



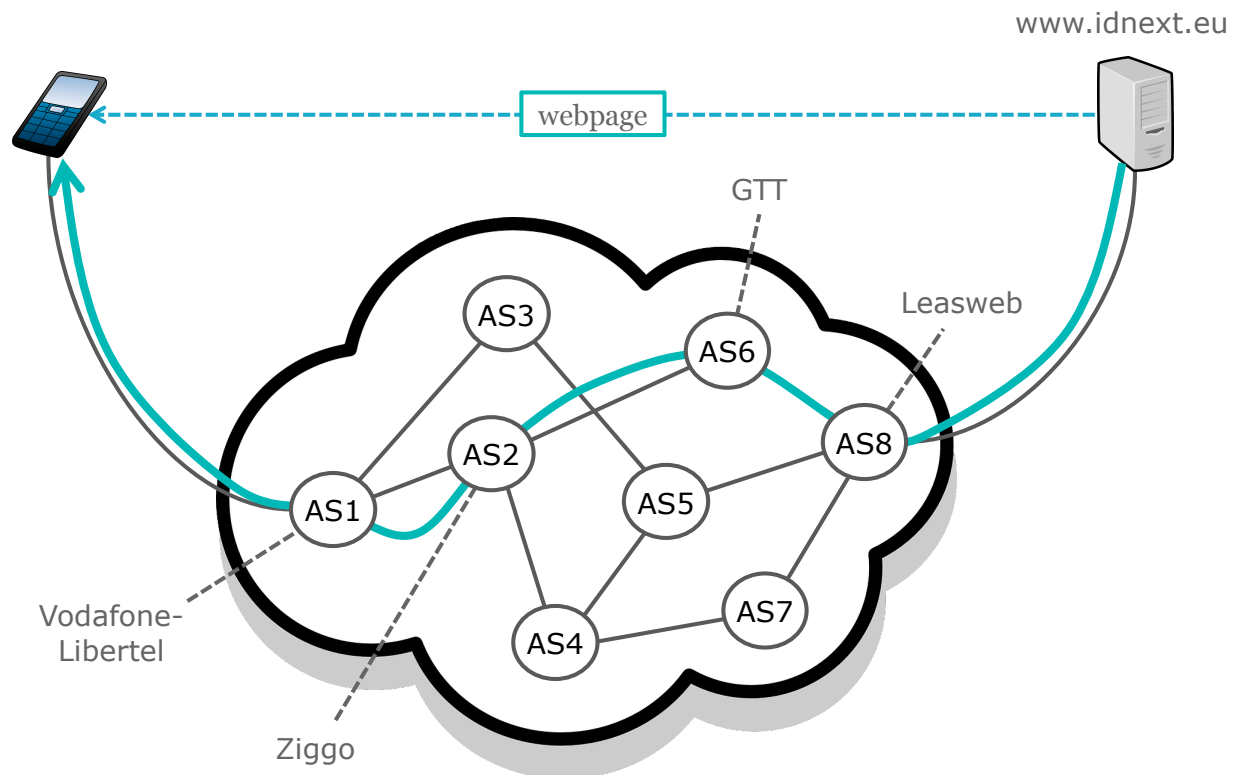
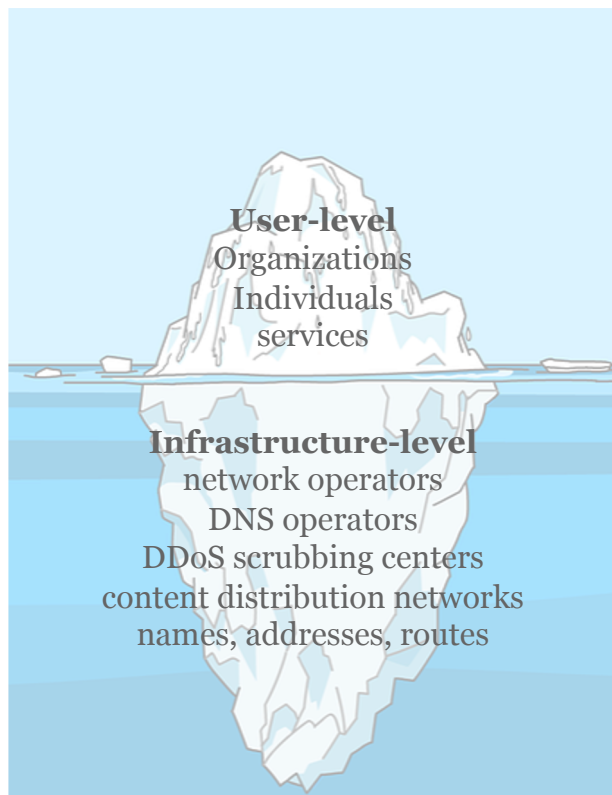
Increasing the trustworthiness of the Internet infrastructure

