State of SCION

Adrian Perrig

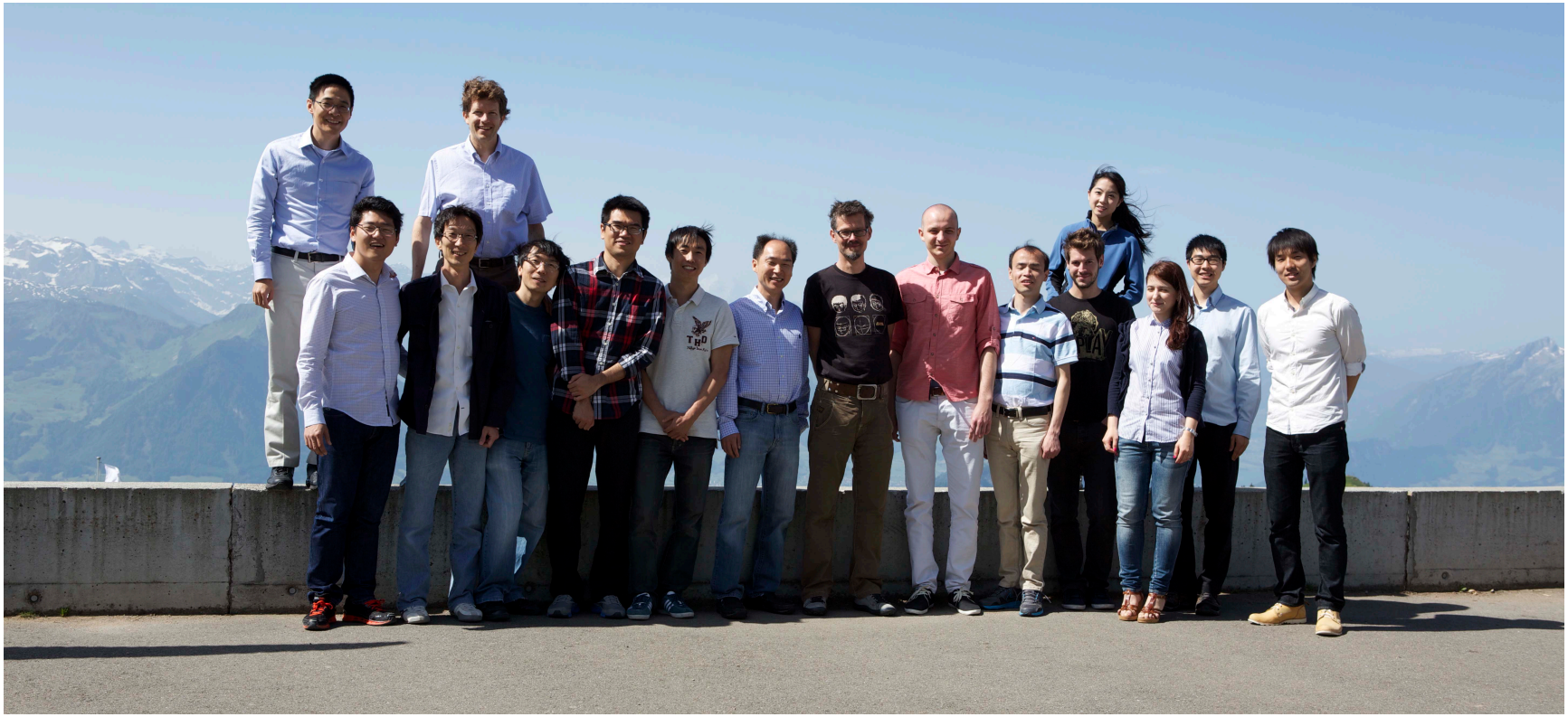
Network Security Group, ETH Zürich

SCION Day 2019

ETH zürich

SCION

Rigi Workshop 2013

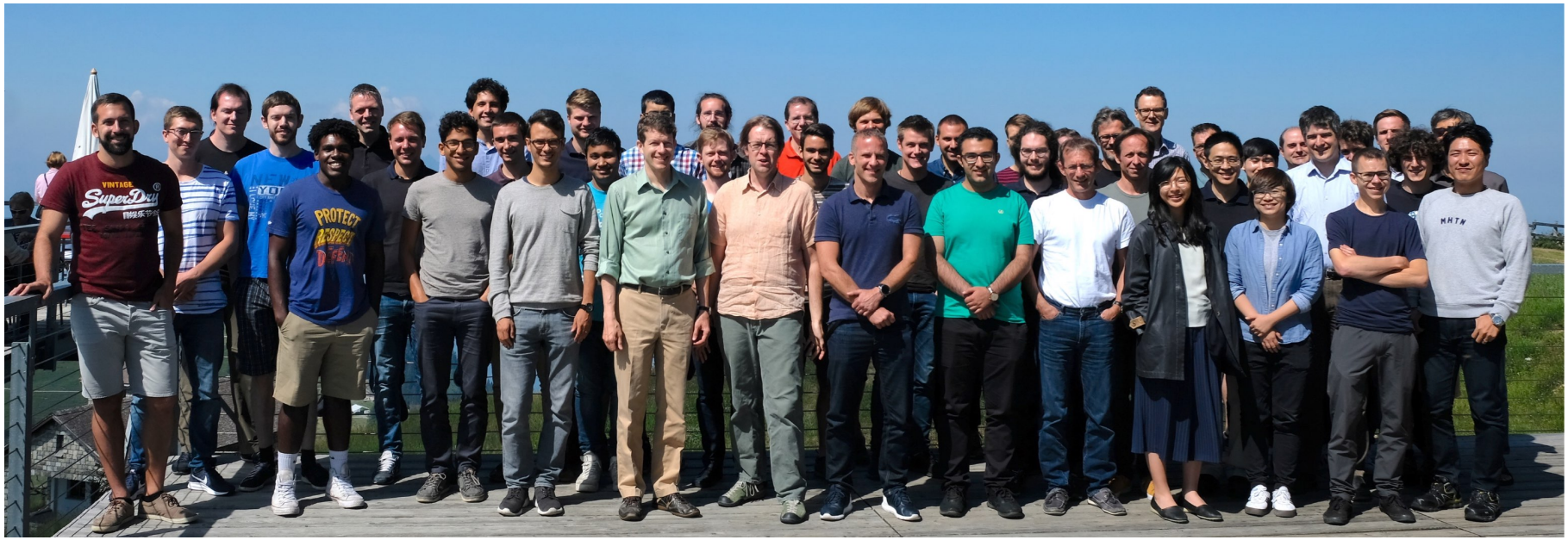


ETH zürich

SCION

Rigi Workshop 2018

- Netsec: Laurent Chuat, Sergiu Costea, Piet De Vaere, Sam Hitz, Mike Farb, Matthias Frei, Giacomo Giuliari, Cyrill Krähenbühl, Jonghoon Kwon, Juan Pardo, Adrian Perrig, Benjamin Rothenberger, Simon Scherrer, Stephen Shirley, Jean-Pierre Smith, Joel Wanner, François Wirtz
- Infsec: David Basin, Tobias Klenze, Sergio Monroy, Ralf Sasse, Christoph Sprenger
- Programming Methodology: Marco Eilers, Martin Clochard, Felix Wolf, Peter Müller
- Korea University: Heejo Lee, KU Leuven: Nele Mentens, Uni Magdeburg: David Hausheer, UIUC: Yih-Chun Hu, National Taiwan University: Hsu-Chun Hsiao, Singapore Management Univ: Xuhua Ding



Internet Architecture in 21st Century

- Similar to real-world architecture, Internet Architectural trends change over time, typically not just driven by aesthetics, but also by applications
  - Early networks were circuit-switched for telephony
  - 50 years ago, packet switching started and formed the basis of today's Internet
- Recent architectural trends
  - Path-aware networking
  - High security and availability






“Self-evident” Properties of a Next-Generation Internet Architecture

- Security (broadly defined)
  - High availability even under attack
- Path awareness, path selection
- Multi-path operation
- Formal verification
- Transparency
- Sovereignty

Importance of Path Awareness & Multi-path

- Generally, two paths exist between Europe and Southeast Asia
  - High latency, high bandwidth: Western route through US, ~450ms RTT
  - Low latency, low bandwidth: Eastern route through Suez canal, ~250ms RTT
- BGP is a “money routing protocol”, traffic follows cheapest path, typically highest bandwidth path
- Depending on application, either path is preferred
- With SCION, both paths can be offered!

