



FACULTY OF  
COMPUTER SCIENCE

## SCION Project Testbed Trials

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SCION



# SCION: A Secure Internet Architecture

- ❖ SCION: Scalability, Control, and Isolation on Next-Generation Networks
- ❖ SCION Design Goals
  - Availability in the presence of adversaries (e.g. DDoS)
  - Transparency and control over forwarding paths
  - Multipath forwarding
  - Efficiency, Scalability, and Extensibility
  - Incentives for deployment

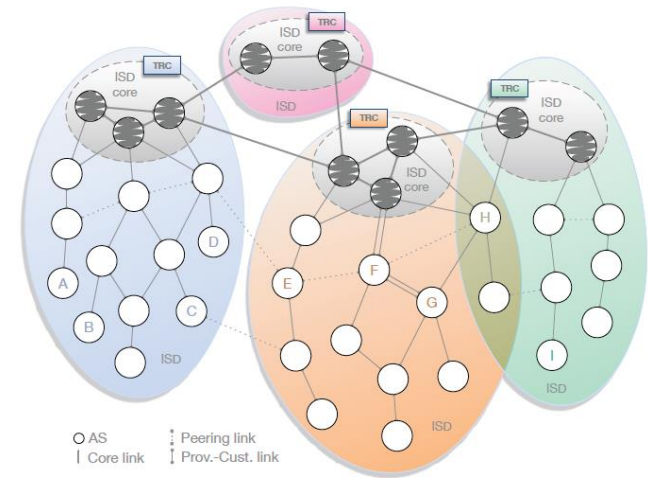


## Activities: APs, Presentations

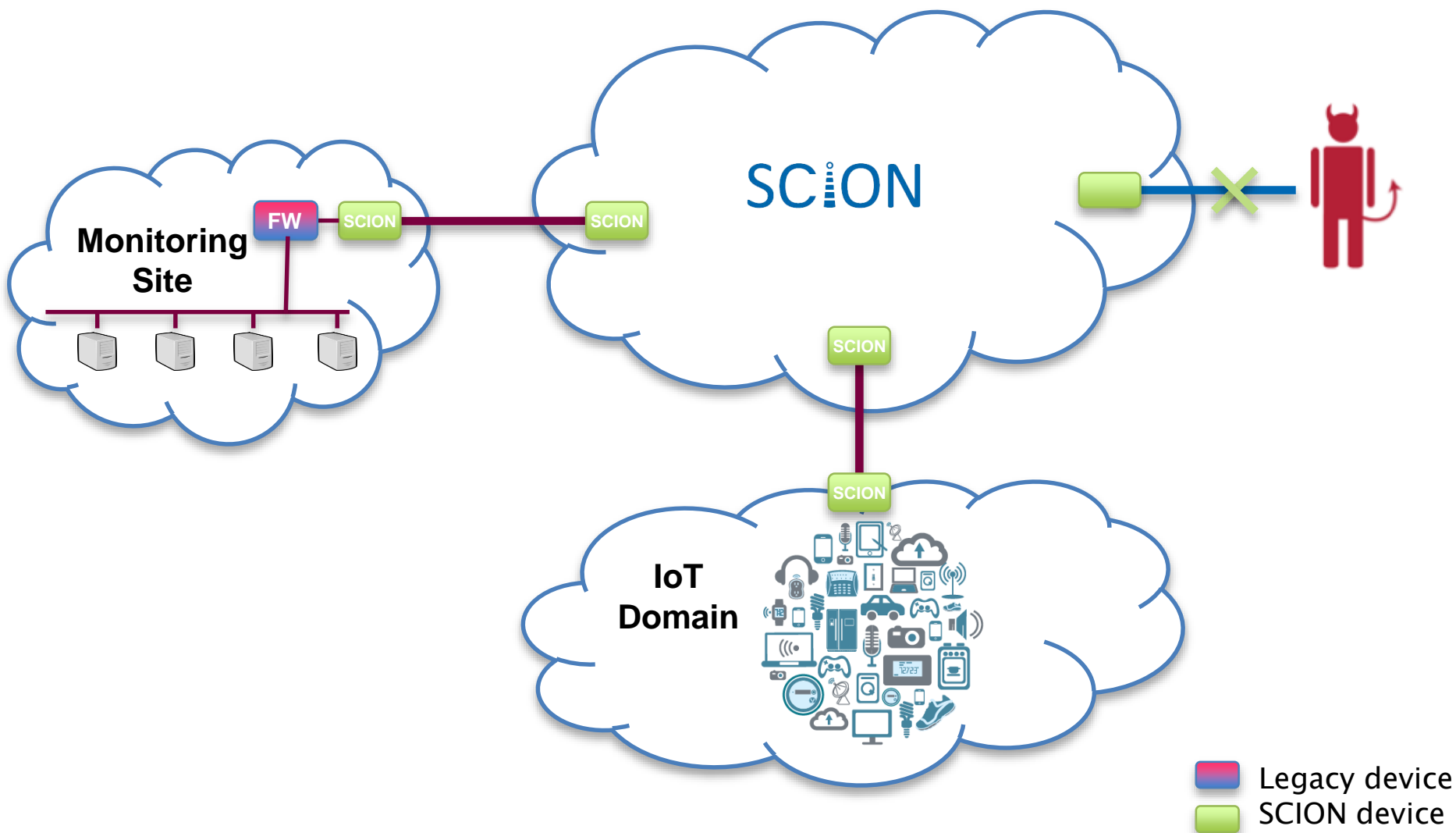
- ❖ 11th STF Meeting Zurich – June 2017 – SCION Concept (overall) – Presenter: Adrian Perrig
- ❖ GEANT Action Proposal – November 2017 – SCION Pilot Service – Submitted by Kurt Baumann
- ❖ 13th STF Meeting Berlin – Feb. 2018 – SCION Testbed Trial (and Whitepaper discussion) – Presenter: David Hausheer
- ❖ TNC2018 – June 2018 – SCIONLab: A Deployment of the Scion secure Infrastructure – Presenter: David Hausheer
- ❖ Fed4FIRE+ Experiment Proposal – Sept. 2018 – Deployment and Evaluation of the SCION Secure Internet Architecture on the GEANT GTS Testbed – Submitted by David Hausheer

