The Responsible Internet

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Top Team ICT Strategy Day
Utrecht, the Netherlands
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Agenda

- The Internet infrastructure
- Two problems: black box nature and centralization
- The Responsible Internet and example building blocks
- Strategy suggestions
- Discussion

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The Internet infrastructure

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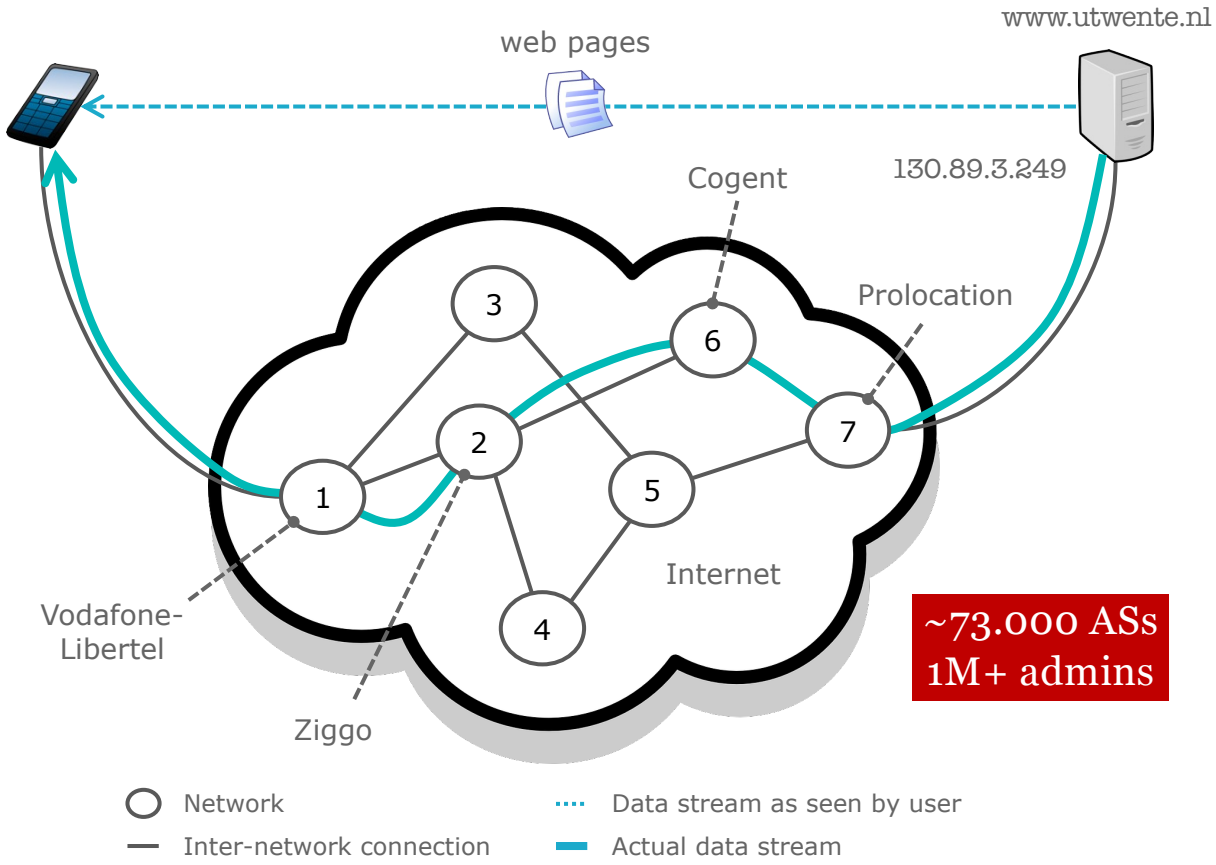
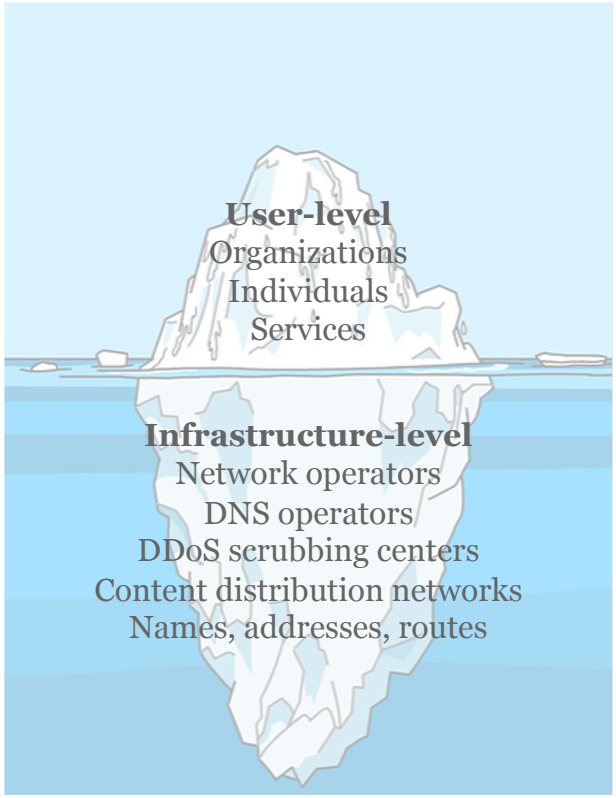
High-level operation of the Internet infrastructure





