

ETH zürich

SCION[™]
ELEVATING SECURE COMMUNICATION

The Next² SCION Internet: Unlocking opportunities with AI

SCION DAY 2025

Adrian Perrig
ETH Zurich, Network Security Group





Key benefits

- Path transparency enables geofencing
- Multipath communication
- Failure resilience, rapid failover
- Protection against routing attacks
- Strong Sovereignty via Isolation Domains

Particularly valuable in sectors that require reliable, trusted communication

SS*N created growing ecosystem

> 20 NSPs offer global SCION connectivity

Native SCION apps can unlock the full potential



SCION
SCION
SCION

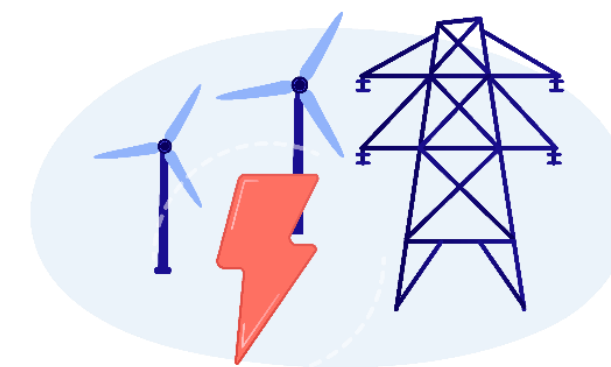


Secure Swiss Finance Network (SSFN)

321 participants (banks, insurers)



Secure Swiss Healthcare Network (SSHN)



Secure Swiss Utility Network (SSUN)



Secure Swiss EFTPOS Network (SEPN)

↑ **Mostly rely on SCION-IP-Gateway (SIG)**



Scaling SCIERA: A Journey Through the Deployment of a Next-Generation Network

François Wirz^{*3} Marten Gartner^{*9} Jelte van Bommel^{*3} Elham Ehsani Moghadam³
Grace H. Cimaszewski¹⁰ Anxiao He¹⁵ Yizhe Zhang¹⁵ Henry Birge-Lee¹⁰ Felix Kottmann³
Cyrill Krähenbühl¹⁰ Jonghoon Kwon³ Kyveli Mavromati¹ Liang Wang¹⁰ Daniel Bertolo¹³
Marco Canini⁶ Buseung Cho⁷ Ronaldo A. Ferreira¹⁴ Simon Peter Green¹¹ David Hausheer⁹
Junbeom Hur⁸ Xiaohua Jia² Heejo Lee⁸ Prateek Mittal¹⁰ Omo Oaiya¹⁶ Chanjin Park⁷
Adrian Perrig^{1,3} Jerry Sobieski^{5,12} Yixin Sun¹⁵ Cong Wang² Klaas Wierenga⁴

¹Anapaya Systems ²CityUHK ³ETH Zurich ⁴GÉANT ⁵GMU ⁶KAUST ⁷KISTI ⁸Korea University ⁹OVGU Magdeburg
¹⁰Princeton ¹¹SingAREN ¹²Sobieski Systems & Services ¹³SWITCH ¹⁴UFMS ¹⁵UVA ¹⁶WACREN

ABSTRACT

The SCION Next-Generation Network (NGN) architecture has expanded steadily since 2017, with today 20+ ISPs offering SCION connectivity. In production, IP-to-SCION-to-IP translation by SCION-IP-Gateways (SIGs) is used, such that applications are unaware of the NGN communication. To accelerate innovation and deployments, our aim is to increase the number of *native* SCION use cases, where the application is fully SCION-aware and optimizes communication across all path choices offered by the network. We set out to achieve two core objectives: (1) facilitating **simple native connectivity** for applications, and (2) enhancing the **scalability of SCION deployment** at academic sites.

With these goals in mind, we built the SCION Education, Research, and Academic (SCIERA) network infrastructure. This paper presents key lessons learned from the SCIERA deployment, which we anticipate will offer actionable insights to researchers, network operators, and system builders seeking to overcome practical challenges also for other NGN deployments. We report on establishing native SCION connectivity at research and education institutions that can reach 250,000 people across five continents, without relying on BGP. Our evaluation demonstrates that our core objectives were reached. Today, the SCIERA deployment offers tangible real-world benefits to users by providing rich global connectivity through a multitude of inter-domain paths.