# SCION as a Research Testbed

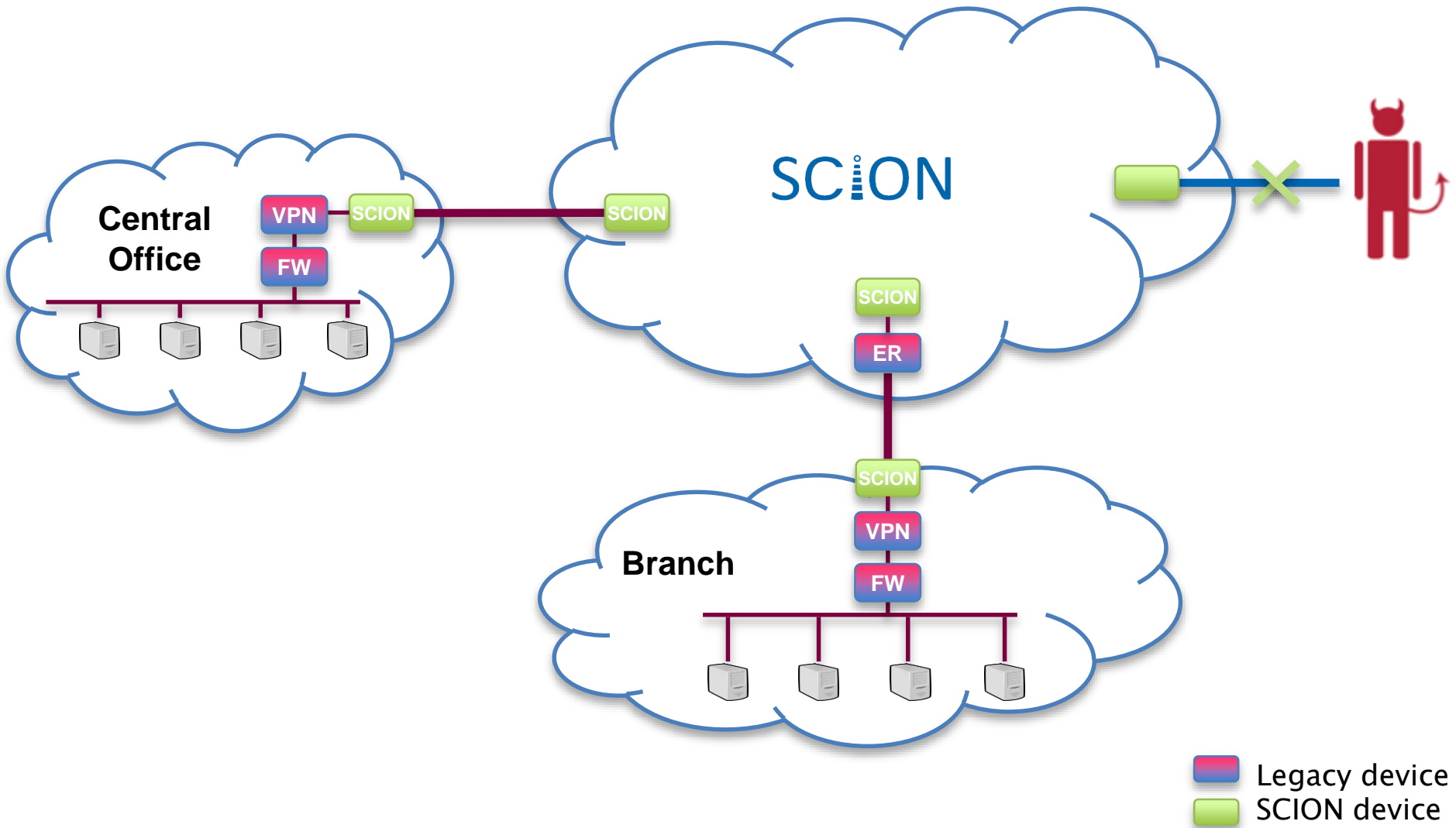
- ❖ SCION supports research activities in several areas, e.g.:
  - Multipath communication
  - Advanced and highly secure PKI systems
  - In-network DDoS defenses
  - Next-generation routing architecture
  - policy definitions
  - Path-aware applications
  - Path-based inter-domain routing architectures
  
- ❖ Those are difficult to evaluate on the current Internet!



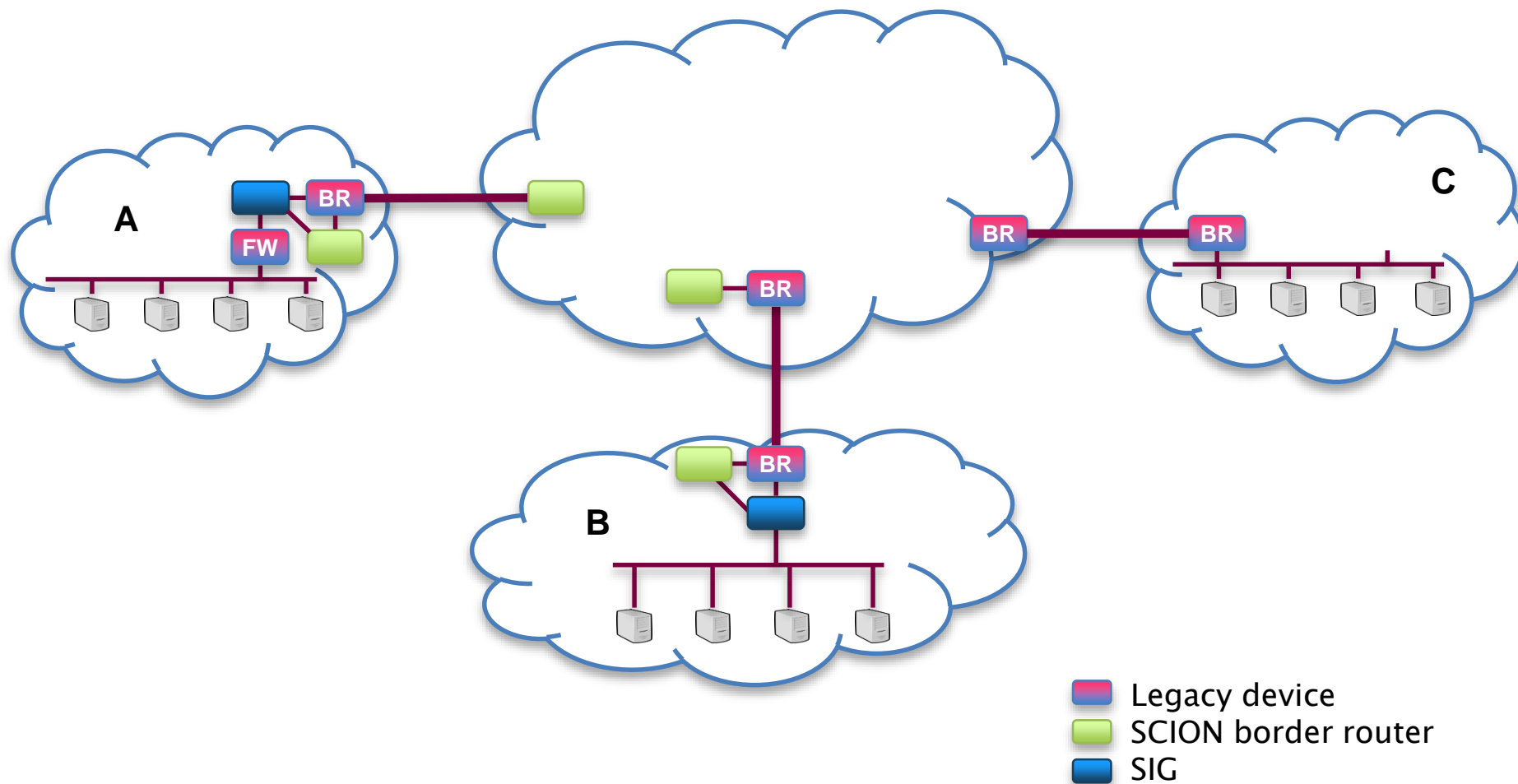
# Use Case: IoT Protection through Default Off