Per-AS planning and coordination, no central authority

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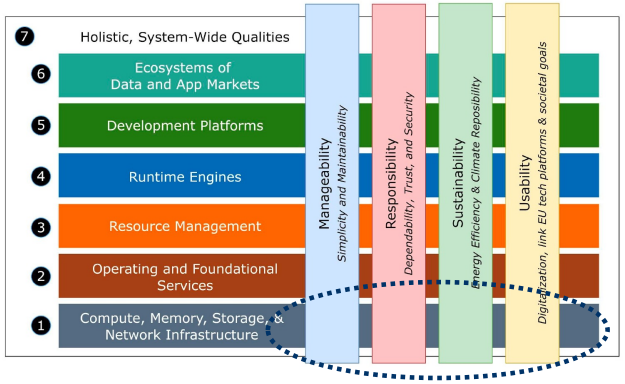
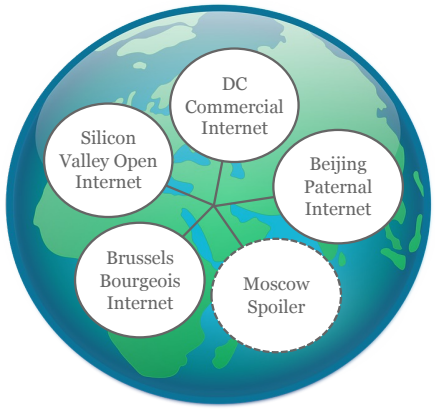
Strategic developments

- Ever increasing dependency on the Internet infrastructure for citizens, organizations, society
- Vision: will eventually also serve cyber-physical systems such as smart grids, tele-robots, ITSs
- The Internet and societal systems increasingly co-develop (e.g., strategic digital autonomy, IoT security, DNS4EU)
- Many challenges going forward, such as security, manageability, sustainability





A. Iosup and F. Kuipers (Editors), "Future Computer Systems and Networking Research in the Netherlands: A Manifesto", Oct 2021
O'Hara, K., Hall, W.: Four Internets: Considering the merits of several models and approaches to Internet governance". Communications of the ACM 63, 3 (2020)

Two problems of the Internet infrastructure

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Problem #1: it's a black box for users

- Traditional focus on uninterrupted and seamless connectivity
  - No insight in nor notification of route changes
  - Such as in terms of operators, vendors, security, jurisdictions
  - No control over response (e.g., stop transmission or reroute)

- Downside: data might travel through untrusted networks
  - Store data, metadata analysis, disrupting equipment or data
  - Potentially huge impact on society
  - Particularly relevant for cyberphysical/OT services (safety)