ACM Reference Format:

François Wirz, Marten Gartner, Jelte van Bommel, Elham Ehsani Moghadam, Grace H. Cimaszewski, Anxiao He, Yizhe Zhang, Henry Birge-Lee, Felix Kottmann, Cyrill Krähenbühl, Jonghoon Kwon, Liang Wang, Daniel Bertolo, Marco Canini, Buseung Cho, Ronaldo A. Ferreira, Simon Peter Green, David Hausheer, Junbeom Hur, Xiaohua Jia, Heejo Lee, Prateek Mittal, Omo Oaiya, Chanjin Park, Adrian Perrig, Jerry Sobieski, Yixin Sun, Cong Wang, Klaas Wierenga. Scaling SCION Through the Deployment of a Next-Generation Network. In *2025 Conference (SIGCOMM '25)*. ACM, New York, NY, USA, 2025.

1 INTRODUCTION

Radical innovation at modest changes such as substantial adoption [56] as a result, deploying that fundamentally infeasible.

The main obstacle is little incentive to join. To connect with. A case study adoption worthwhile. The paper states that the value of its user base [56]. Even with subsequent rollout faces resistance.



Details about our journey in the paper

Deployment Details & Governance

Scaling with Goodwill & Recycled parts

Maintenance, Alerting and Observability

Dealing with Heterogeneous Networks

Feature creep

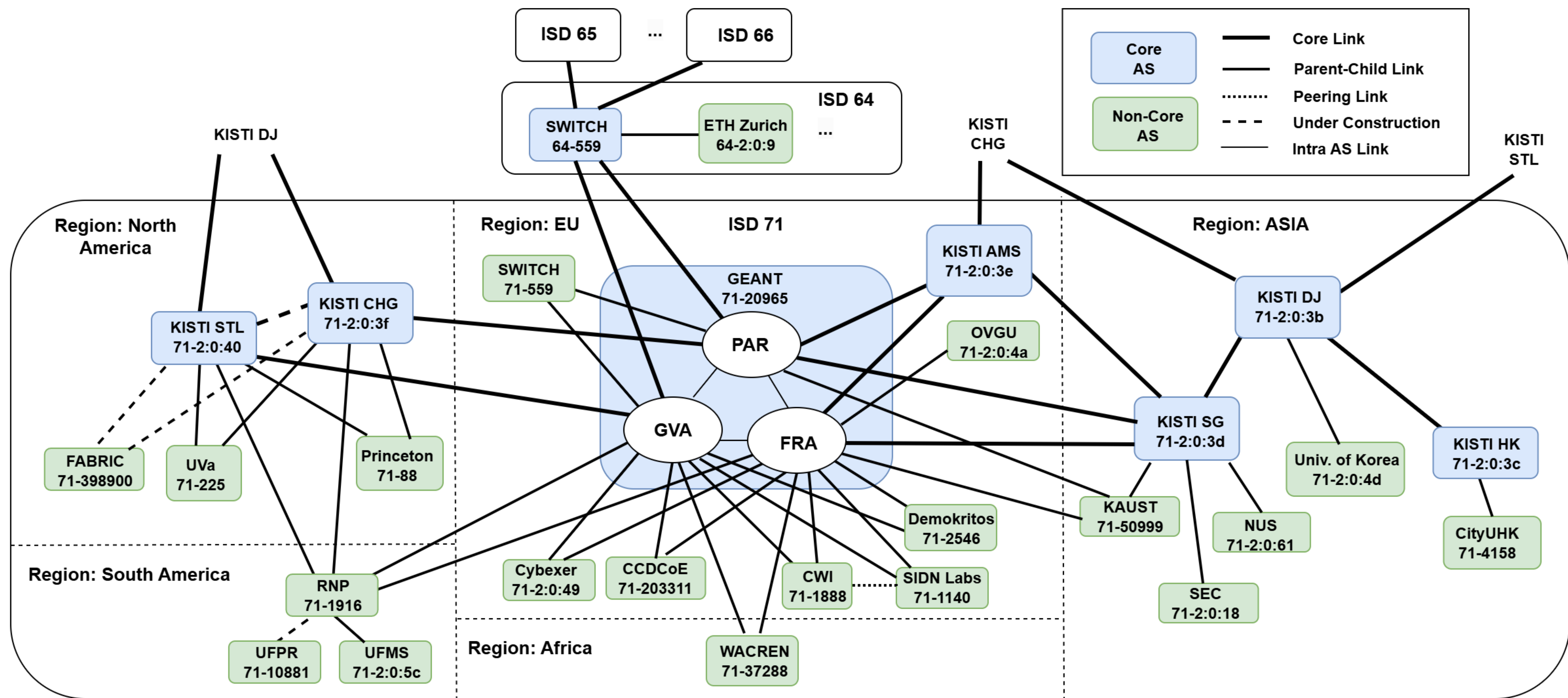
Design 'Mistakes'