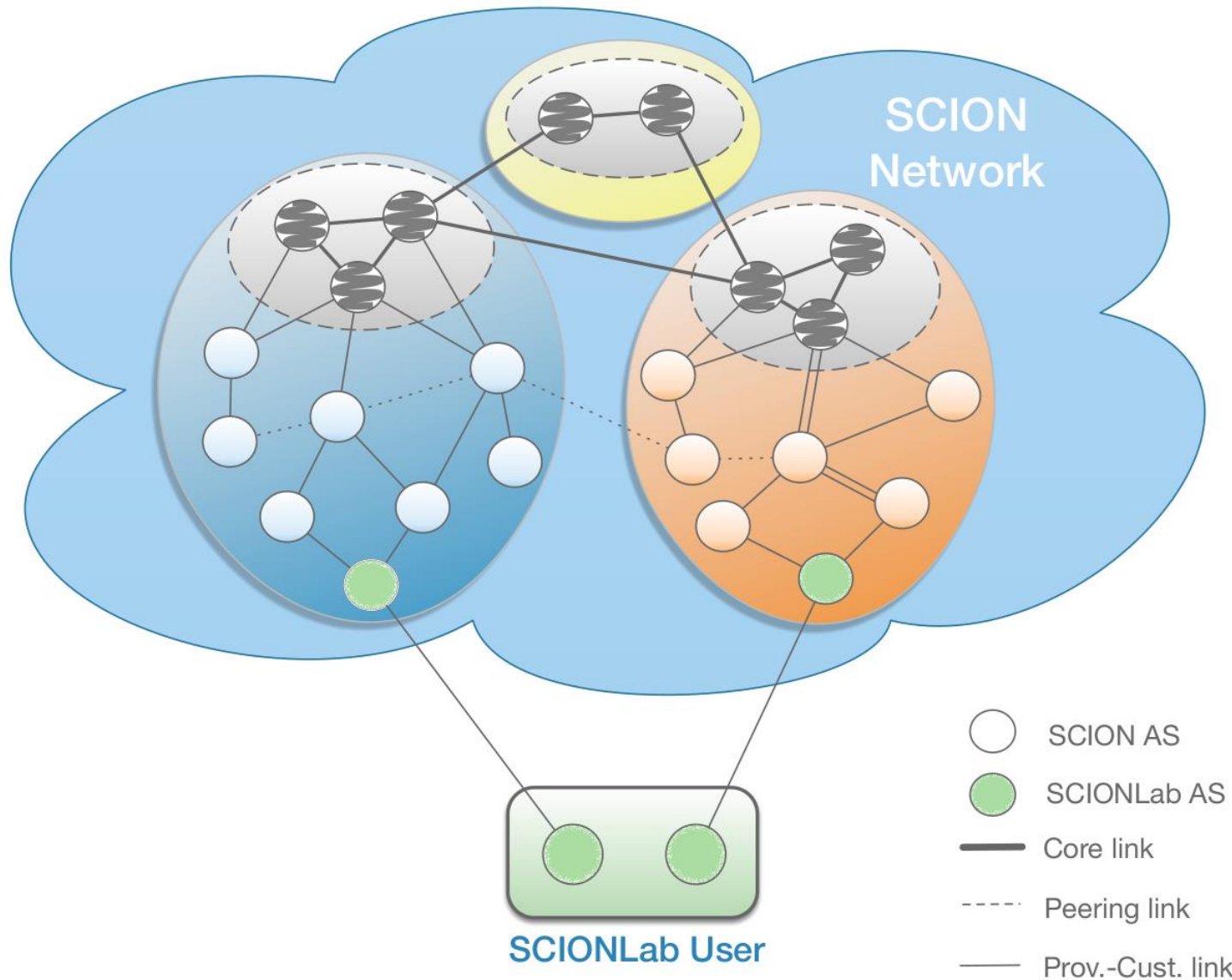
# Use Case: VPN-based Deployment



# SCION-IP Gateway (SIG) Deployment



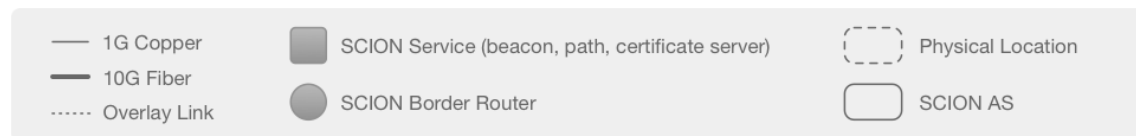
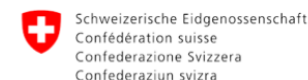
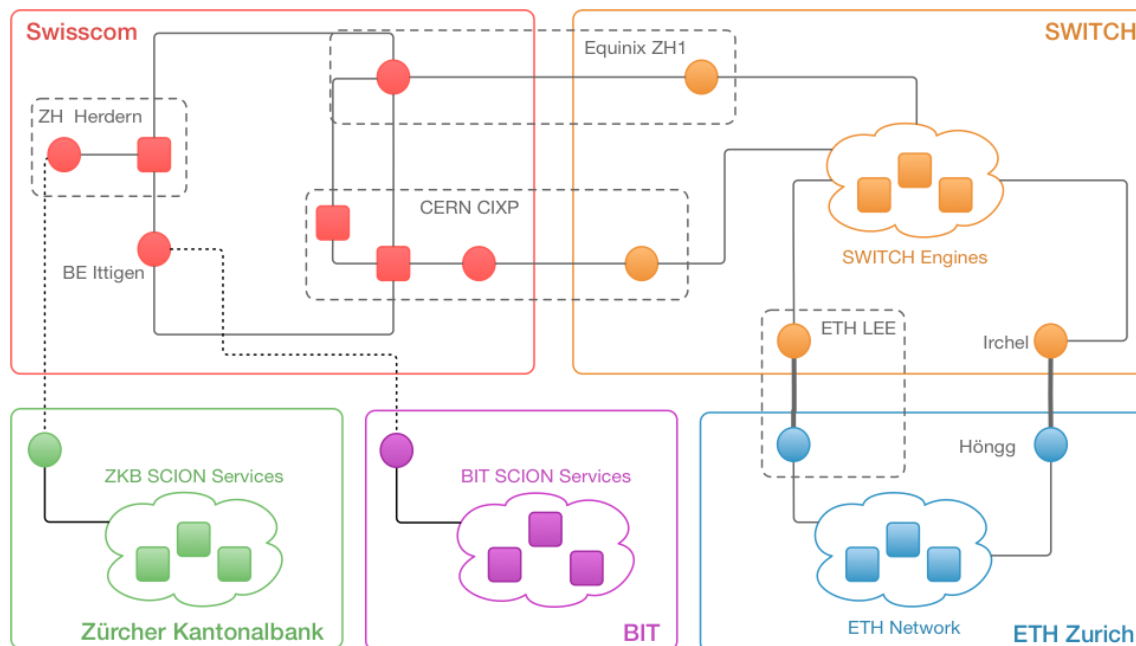
# SCIONLab