- Reduced **trust** in the foundations of our digital society

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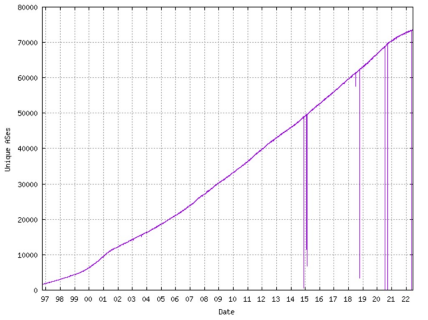
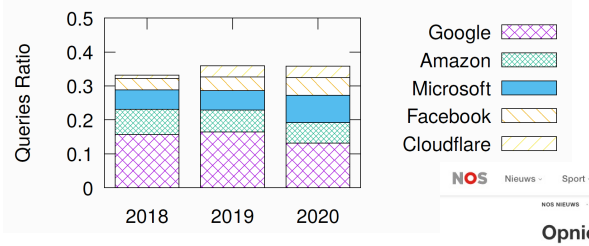
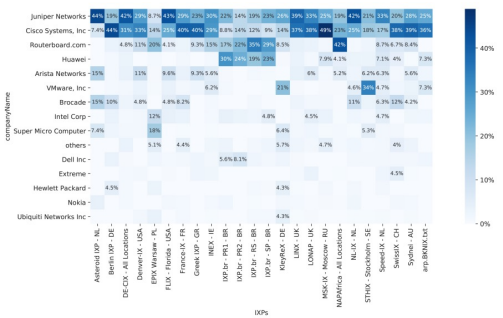
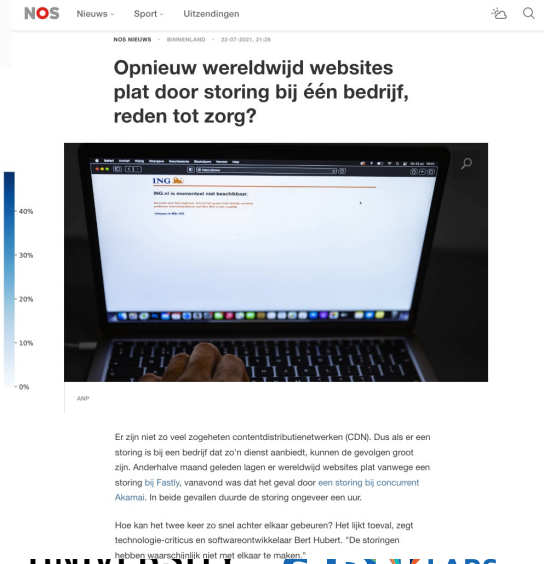
Problem #2: increasing centralization

- Internet designed to be “in the hands of many”
  - Decentralized and distributed ownership and control
  - Resilience through diversity
- Under pressure due to market concentration
  - A few large powerful players, often non-EU
  - Operators (e.g., DNS, CAs, time) and vendors
  - Pro: quickly introduce new technologies at scale
- Risk for the **resilience** of the Internet and that of society (knowledge, data, technologies elsewhere)









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What does it take to address these problems and enable a more trusted and resilient Internet infrastructure?

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Approach: the Responsible Internet

- New security-enhancing properties: transparency, accountability, controllability
- Open software, hardware, protocols, designs (~TRL7)
- Open Internet measurements (exogenous)
- Added value for critical infrastructure operators, network operators, policy makers, individuals

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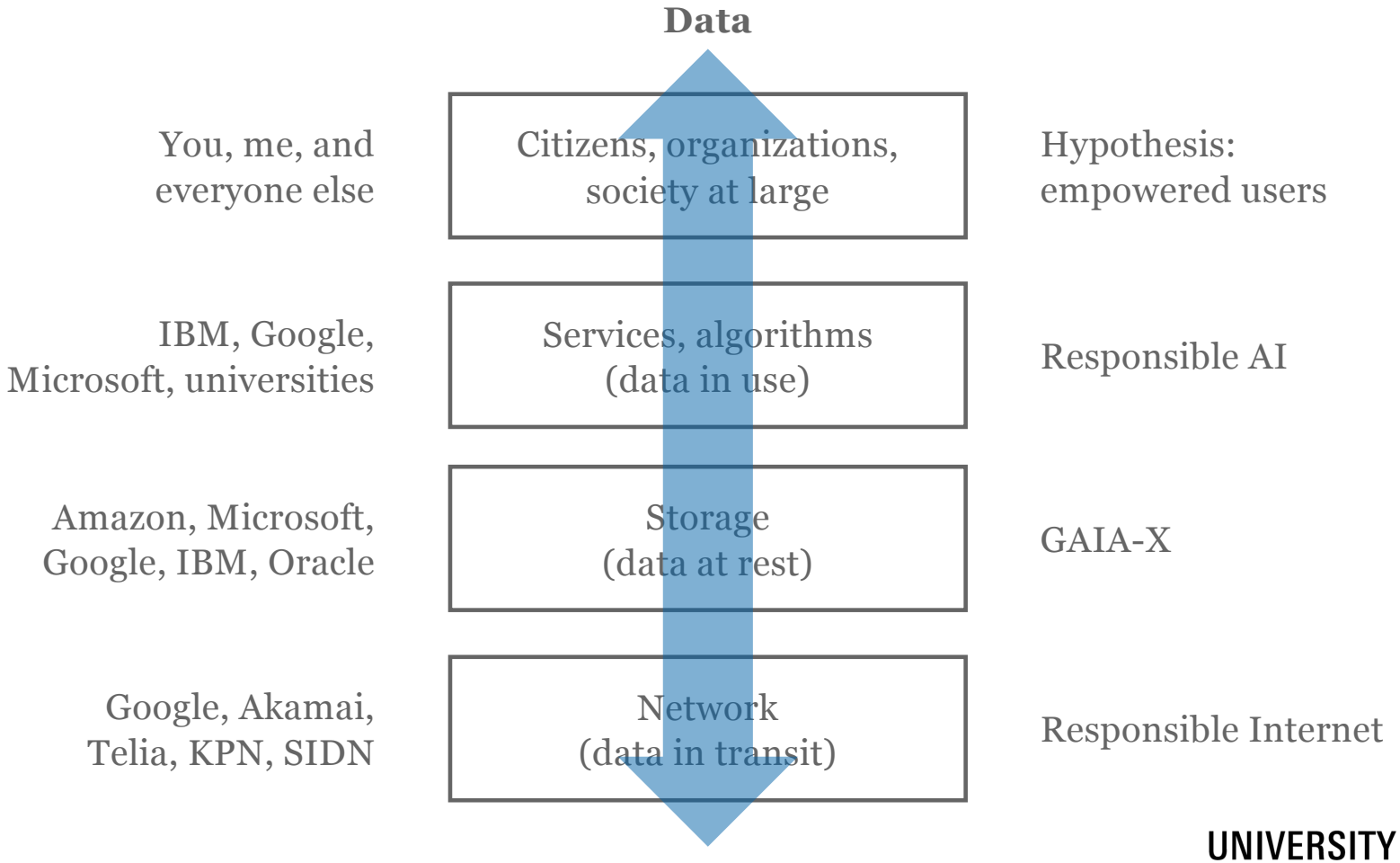
Inspiration: responsible AI and GAIA-X