SCION Architecture Principles

- Near-stateless packet forwarding
- Convergence-free routing
- Path-aware networking
- Multi-path communication
- High security through design and formal verification
- Sovereignty and transparency

Vision: secure, available, and transparent global public Internet

ETH zürich

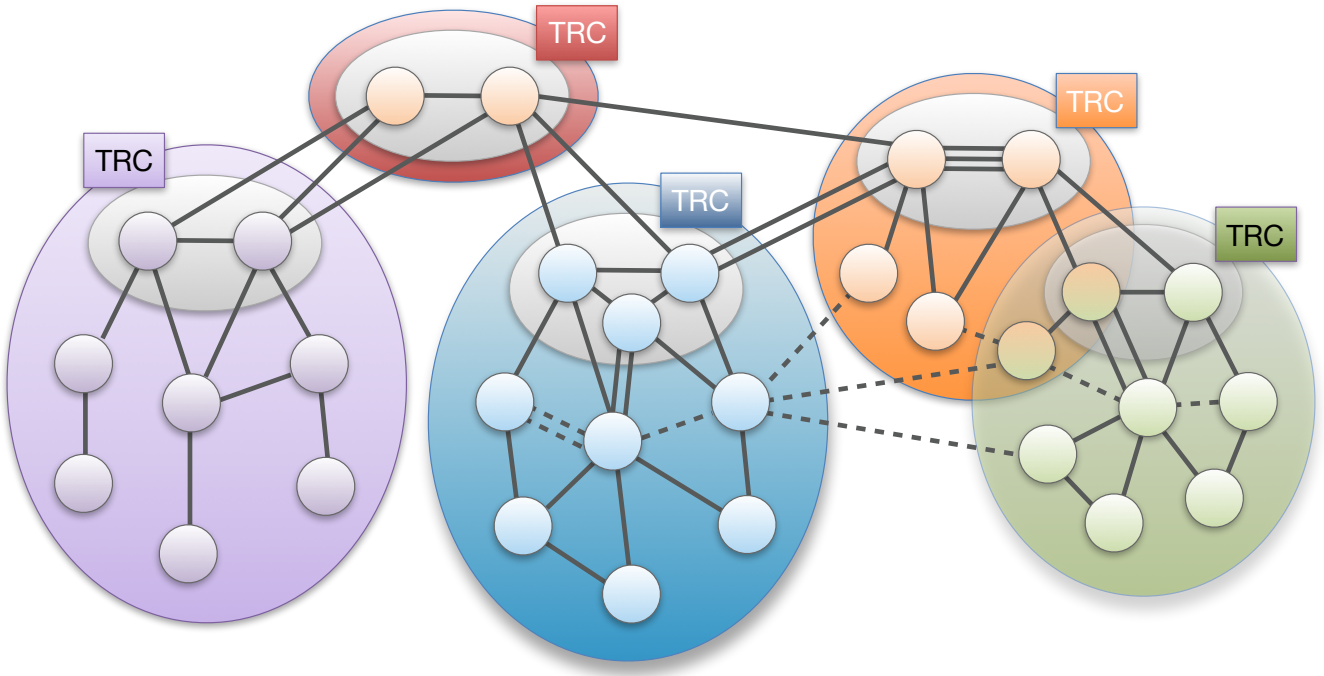
SCION

What is SCION?

- Secure inter-domain routing architecture, to replace BGP
- Open Internet platform, open-source
- Highly efficient: enables faster communication than in current Internet
- Highly secure: attacks are either impossible by design or significantly weakened
- Verifiably secure: Security proofs through formal methods
- **Next-generation Internet: path-aware multi-path communication**

Approach for Sovereignty: Isolation Domain (ISD)

Isolation Domain (ISD): grouping of Autonomous Systems (AS)