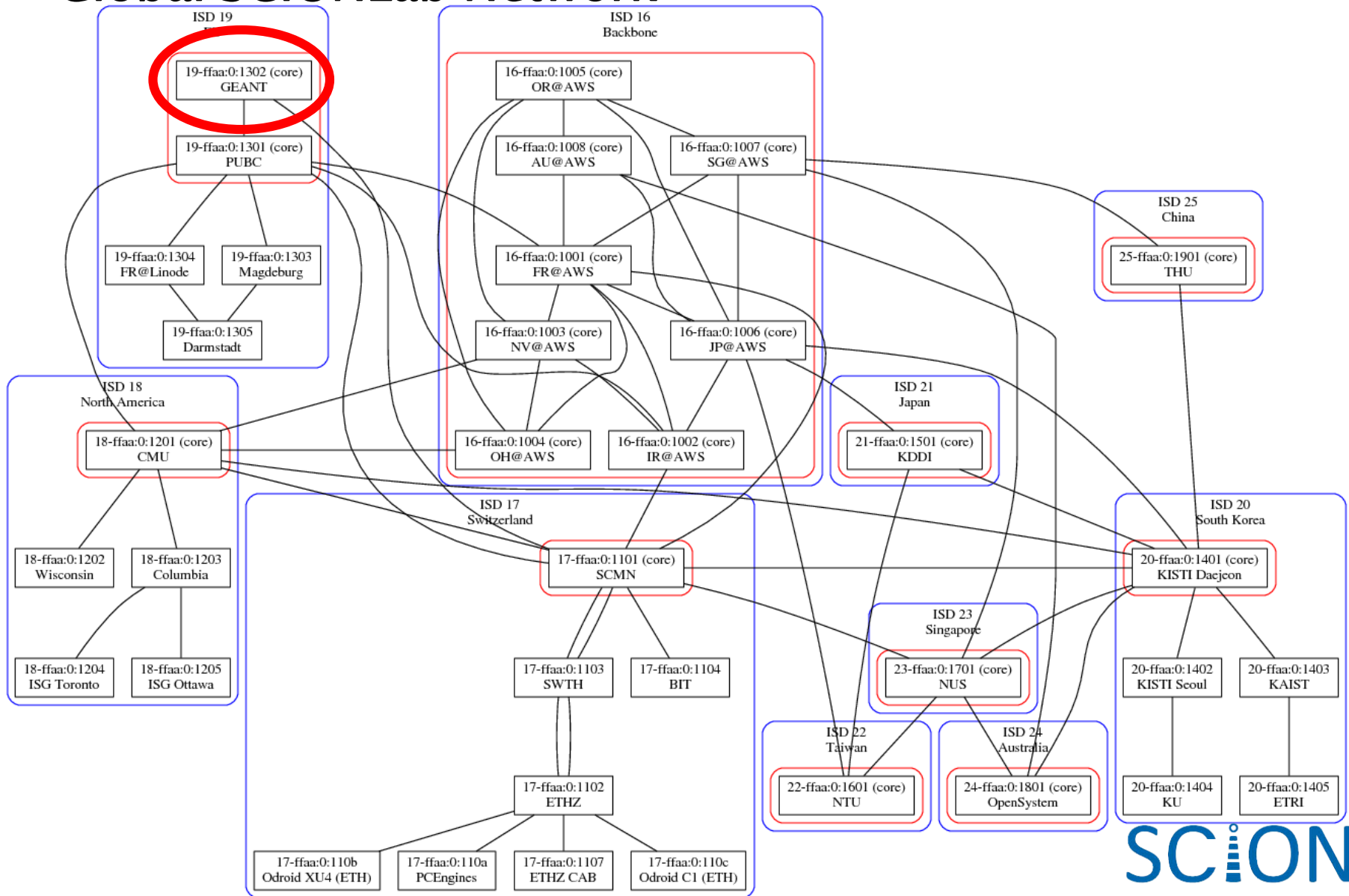


# Swiss SCIONLab Network

- ❖ SCION running in test environments at SWITCH, Swisscom, and ETH over the past 18 months



# Global SCIONLab Network



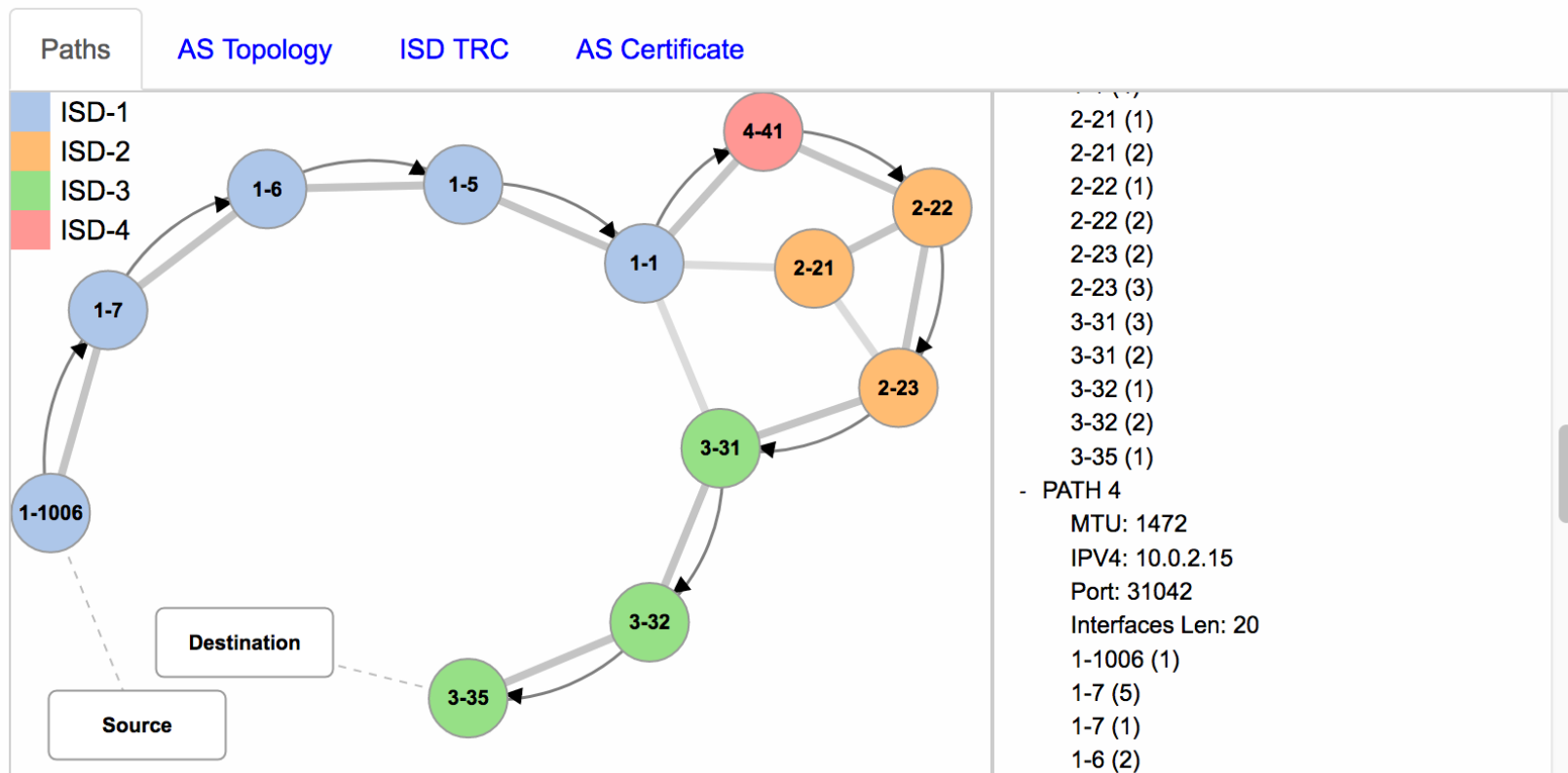
# SCIONLab Visualization

## SCION AS Visualization

- [SCION Website](#)
- [SCION on Github](#)
- [SCION Visualizations](#) on Github

Source AS:  Destination AS:  Data:

SCIOND IP Address:



# Bandwidth Tester

SCIONLab Go Tests - Mozilla Firefox

SCIONLab Go Tests

127.0.0.1:8080

SCIONLab Go Tests

This Go web server wraps several SCION test client apps and provides an interface for any text and/or image output received. [SCIONLab Apps](#) are on Github.