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Examples of required mechanisms

Building block	Examples of mechanisms
Controllability	• Descriptions of path security requirements • Path-aware technologies (e.g., SCION or segment routing) • Virtual Network Functions (VNFs)
Accountability	• Append-only distributed logging (cf. certificate logs) • Scalable path validation • Cross-measurements from multiple vantage points
Transparency	• Network scopes, network-level data exchanges • Active measurements (e.g., OpenINTEL), in-band telemetry • Self-descriptions (cf. GAIA-X and “cybersecurity labels”)
Incentives	• Pilots and lessons learned with “vertical” use cases • New CAT-based applications and business models • Insight in investments and operational costs
Policy	• Standardized CAT levels • Policy models (voluntarily, regulated, (inter)national) • Policy bodies (cf. MANRS or ICANN)

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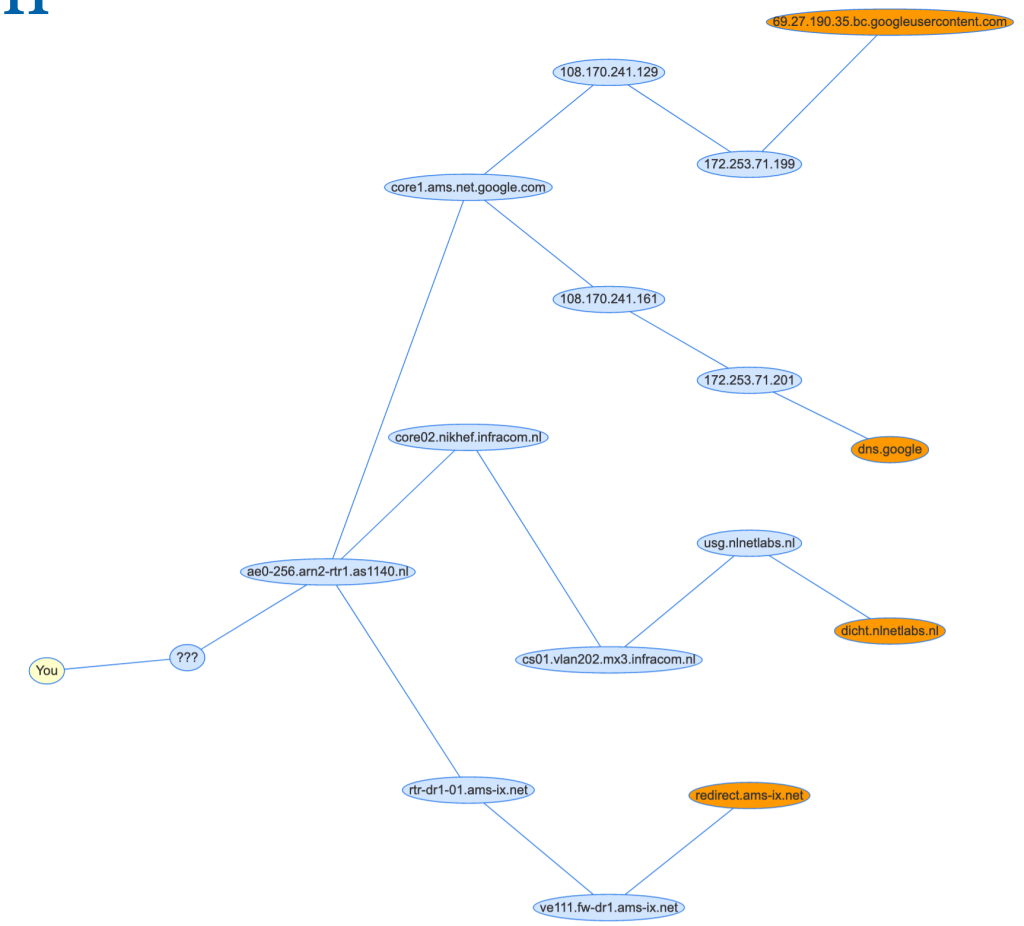
Example building blocks