Cristian Hesselman, SIDN Labs

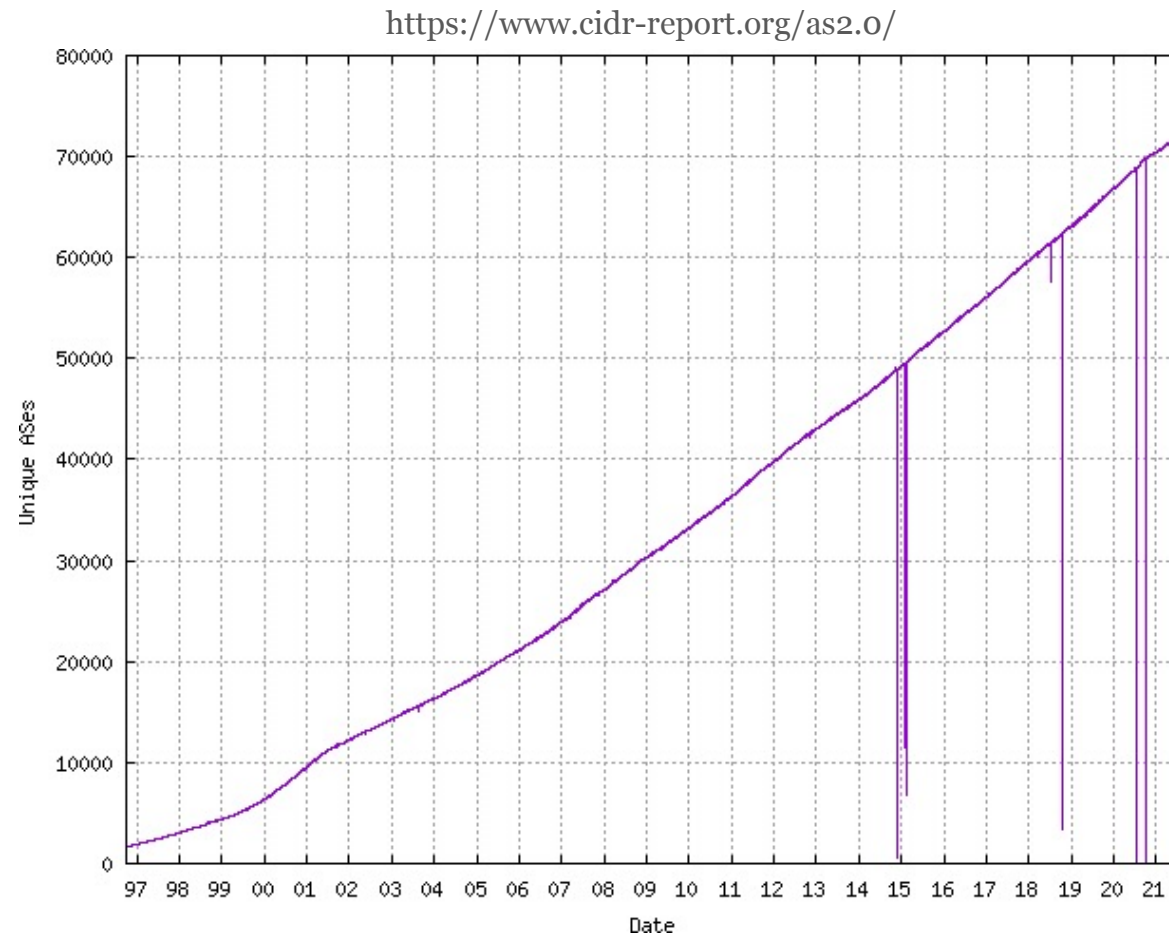
IDnext, October 12, 2021



High-level operation of the Internet



The Internet's spectacular growth

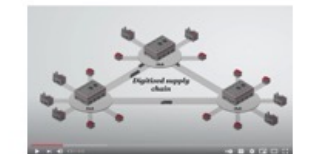


Problem: declining digital autonomy of societies

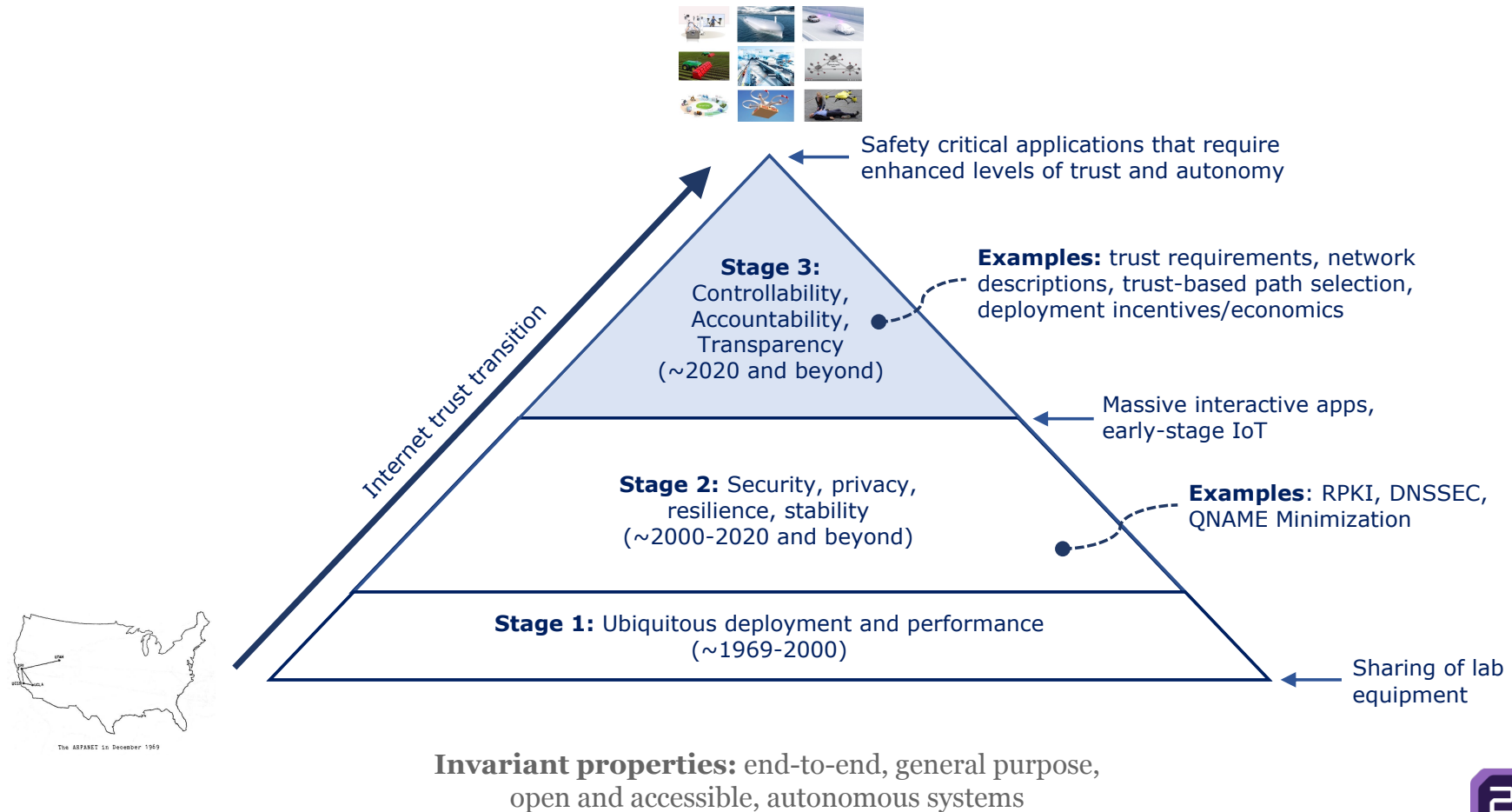
- Increasing **dependency** on digital services, but **limited insight in and control over** the nature of these dependencies and the underlying mesh of systems and operators (black box)
- Concerns about **integrity** of digital systems because of (alleged) vulnerabilities
 - Eavesdropping, remotely disrupting or destroying systems and data, amongst others
 - No control => potential huge societal impact (e.g., smart grids, robots, 5G networks, ICSs)
- Concerns about **dominance** of a few large and economically very powerful companies
 - Disproportional power (knowledge, data, technologies), different jurisdictions
 - No control => limits societies in determining their own direction, SPoFs
- **Reduces trust** in the foundations of our digital society

