. Vormayr, T. Zseby, J. Fabini, “Botnet Communication Patterns”, IEEE Communications Surveys & Tutorials, 19 (2017), 4; 2768 - 2796.

Example: DDoS attacks (Mirai botnet)





Mirai botnet attackers are trying to knock an entire country offline

The nation state has a single point of failure fiber, recently installed in 2011, and it could spell disaster for dozens of other countries.

By Zack Whittaker for Zero Day | November 3, 2016 -- 15:06 GMT (15:06 GMT) | Topic: Security

A single submarine cable, like the one pictured, provides the bulk of the nation's internet. (Image: file photo)

One of the largest Distributed Denial-of-Service (DDoS) attacks happened this week and almost nobody noticed.

Since the cyberattack on Dyn two weeks ago, the internet has been on edge, fearing another massive attack that would throw millions off the face of the web. The attack was said to be upwards of 1.1Tbps -- more than double the attack a few weeks earlier on security reporter Brian Krebs' website, which was about 620Gbps in size, said to be one of the largest at the time. The attack was made possible by the Mirai botnet, an open-source botnet that anyone can use, which harnesses the power of insecure Internet of Things (IoT) devices.

This week, another Mirai botnet, known as Botnet 14, began targeting a small, little-known African country, Liberia, sending

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A few DDoS trends

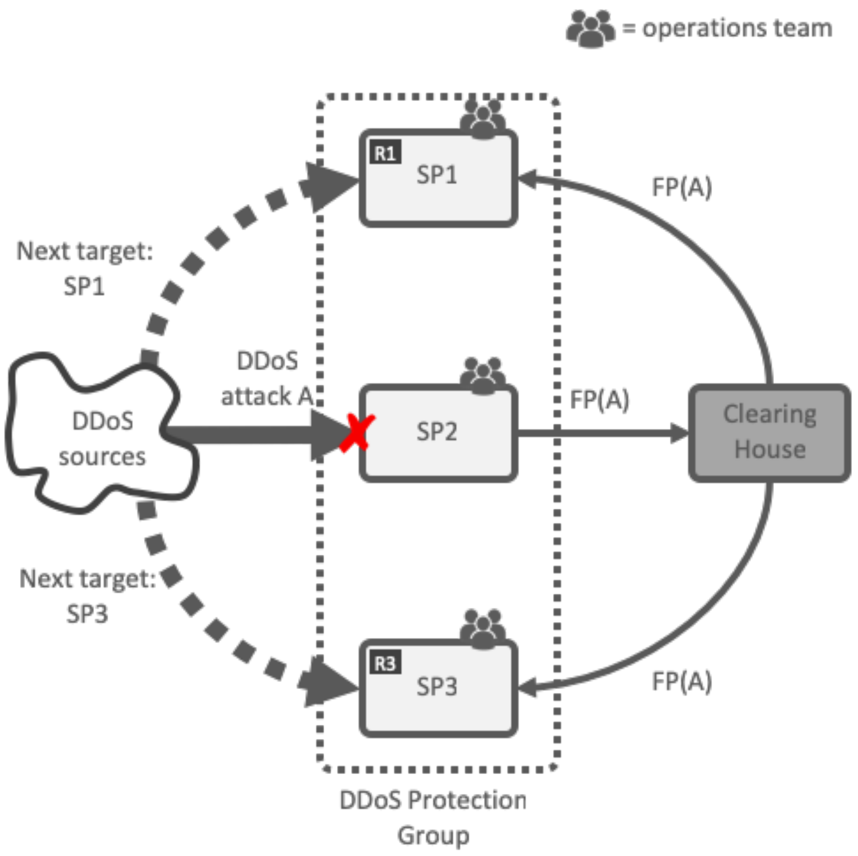
- Volume at 1+ Tbps, likely going up (Dyn 1.2 Tbps, GitHub 1.3 Tbps)
- Many widely distributed sources (Mirai 600K, Hajime 400K)
- High propagate rates (e.g., Mirai from 42K to 71K bots in 1 hour)
- Complex traffic (e.g., bot churn, volumetric/TCP state exhaustion)
- Easier to launch through booters/stressers (Mirai)
- Reflection attacks possible (e.g., Mirai and Reaper botnets)

➔ At the same time, our societies increasingly depend on network services!