Connectivity & Multipath Analysis

Deployment Effort

Operator Survey

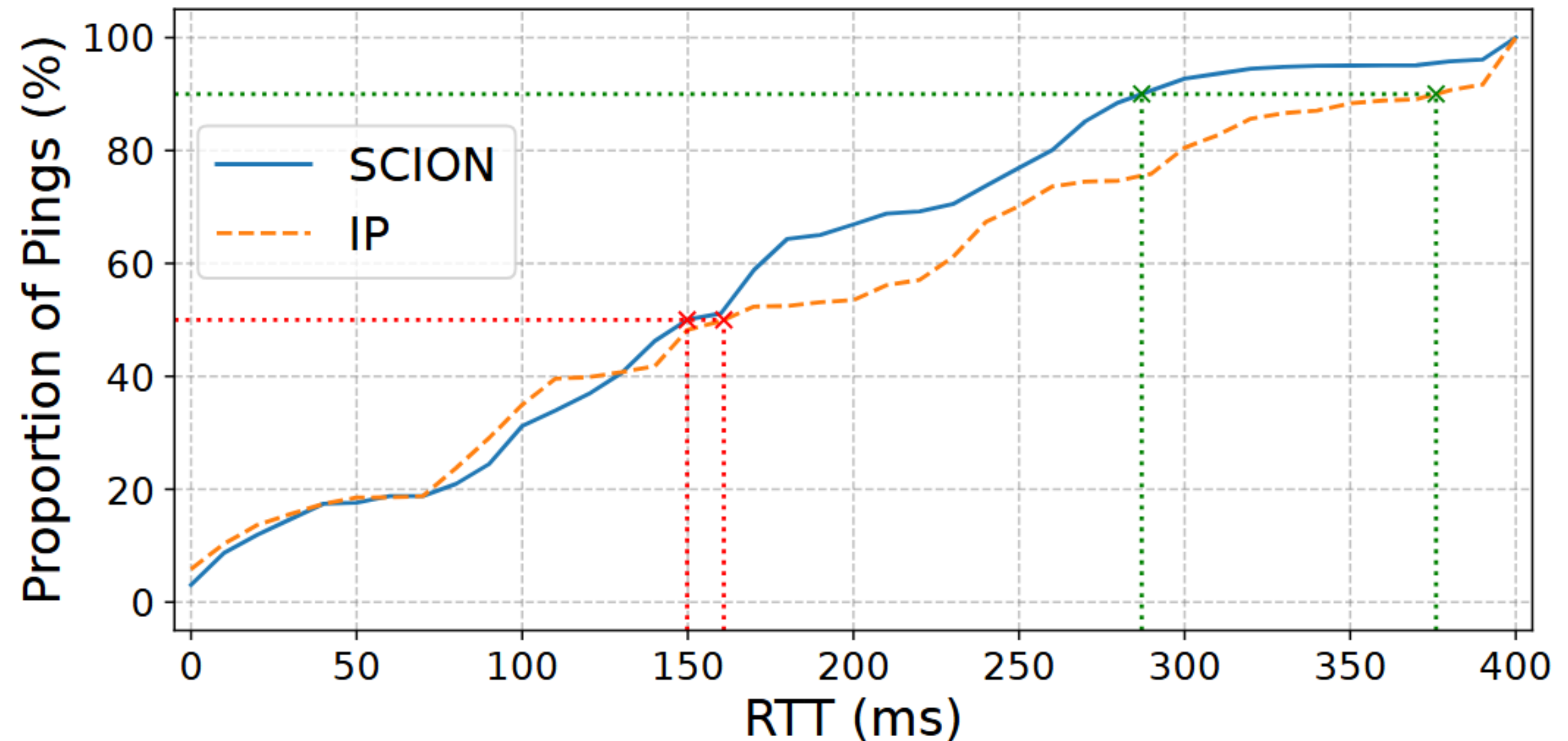
SCION Research and Education Network



SCI ERA Evaluation – Connectivity & Multipath



- Pings
 - ICMP Ping
 - SCMP (SCION) Ping
 - Shortest, fastest, most disjoint
- 11 ASes (5 EU, 2 Asia, 3 NA, 1 SA)
- 20-day period
- 265M ping measurements
 - Dataset publicly available