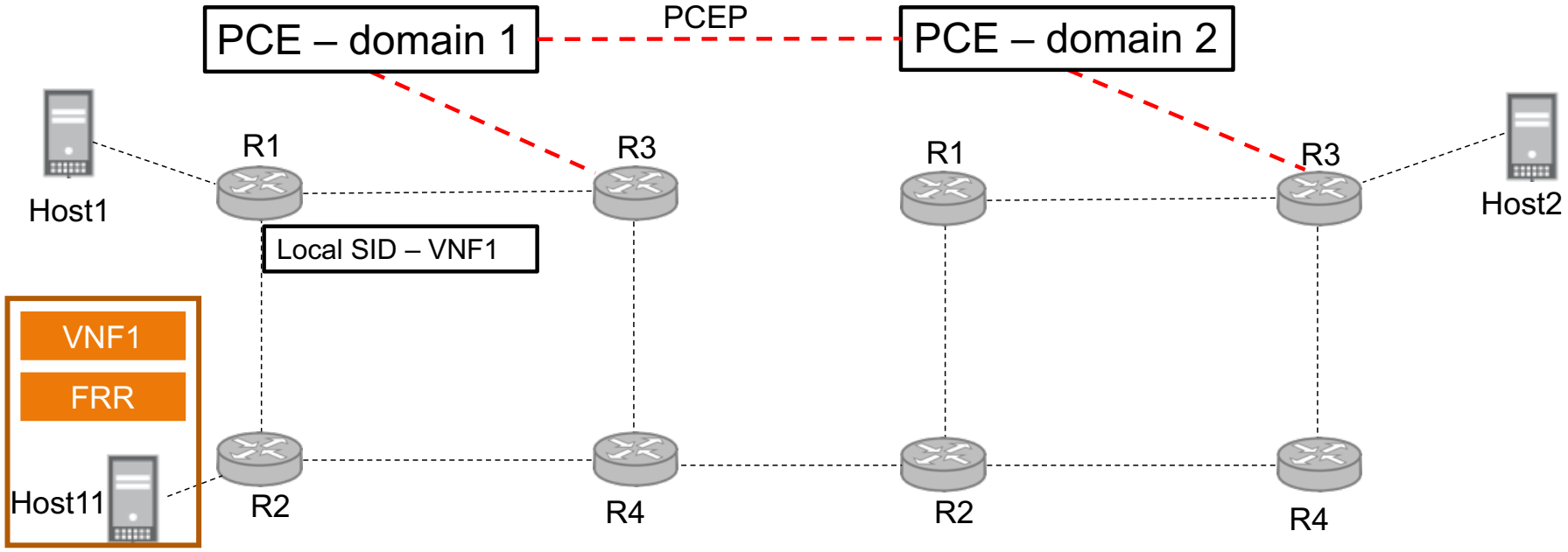
Inter-domain path validation

- Users get a cryptographically signed “receipt” of how their data flows through the network
- When it changes, they can stop transmission or redirect data through a different path
- Hypothesis: benefits applications with higher security requirements
- Challenges: technical design, security vs. transparency, scoped deployment