SCION Overview in One Slide

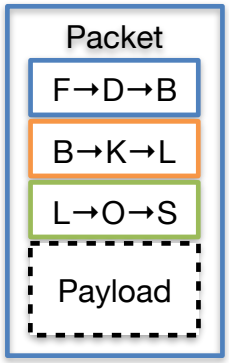
Path-aware Network Architecture

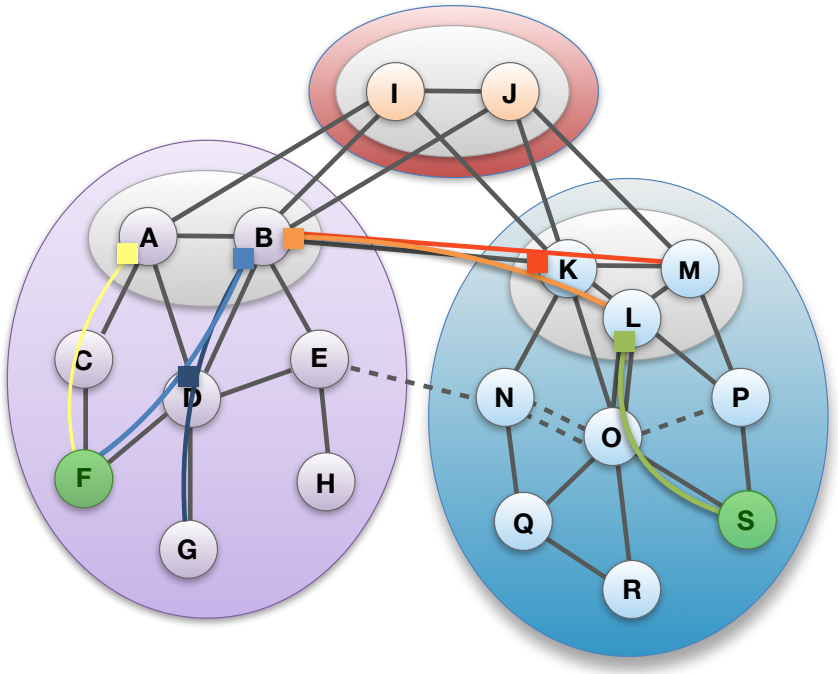
Control Plane - Routing

- Constructs and Disseminates Path Segments

Data Plane - Packet forwarding

- Combine Path Segments to Path
- Packets contain Paths
- Routers forward packets based on Path
  - Simple routers, stateless operation





ETH zürich

SCION

Recent Highlights

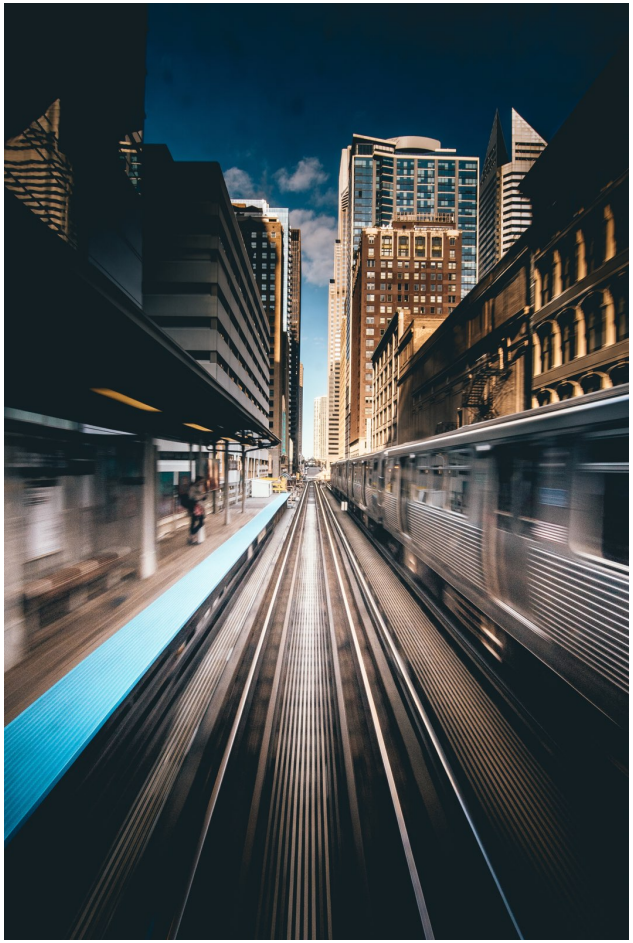
- Main thrust: operationalize + drive deployment
- SCI-ED project
- SCIONLab
- Production network
- DRKey + control-plane PKI

SCI-ED: SCION for ETH Domain

- Goals
  - Large-scale real-world deployment: ETH, EPFL, PSI, CSCS, EMPA, EAWAG, WSL
  - Operationalize SCION in SWITCH network
  - Expand and demonstrate maturity of SCION on real-world use cases
- SCION use cases in the ETH Domain
  - High-performance data transmission
  - Secure communication of sensitive data
  - High availability for critical infrastructures
  - Platform for networking research