Network-level problem: no data autonomy “in transit”

- Relying parties have no insight in nor control over the Internet’s end-to-end structure and operation, cannot sufficiently assess if they trust the network
- What network operators transport my data? How secure are their routers? I only want to use security-audited networks!
- Similar problems in complementary areas of Artificial Intelligence (data in use) and cloud services (data at rest)

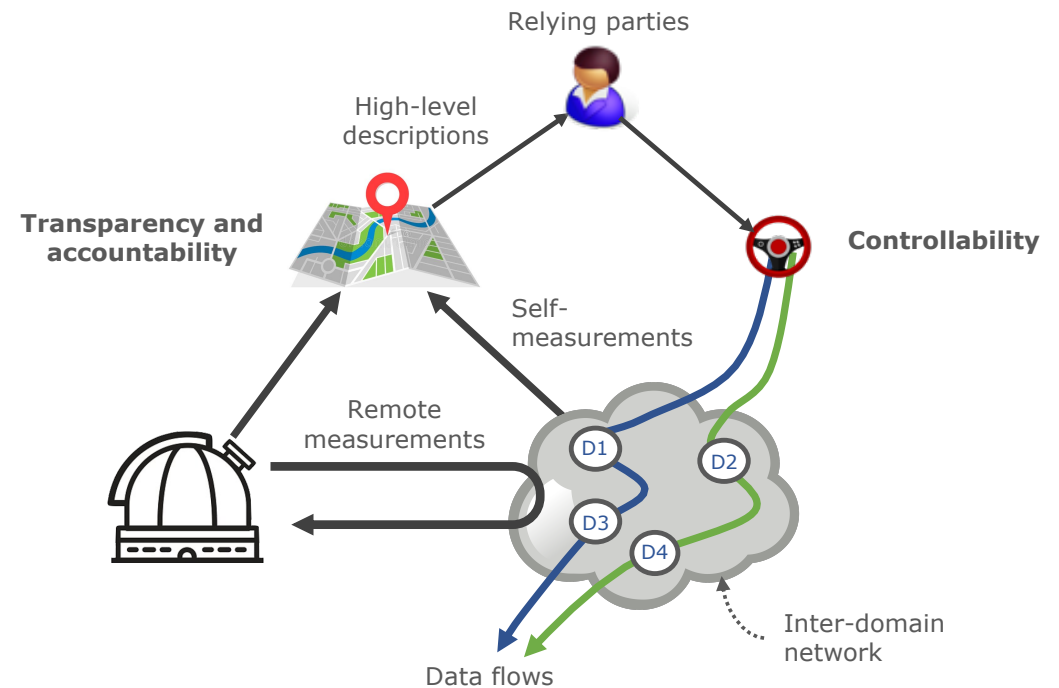


Our vision: we need a new communication paradigm



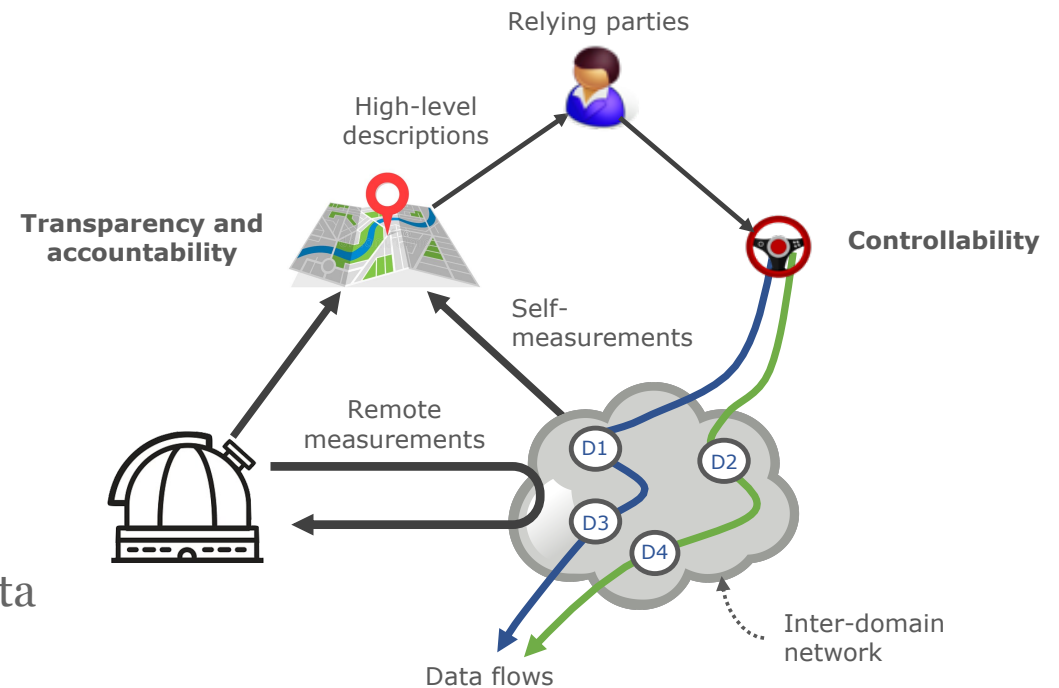
Our proposal: the Responsible Internet

- Addresses lack of insight in and control over Internet's end-to-end structure and operation
- Adds CAT to Internet's original 7 design goals
 - Control over network paths and properties
 - Evidence of operational behavior
 - Insight into Internet structure and operation
- Enables relying parties to communicate with more confidence and trust than today



Added value for various types of relying parties

- Critical service providers: send traffic through chains of networks they consider secure enough
- Policy bodies: more data-driven and proactive policy making, mediation and enforcement
- Network operators: handle large-scale security incidents more proactively
- Citizens: more insight and control over their data (cf. Zoom Data Routing)



How to make the Responsible Internet a reality?

Building block	Examples of mechanisms
Controllability	<ul style="list-style-type: none">• Virtual Network Functions (VNFs)• Open programmable networks (e.g., using P4)• Network technologies (e.g., SCION or segment routing)
Accountability	<ul style="list-style-type: none">• Distributed logging (cf. certificate logs)• Trust roots (cf. RPKI)• Cross-measurements from multiple vantage points
Transparency	<ul style="list-style-type: none">• Network description languages (e.g., NDL)• Active measurements (e.g., OpenINTEL)• Self-descriptions (cf. GAIA-X and “cybersecurity labels”)
Incentives	<ul style="list-style-type: none">• Pilots and lessons learned with “vertical” use cases• New CAT-based applications and business models• Insight in investments and operational costs
Policy	<ul style="list-style-type: none">• Standardized CAT levels• Policy models (voluntarily, regulated, (inter)national)• Policy body (cf. MANRS or ICANN)

Approach: showing-by-doing research projects



- CATRIN (€1.9M): build small-scale multi-operator testbed and ecosystem around it