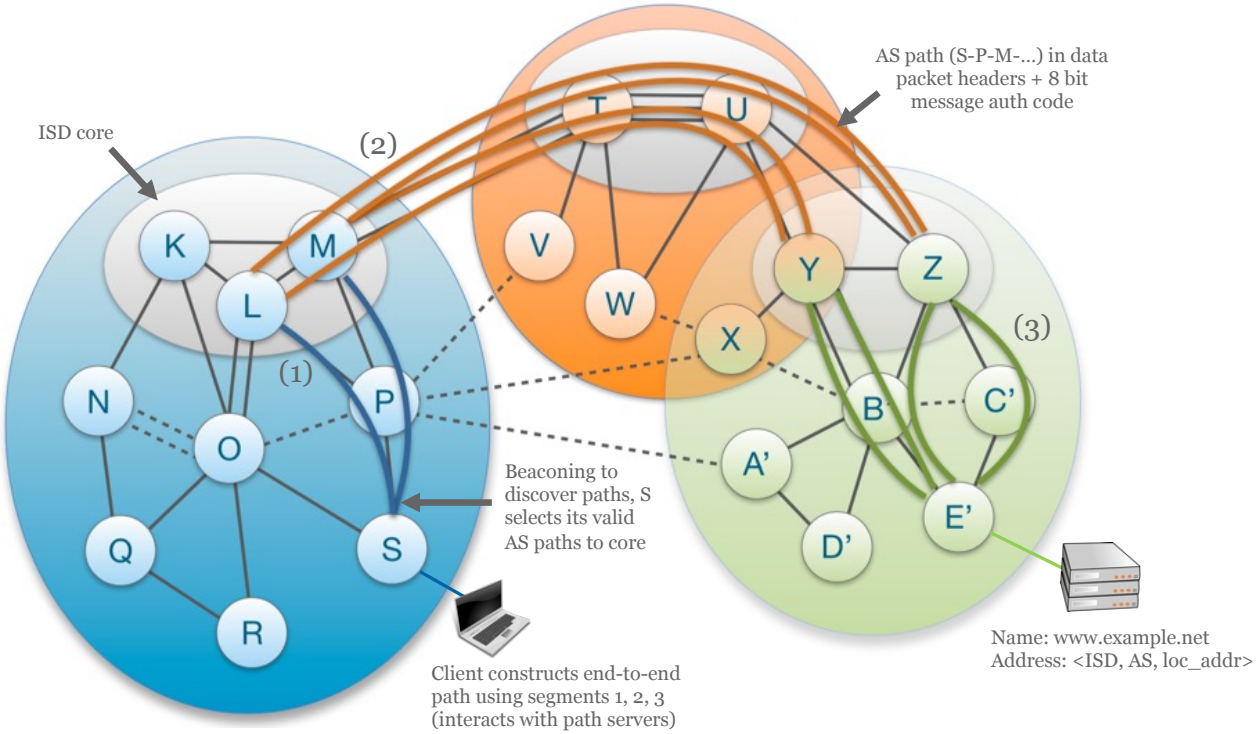
CATRIN and UPIN received funding from the Dutch Research Council (NWO)

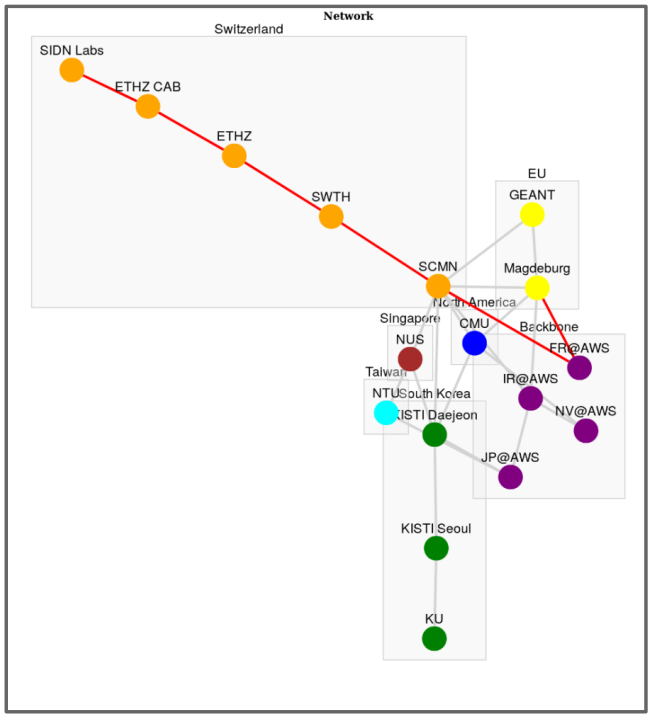
Inter-domain path control



UPIN received funding from the Dutch Research Council (NWO)