- Antonakakis, T. April, M. Bailey, M. Bernhard, E. Bursztein, J. Cochran, Z., Durumeric, J. A. Halderman, L. Invernizzi, M. Kallitsis, D. Kumar, C. Lever, Z. Ma, J. Mason, D. Menscher, C. Seaman, N. Sullivan, K. Thomas, and Y. Zhou, "Understanding the Mirai Botnet", 26th USENIX Security Symposium, 2017
- S. Herwig, K. Harvey, G. Hughey, R. Roberts, and D. Levin, "Measurement and Analysis of Hajime, a Peer-to-peer IoT Botnet", Network and Distributed Systems Security (NDSS) Symposium 2019, San Diego, CA, USA, February 2019

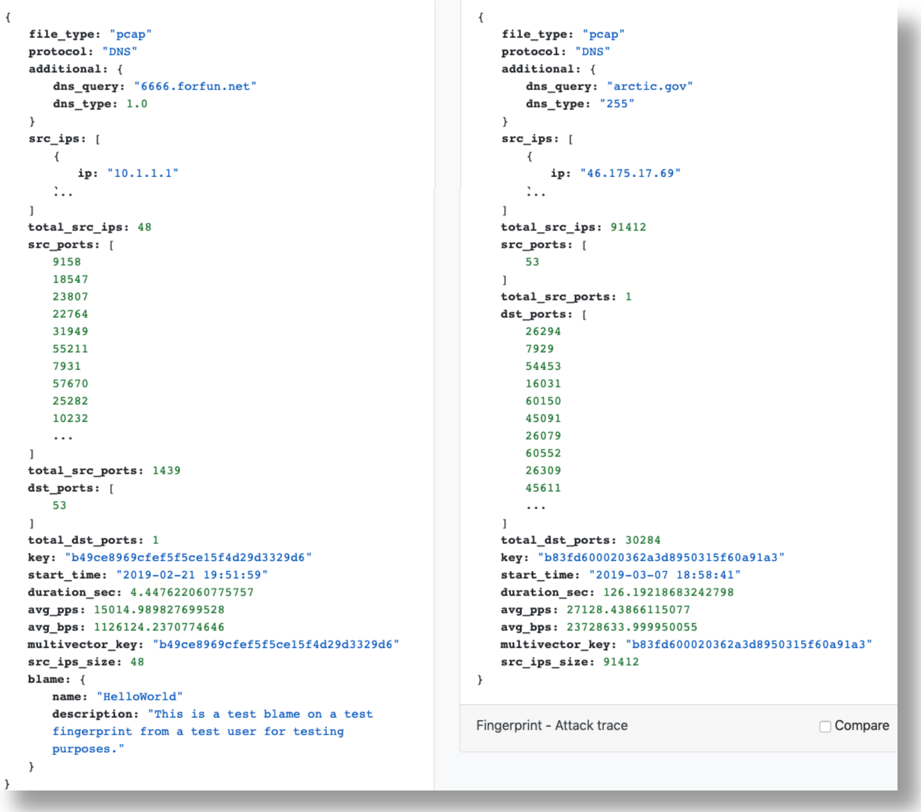
New: DDoS information sharing in NL

- Continuous and automatic sharing of “DDoS fingerprints” buys providers time (proactive)
- Extends DDoS protection services that critical service providers use and does not replace them
- Improves attribution, allowing for better prosecution and increased deterrent effects
- Open to all critical providers in the Netherlands (Internet, financial, energy, water, etc.)