Browse File System

Client

bwtester camerapp sensorapp

Server

seconds  pkt size (b)  packets 1250 bw (mbps) 

IA: 1-11  
Host: 127.0.0.3  
Port: 30001

seconds  pkt size (b)  packets 12500 bw (mbps) 

IA: 1-12  
Host: 127.0.0.2  
Port: 30105

Execute SCION Client Reset Fields Additional Argument:

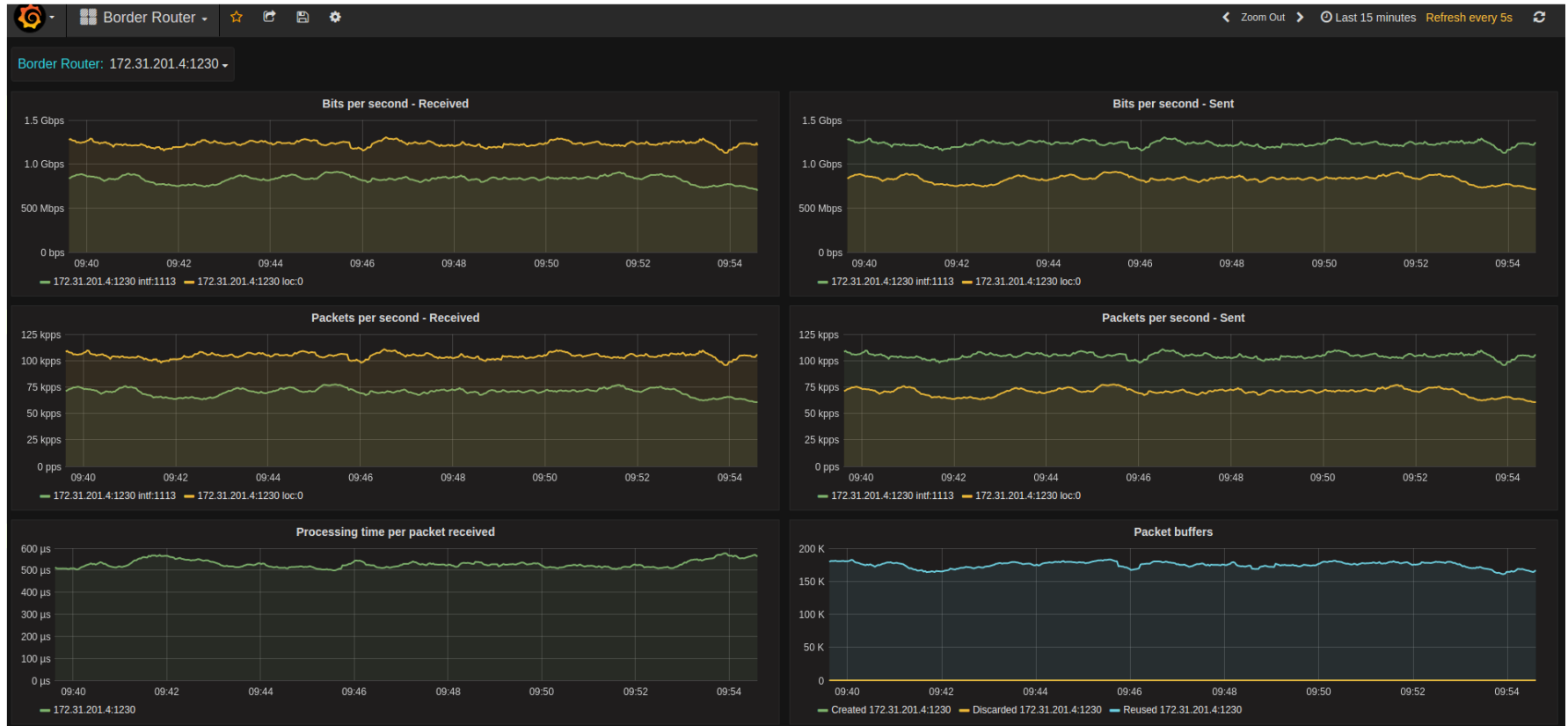
```
Interarrival time variance: 32ms, average interarrival time: 0ms
Interarrival time min: 0ms, interarrival time max: 32ms

C->S results
Attempted bandwidth: 1000000 bps / 1.00 Mbps
Achieved bandwidth: 1000000 bps / 1.00 Mbps
Loss rate: 0 %
Interarrival time variance: 35ms, average interarrival time: 8ms
Interarrival time min: 0ms, interarrival time max: 43ms
```

# IoT Camera

[illegible]

# AS Router Monitoring with Prometheus

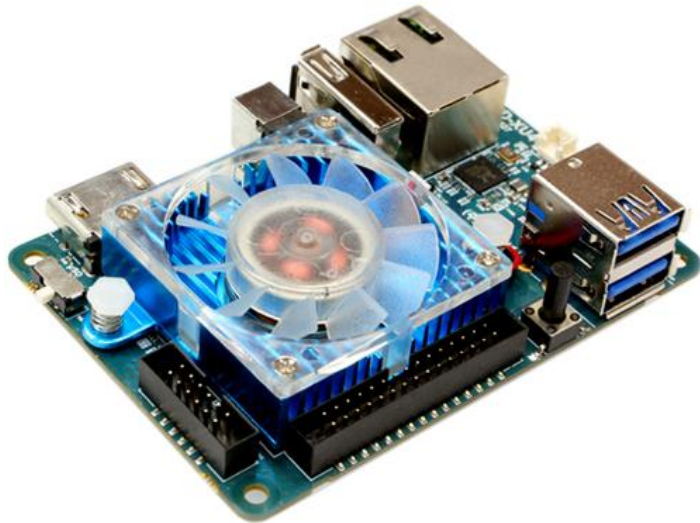




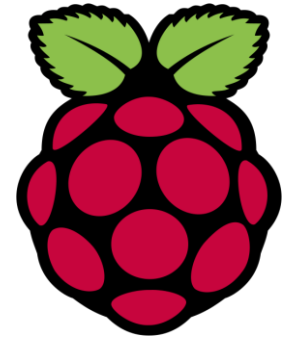
# SCION AS runs on Small Scale Devices

- ❖ SCION as a platform for smart home environments, IoT applications

**ODROID**  
Hardkernel



**Raspberry Pi**



# SCION Enhancements for Key Stakeholders

- ❖ SCION architecture provides opportunities for several parties:
  - **Researchers** so far needed to rely on simulations, e.g.:
    - Path-aware networking
    - DDoS defenses relying on inter-domain mechanisms
  - **End users** can benefit from several improvements:
    - Enhanced availability and reliability for applications
    - Increased bandwidth thanks to multi-path operation
    - Path optimization during a connection → increased bandwidth and/or decreased latency.
  - **NRENs**:
    - Better utilization of network resources through multi-path support
    - Potential cost-savings in leased-line connections
    - Lower management overhead (e.g., link access control and path selection done by end domain)
    - New types of route policy expressible
    - Path-aware networking offers many new opportunities



# SCION Pilot Service within GEANT

- ❖ SCION has matured
  - SCION prototype software in its 5th generation
  - Successful course assignment in a network security course over the prototype SCIONLab environment
- ❖ SCION is now ready for a large-scale pilot service deployment within GEANT
- ❖ SCION pilot service can contribute to several planned GEANT research activities:
  - **Next-Generation Internet (NGI)** activity
    - SCION provides a scalable and reliable platform for future Internet applications, e.g., IoT
  - **Security** activity

# Goals of the SCION Pilot Service

- ❖ Development of the SCIONLab pilot software environment
- ❖ Deployment of the SCIONLab infrastructure
- ❖ Providing a platform for NGI research
  - Enabling real-world research that is otherwise only possible in simulated environments
- ❖ Interaction with other deployed SCION networks and services
- ❖ SCIONLab enables a broad range of applications:
  - Nodes can contribute to the routing within the SCION topology
  - Researchers can attach their own computing resources anywhere within the SCIONLab network