SCION-based networks





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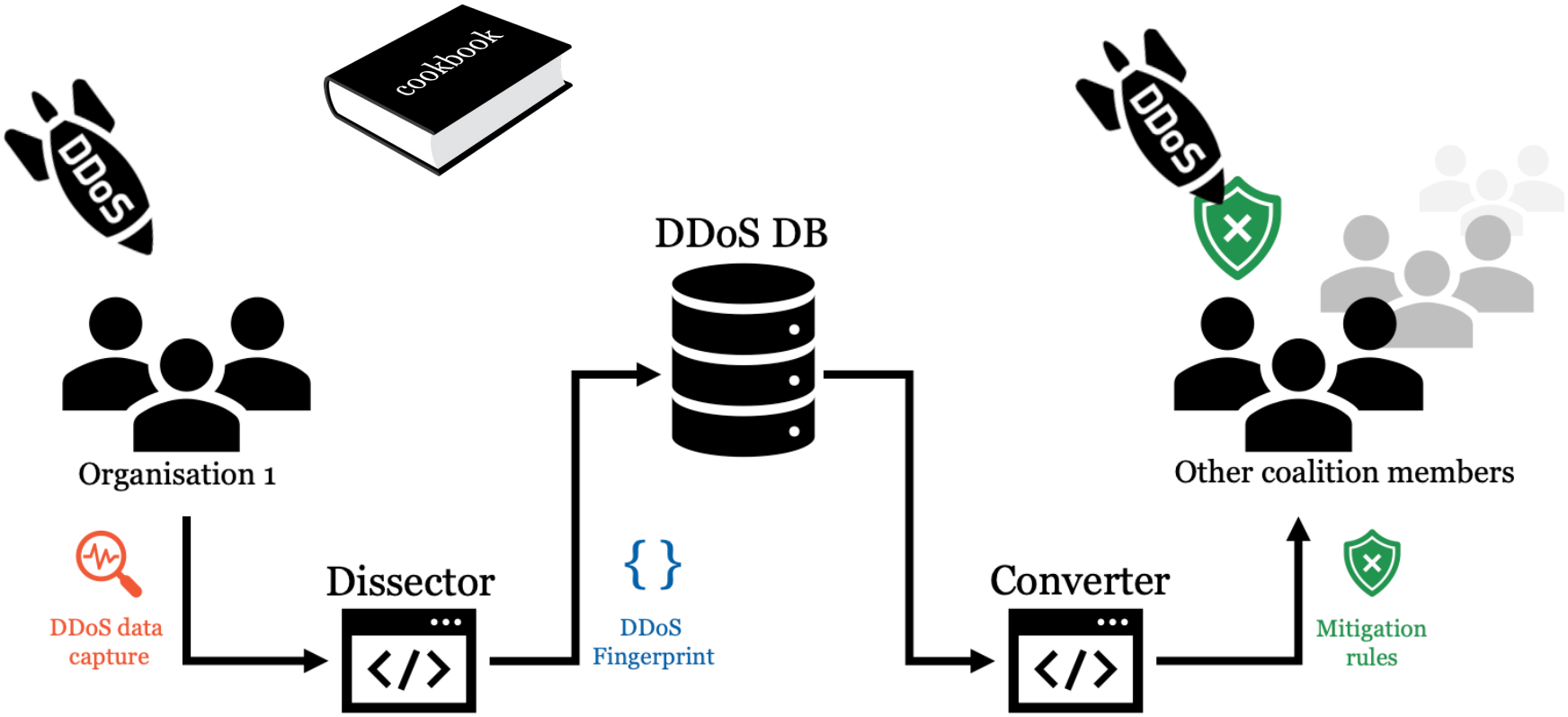
Data exchange between network operators (DDoS)



This work was funded by the European Union's Horizon 2020 Research and Innovation program under Grant Agreement No 830927

P4 testbed

- Equipment uses open software and open programmable hardware (e.g., P4-based)
- Enables transparency and experimentation with new data plane functions (e.g., PCFS)
- Explore and learn from “clean slate” architectures such as SCION (e.g., SCION-in-P4)