DDoS fingerprints = summary of DDoS traffic

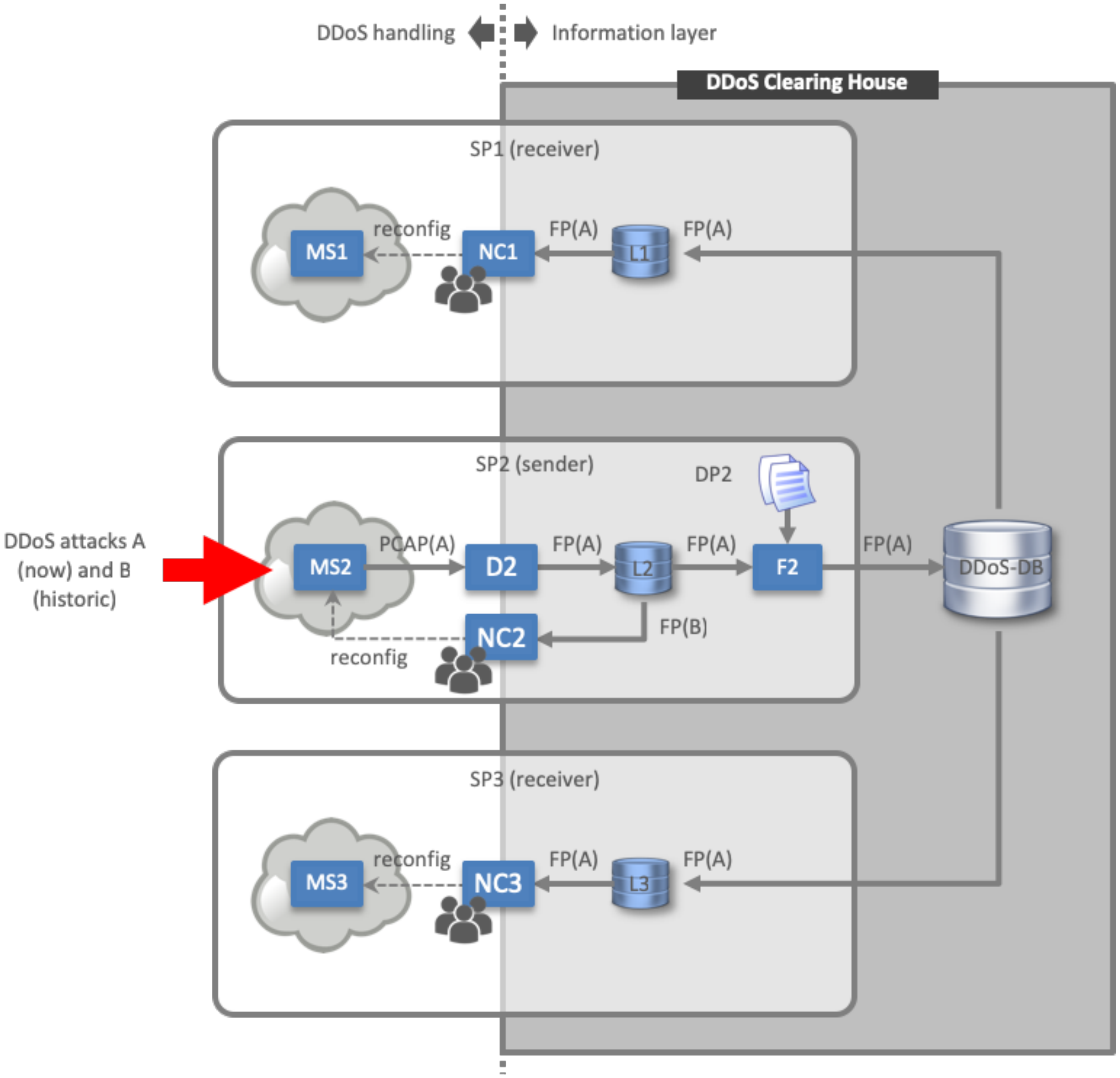
- Domain names used, source IP addresses, protocol, packet length, no victim IP addresses
- Optional extensions: PCAPs, device-specific packet filter rules that ops teams used, suspected type of DDoS attack (e.g., Mirai or Hajime-powered), contact details of ops team
- Created from network measurements (e.g., PCAP, Netflow, IPFIX, sFlow, Logfile)



```
{
   file_type: "pcap"
   protocol: "DNS"
   additional: {
      dns_query: "6666.forfun.net"
      dns_type: 1.0
   }
   src_ips: [
      {
         ip: "10.1.1.1"
      }...
   ]
   total_src_ips: 48
   src_ports: [
      9158
      18547
      23807
      22764
      31949
      55211
      7931
      57670
      25282
      10232
      ...
   ]
   total_src_ports: 1439
   dst_ports: [
      53
   ]
   total_dst_ports: 1
   key: "b49ce8969cfef5f5ce15f4d29d3329d6"
   start_time: "2019-02-21 19:51:59"
   duration_sec: 4.447622060775757
   avg_pps: 15014.989827699528
   avg_bps: 1126124.2370774646
   multivector_key: "b49ce8969cfef5f5ce15f4d29d3329d6"
   src_ips_size: 48
   blame: {
      name: "HelloWorld"
      description: "This is a test blame on a test
      fingerprint from a test user for testing
      purposes."
   }
}
```

```
{
   file_type: "pcap"
   protocol: "DNS"
   additional: {
      dns_query: "arctic.gov"
      dns_type: "255"
   }
   src_ips: [
      {
         ip: "46.175.17.69"
      }...
   ]
   total_src_ips: 91412
   src_ports: [
      53
   ]
   total_src_ports: 1
   dst_ports: [
      26294
      7929
      54453
      16031
      60150
      45091
      26079
      60552
      26309
      45611
      ...
   ]
   total_dst_ports: 30284
   key: "b83fd600020362a3d8950315f60a91a3"
   start_time: "2019-03-07 18:58:41"
   duration_sec: 126.19218683242798
   avg_pps: 27128.43866115077
   avg_bps: 23728633.999950055
   multivector_key: "b83fd600020362a3d8950315f60a91a3"
   src_ips_size: 91412
}
```