# Planned SCION Pilot Activities

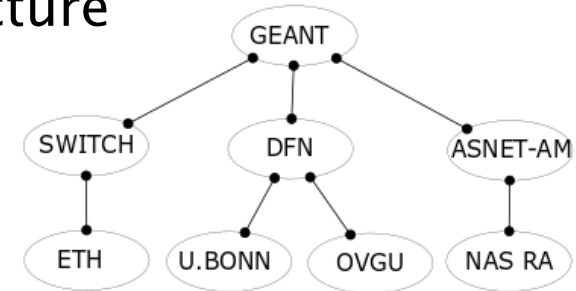
- ❖ Development activities:
  - Supporting extension of SCIONLab
  - SCIONLab resource monitoring and enforcement mechanisms
  - Tools to help writing SCIONLab applications
- ❖ Operations/support activities:
  - Purchase and management of SCIONLab nodes within GEANT, NRENs and associated universities → serving as attachment points for SCIONLab users and application developers
  - Study usability of the infrastructure for administrators and end users
- ❖ Potential target KPIs:
  - Ease-of-use for researchers
  - Network availability and performance (bandwidth and latency)
  - Supported features (PKI, DDoS defense mechanisms, path selection support, end host / application support)
  - Usability
  - Scalability in terms of network size and amount of usage

# Planned Roadmap: Year 1

## ❖ Building up the SCION pilot service infrastructure

### ❖ Pilot partners:

- (N)RENs: SWITCH, DFN, ASNET-AM
- GEANT
- Universities and research institutes: ETH, U. Bonn, U. Magdeburg, National Academy of Sciences of Armenia



### ❖ Initial deployment:

- 15 SCION nodes across 3 GEANT PoPs and at the universities
  - Border router network for SCION pilot backbone → use of GEANT GTS
  - Routers only needed at interconnection points with other SCION networks
  - Internally: standard communication infrastructure used for SCION traffic

### ❖ Key milestones after Year 1:

- Support of SCION pilot service users through SCIONLab
- Path-aware networking and hidden paths for secure IoT operation
- Basic resource allocation system and control-plane PKI in place for SCIONLab users

# Planned Roadmap: Year 2 & 3

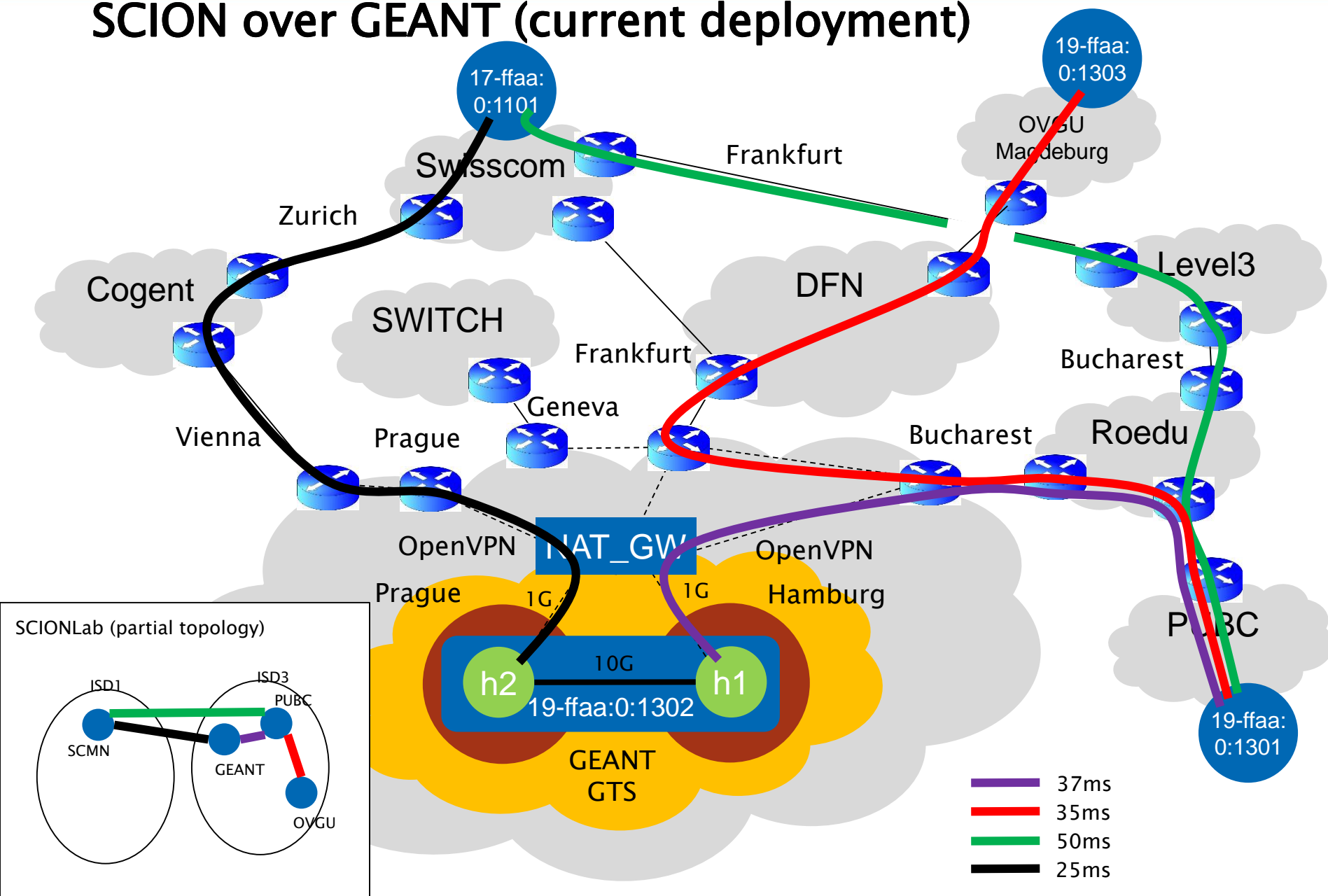
## ❖ Year 2:

- Multi-path research, delivery of a multi-path QUIC socket that applications can use
- Accurate resource monitoring throughout SCIONLab
- End-to-end PKI system that application developers can rely on to build highly secure TLS applications

## ❖ Year 3:

- SIBRA inter-domain resource allocation system → strong DDoS defense mechanism.
- Resource monitoring and policing → enables detection and mitigation of users that exceed their allocated resources
- Improve easy-to-use control- and end-to-end PKI systems