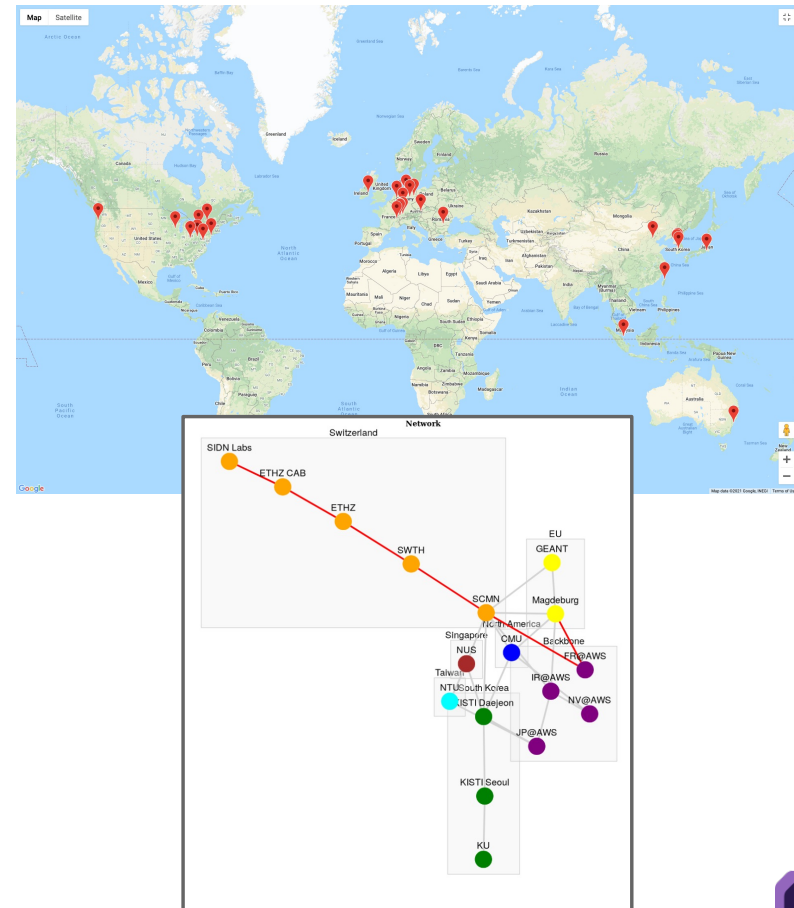
Additional partners:



- UPIN (€514K): user-driven path verification and control for inter-domain networks
- INTERSECT (€250K): how to make IoT deployments more transparent and controllable?
- A total of 10 Ph.D. students plus ~20 researchers of ~15 partners, industry and academia
- Hands-on work based on testbeds, experiments, and “vertical” use cases



Examples of testbeds: 2STiC P4 network and SCIONlab



Summary

- Huge undertaking, but essential (and perhaps radical) improvements urgently needed
- The Responsible Internet is a possible way forward to add CAT properties
- Aligns with similar developments in AI and cloud (GAIA-X)
- In addition to “going concern” of increasing Internet security
- Very much a multidisciplinary effort (technical, business, governance)!
- Interested in talking to folks who see opportunities for use cases or have other feedback

Further reading

Original paper (concept and research agenda):

C. Hesselman, P. Grosso, R. Holz, F. Kuipers, J. Hui Xue, M. Jonker, J. de Ruiter, A. Sperotto, R. van Rijswijk-Deij, G. C. M. Moura, A. Pras, and C. de Laat, “A Responsible Internet to Increase Trust in the Digital World”, Invited paper, Journal of Network and Systems Management (JNSM), special issue on “Future of Network and Service Operations and Management: Trends, Developments, and Directions”, October 2020, <https://link.springer.com/article/10.1007/s10922-020-09564-7>

Blogs (summaries of the paper and further discussion):

<https://www.sidnlabs.nl/en/news-and-blogs/three-more-things-you-need-to-know-about-the-responsible-internet>

<https://www.sidnlabs.nl/en/news-and-blogs/a-responsible-internet-increasing-trust-in-the-foundation-of-digital-societies>

<https://www.sidnlabs.nl/en/news-and-blogs/a-practical-demo-of-scion-a-new-internet-architecture>

<https://www.sidnlabs.nl/en/news-and-blogs/future-internet-at-terabit-speeds-scion-in-p4>

<https://decorrespondent.nl/12785/ligt-whatsapp-je-telefoonnetwerk-of-het-internet-plat-dat-komt-maar-zelden-door-hackers/19324311638060-d80of990> (in Dutch)

Questions and discussion

Acknowledgements:

This work is part of the 2STiC research program (Security, Stability and Transparency for inter-network Communications). Website: <https://www.2stic.nl/>
SIDN and the University of Twente were partly funded by the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement No 830927. Project website: <https://www.concordia-h2020.eu/>
University of Amsterdam was funded by the Dutch Science Foundation in the Commit2Data program (grant no: 628.001.001). Project website: <https://dl4ld.nl/>
The projects CATRIN, UPIN, and INTERSECT received funding from the Dutch Research Council (NWO). Project websites: www.catrin.nl, www.upin-project.nl, www.intersct.nl