Clearing house overall architecture (DRAFT)



DDoS clearing house NL partners

- Embraced by a coalition of 25 players from industry (ISPs, xSPs, IXPs, banks, not-for-profit DPS) and gov’t (ministries and agencies)

- Including various existing collaborative anti-DDoS initiatives, such as the Dutch Continuity Board (DCB), NoMoreDDoS, NBIP-NaWas

- Working groups:
  - Clearing house
  - Cross-industry information sharing
  - Outreach
  - Ground rules and incident response
  - Exercises

- Facilitated by Dutch National Cyber Security Centre (NCSC-NL)

Status

- Technical track
  - Operational version of DDoS-DB based on open source prototype developed by the University of Twente
  - Closed user group: KPN, THTC, NBIP, NCSC-NL, SIDN, UT, NL-ix, VodafoneZiggo, Dutch Payment Association

- Legal track: data sharing agreement
  - Draft developed by legal experts of SIDN and KPN
  - Covers topics like governance, liability, and audits
  - Focus on simplicity, scalability (NL/EU), and various devops phases

Next steps

- Pilot in the Netherlands (short-term)
  - Approach: start small and iteratively scale up to more partners
  - First share pre-generated fingerprints, then on-the-fly generated prints

- DDoS clearing house for Europe
  - Part of CONCORDIA project (www.concordia-h2020.eu)
  - Development of a clearing house "cookbook"
  - Second pilot in Italy

- Envisioned long-term growth paths
  - Netherlands → Europe → global
  - Extend to "non-critical" service providers

Q&A

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The development of the Dutch national DDoS clearing house is a joint effort of NBIP-NaWas, KPN, THTC, NCSC-NL, Dutch Payment Association, VodafoneZiggo, NL-ix, SIDN, SURFnet, and the University of Twente (WG clearing house). SIDN, SURFnet, and the University of Twente were partly funded by the European Union's Horizon 2020 Research and Innovation program under Grant Agreement No 830927.