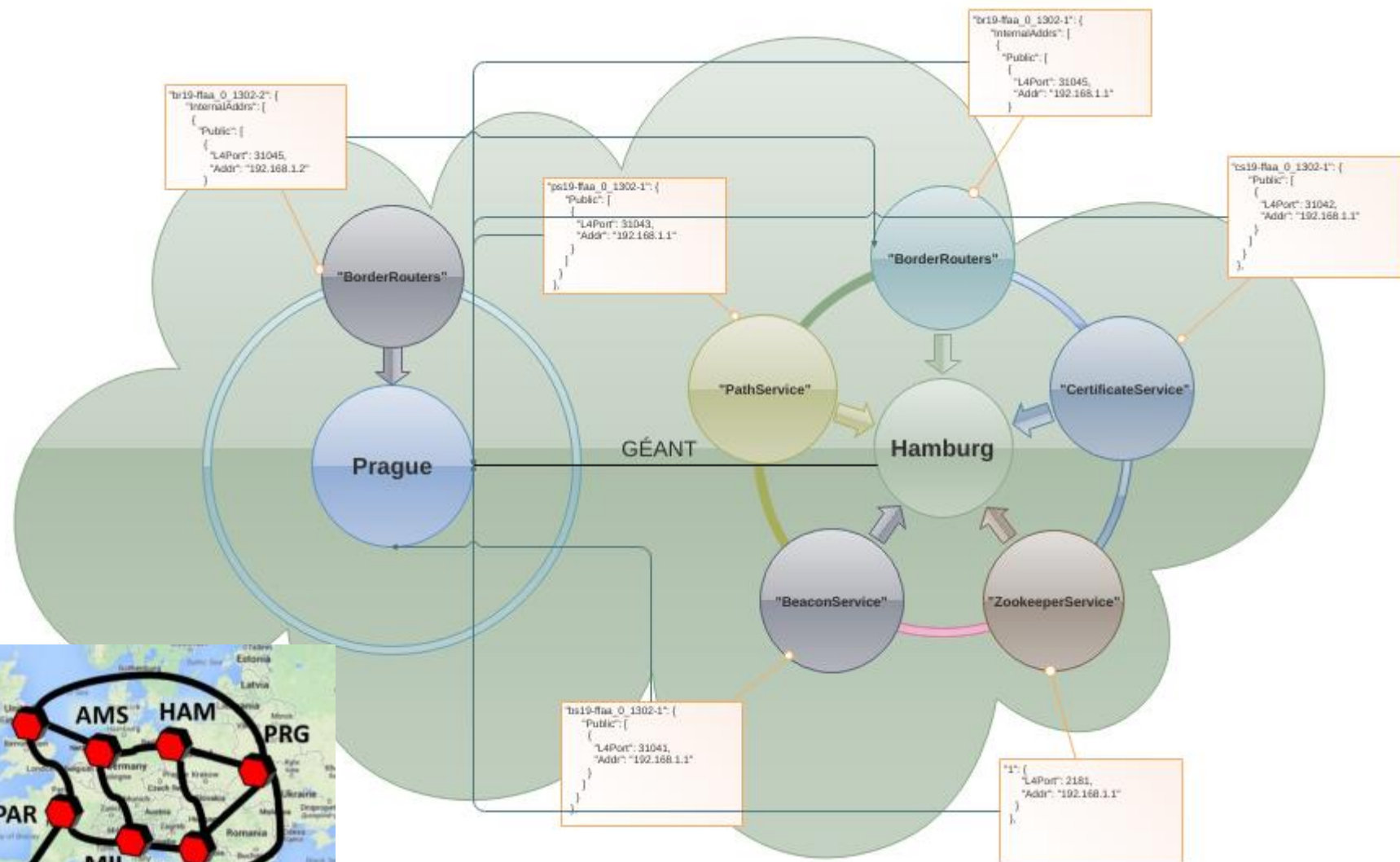
# SCION over GEANT (current deployment)



# Deployment of SCION over GEANT

- ❖ Step 0: Instantiate GEANT GTS testbed for SCION (currently two hosts) and upgrade hosts to Ubuntu 16.04
- ❖ Step 1: Download and execute SCION installation script on GTS nodes
- ❖ Step 2: Establish OpenVPN connections across GTS NAT gateway
- ❖ Step 3: Generate configuration from SCIONLab according to the own AS.
- ❖ Step 4: Configuration of the services in the “gen”-folder in order to communicate correctly with the other SCION ASs and ISDs.

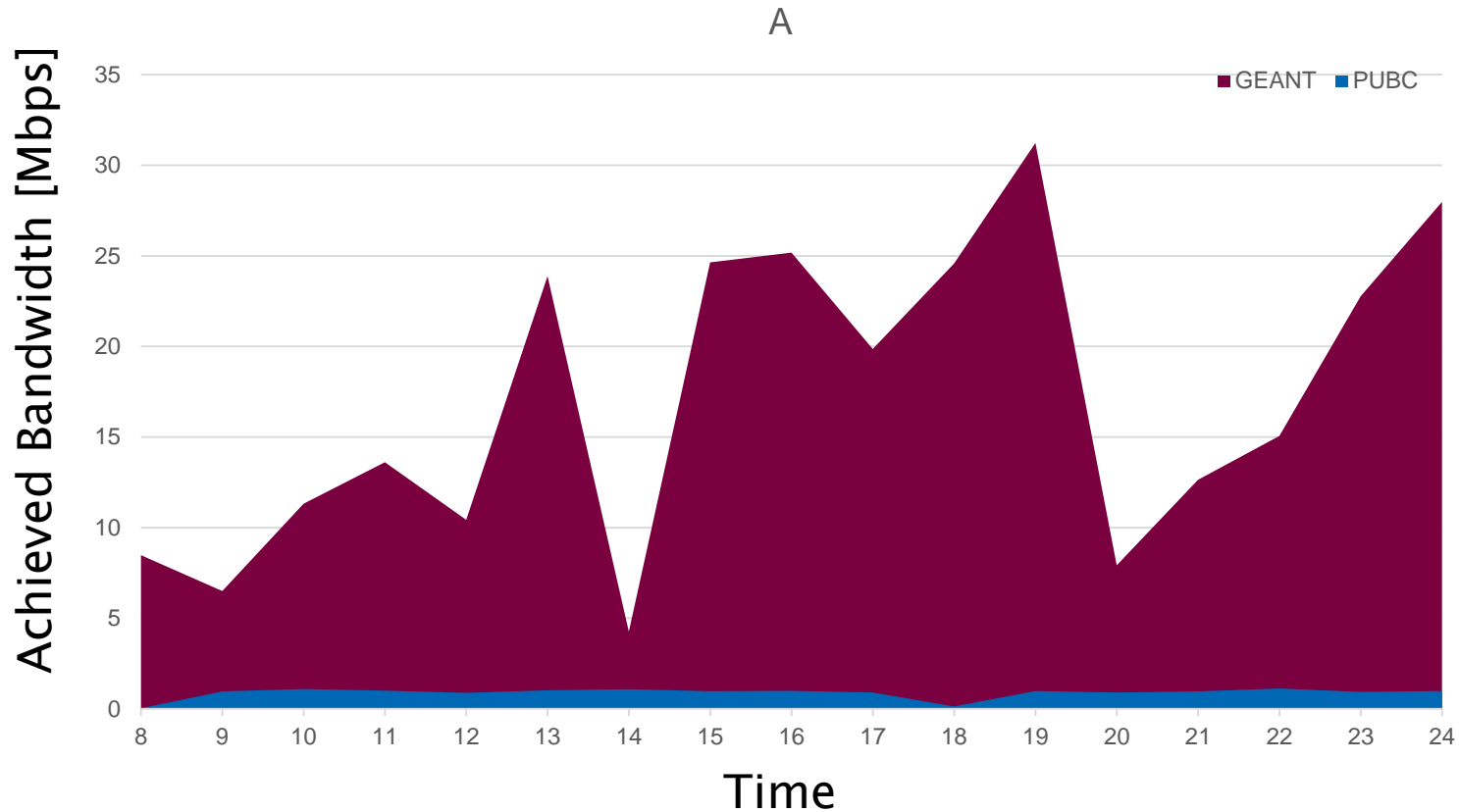
# SCION over GEANT (current deployment)