ETH zürich

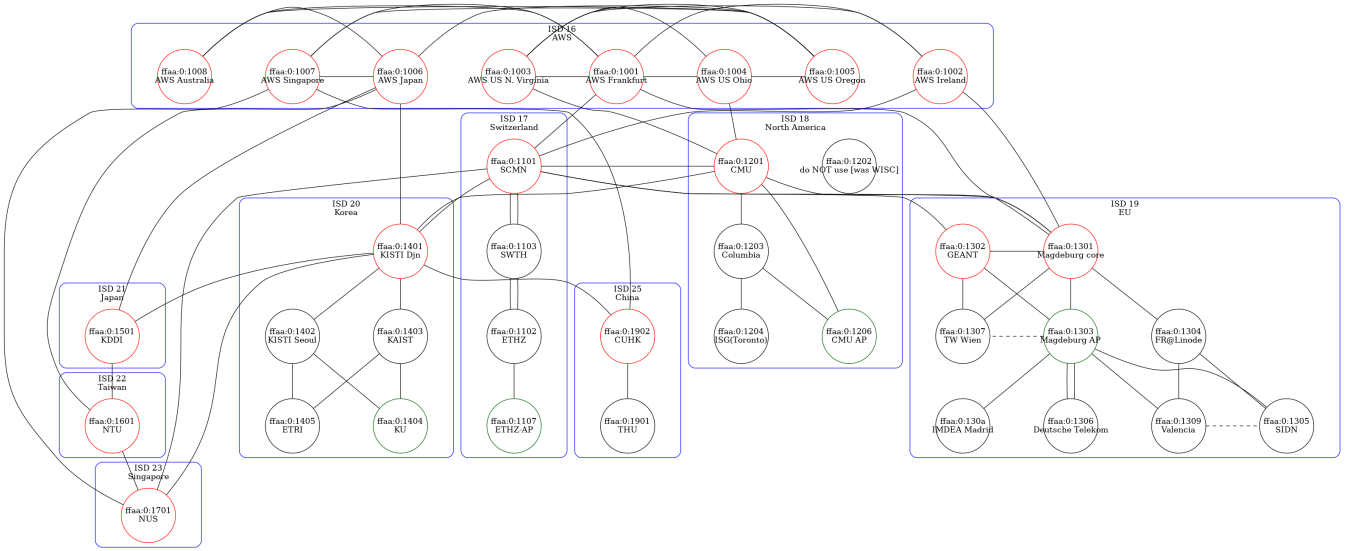
Approach for High-Speed Data Transmission



- Multipath communication, even backup links can be used simultaneously
- QUIC instead of TCP
- Firewall bypassing thanks to high-speed packet authentication
- Data transmission appliance to prevent changes on end host

SCIONLab

- Global SCION research testbed
- Open to everyone: create and connect your own AS within minutes
- ISPs: Swisscom, SWITCH, KDDI, GEANT, DFN
- Korea: GLORIAD, KISTI (KREONET), KU, KAIST, ETRI
- Deployed 35+ permanent ASes worldwide, 600+ user ASes



SCION Production Network

- Led by Anapaya Systems 

- Important point: BGP-free global communication
  - We need failure-independence from BGP protocol

- Discussions with domestic and international ISPs
  - Goal: First **inter-continental public secure** communication network
- Construction of SCION network backbone at select locations to bootstrap adoption
- Current deployment
  - ISPs: Deutsche Telekom, Swisscom, SWITCH
  - Bank deployment: 4 major Swiss banks, some in production use
  - Swiss government has SCION in production use

DRKey & Control-Plane PKI

- SCION offers a global framework for authentication and key establishment for secure network operations
- Control-pane PKI
  - Sovereign operation thanks to ISD concept
  - Every AS has a public-key certificate, enabling AS authentication
- DRKey
  - High-speed key establishment (within nanoseconds), enabling powerful DDoS defense

2020 Outlook

- Global communication guarantees
- Multipath socket
- Formally verified properties
- Construction of high-speed network components
  - SCION to support high-volume communication
    - Hercules: > 30Gbps on commodity hardware
  - LightningFilter: > 100Gbps on commodity hardware
  - Terabit router

Summary

- Path-aware networking + multi-path networks are a promising direction to realize the future Internet vision, providing even enhanced communication efficiency
- High security and availability, verified through formal methods
- Together we have the critical mass required to realize the future Internet vision!

ETH zürich

SCION