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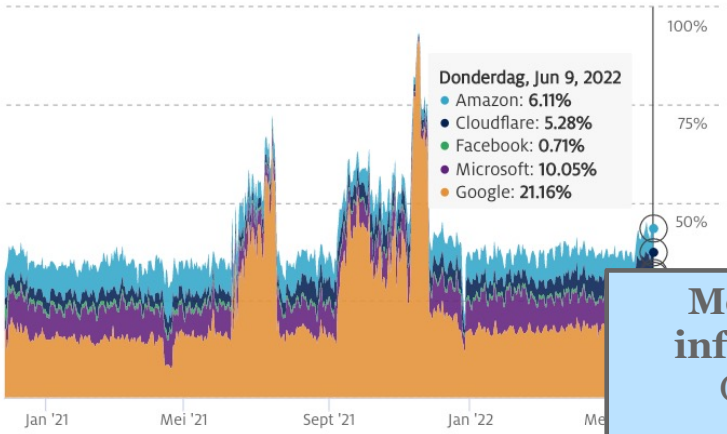
Open Internet measurements



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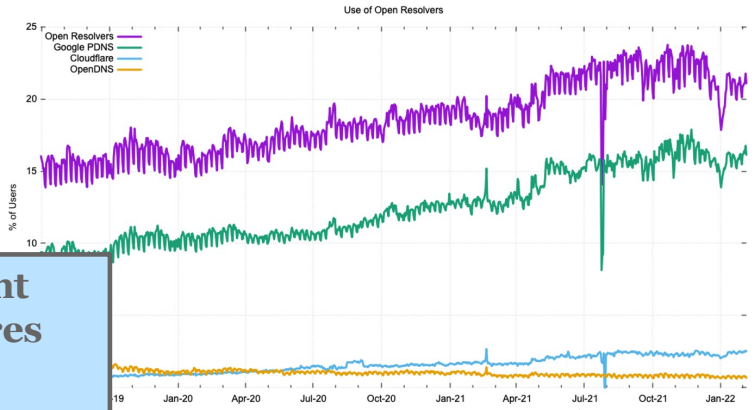
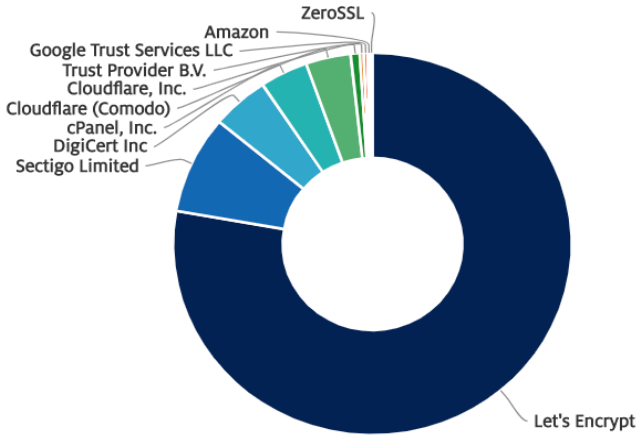


s://blog.apnic.net/2022/02/11/opinion-dns4eu/

Measurement infrastructures

OpenINTEL
ENTRADA
RIPE ATLAS
DMAP
LG servers



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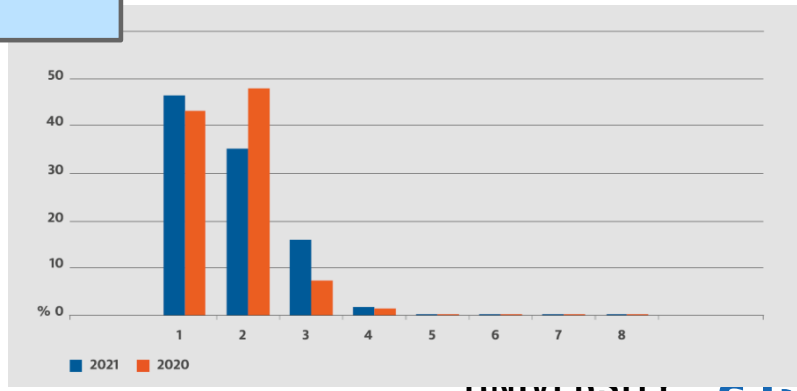

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Strategy suggestions

- A trusted and resilient Internet infrastructure requires additional properties from the network – opportunity to set up a European networking industry in niche areas

- Set up “moon shot” Internet infrastructure testbeds to start and grow the ecosystem
  - Such as the Responsible Internet or the Extensible Internet
  - One joint national research program (e.g., NGF-based)
  - Potential starting points: CATRIN project, 2STiC, TUCCR

- Unlock Internet security and evolution measurements by setting up a portal for policy makers, tech journalists, and others

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Discussion

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