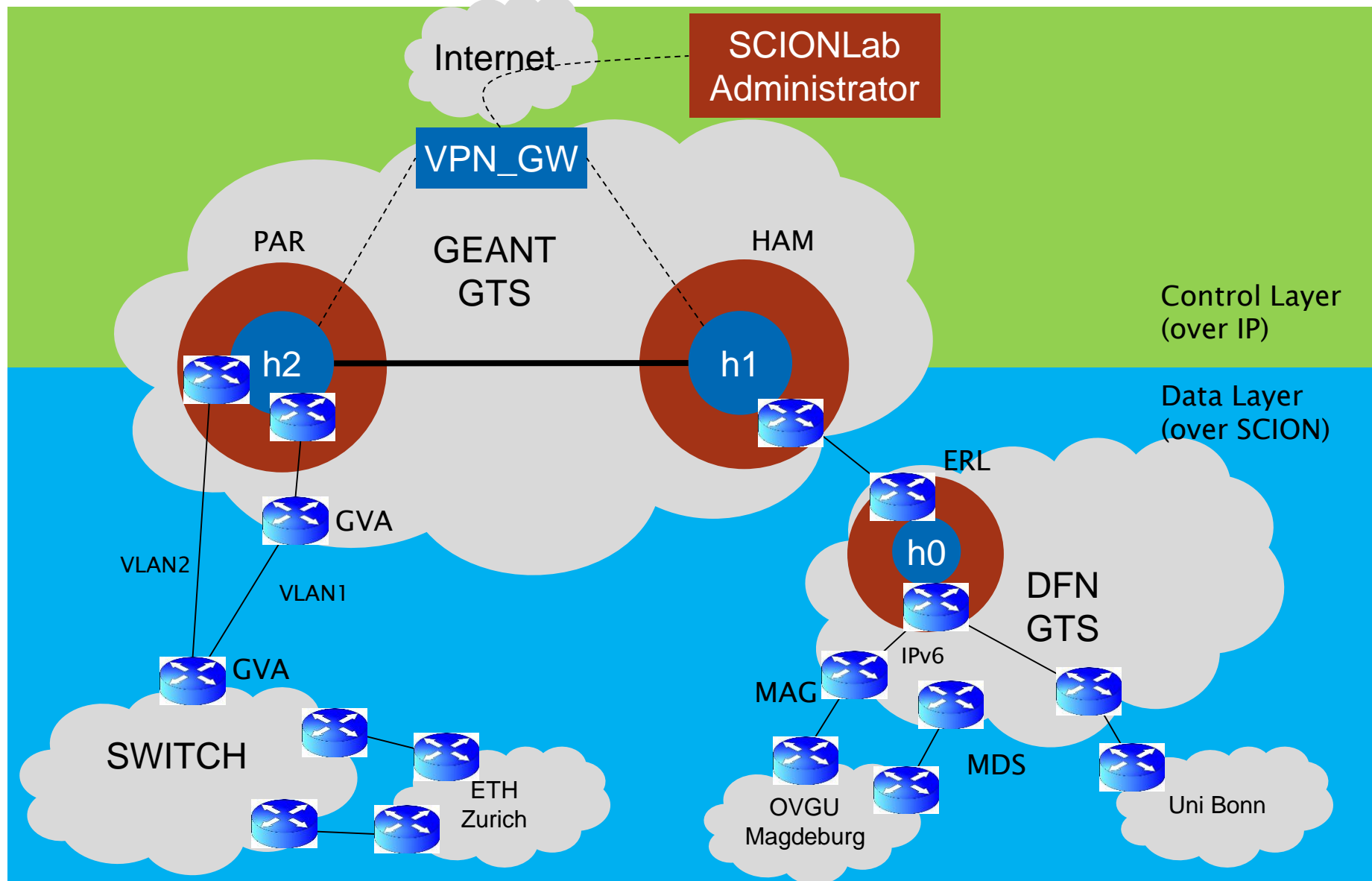
# Bandwidth Test (current deployment)

- ❖ Comparison of GEANT vs non-GEANT paths in SCION



- ❖ On average 20 times higher bandwidth over GEANT

# SCION over GEANT (targeted “native” deployment)



## “Wish List” for potential GEANT GTS Evolution

- ❖ Possibility to install own VM image to avoid tricky replacement
- ❖ Improve ssh access to nodes (e.g. via VPN)
  - Web-based VNC console fairly limited and buggy
- ❖ Global IP(v6) addresses to reach GTS nodes from outside via data layer instead of NAT gateway
- ❖ Automated establishment of external domain connections
- ❖ Possibility to modify (extend/reconfigure) an existing testbed
- ❖ Allow multiple network links to BMS nodes
- ❖ Avoid long maintenance periods
- ❖ Avoid to release projects for deployment of new GTS versions

# Trial Extension

- ❖ SCION pilot service may be extended to further NRENs
- ❖ Requirements:
  - NREN should be interconnected with GEANT
    - Ideally enabling a "native" SCION connection
  - NREN should be willing to contribute
    - Minimum: deploy, housing the nodes
    - For each NREN at least 3x SCION nodes are required
  - Ideally, have customer organizations (associated universities, research labs, etc.) who are willing to deploy a SCION network

# Conclusions

- ❖ SCION is a secure Internet architecture that has matured and is now ready for a large-scale pilot service deployment!
  - SCION prototype software in its 5th generation
  - Running in test environments at SWITCH, Swisscom, and ETH over the past 18 months
  - Running prototype SCIONLab environment
  
- ❖ Numerous benefits for researchers, end users, and NRENs:
  - **Researchers:** Path-aware networking, multipath routing architecture, in-network DDoS defenses
  - **End users:** Enhanced availability and reliability, increased bandwidth, decreased latency, dynamic path optimization
  - **NRENs:** Better utilization of network resources, cost-savings in leased-line connections

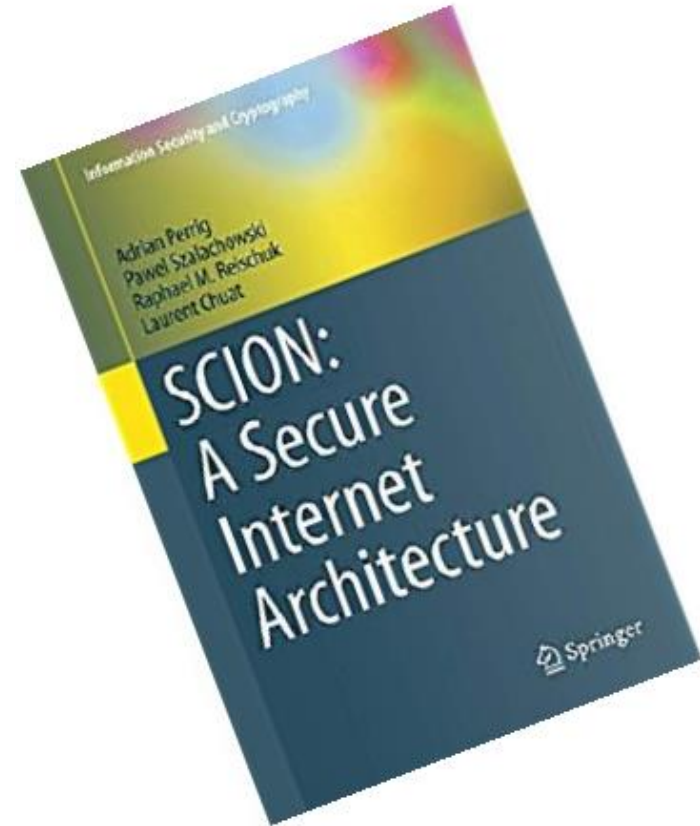


# SCION Project Team



## Further Information

- ❖ <https://www.scion-architecture.net>
  - Book
  - Papers
  - Videos
  - Tutorials
  - Newsletter signup
- ❖ <https://www.anapaya.net>
  - Commercializing SCION equipment
- ❖ <https://github.com/scionproto/scion>
  - Source code
- ❖ <https://www.scionlab.org>
  - SCIONLab Administration Software



# Thank you for your attention! Questions?

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