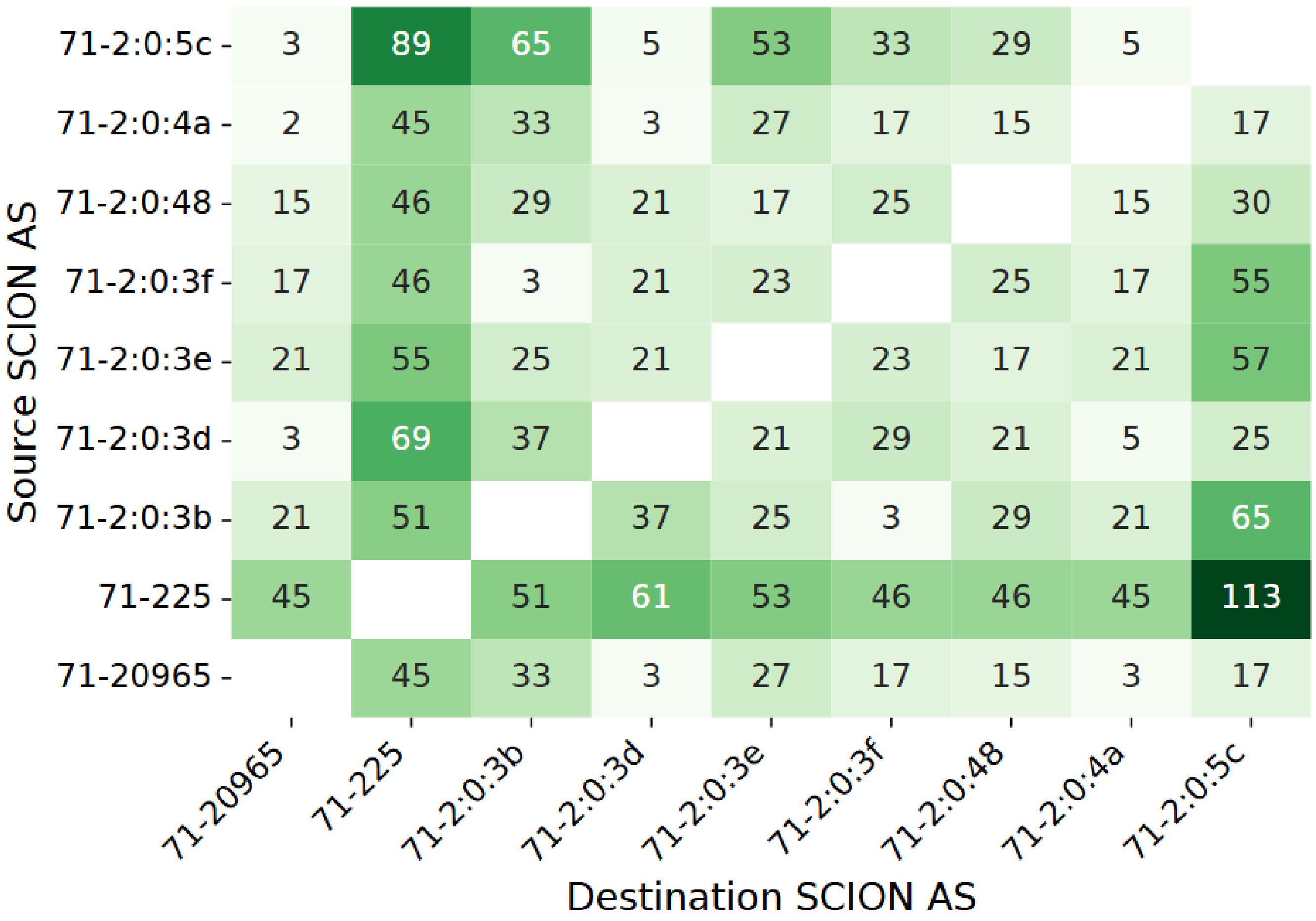


CDF of ping latency for SCION and IP

RTT median ↓ 6.9% vs IP (160.9 → 149.8 ms)

90th percentile RTT ↓ 23.7%

SCI ERA Evaluation – Connectivity & Multipath



100+ path options
between some AS pairs

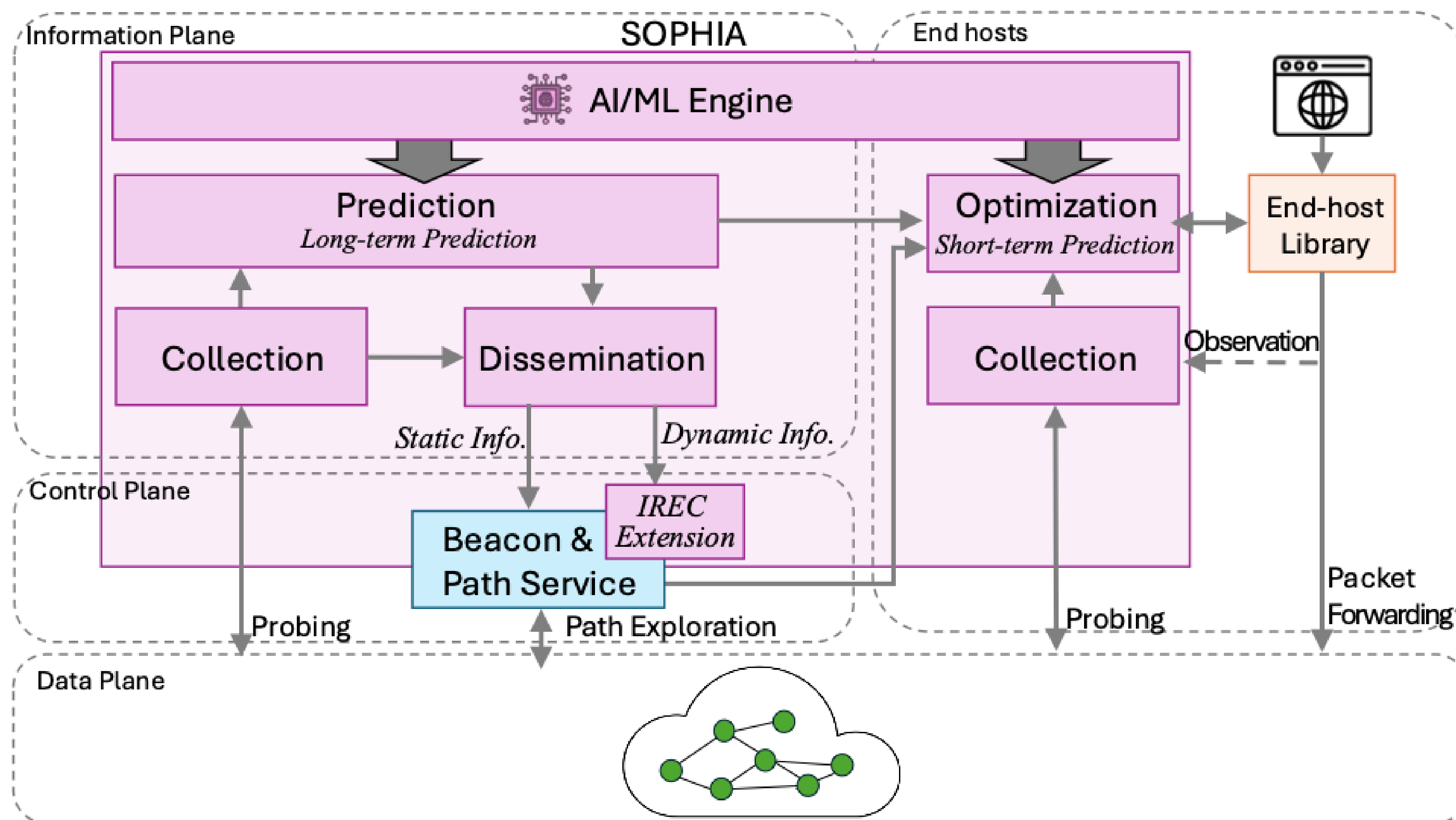
Maximum number of active paths between AS pairs

Challenge: Many Options!

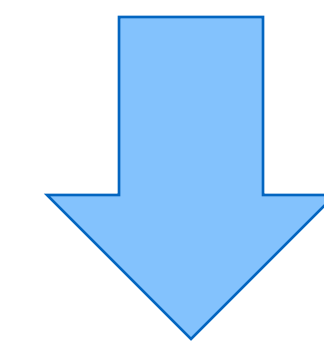
- Observation: hundreds of path choices
- SCION further offers large diversity of path options
 - Best effort
 - Hidden paths
 - Hummingbird
- Research challenge: what should application optimize for?
 - Optimization per flow or even per packet?
 - Example of per-packet arrival deadline control: DMTP by Tony John @ OvGU

Next-Next Generation Network: SCION + SOPHIA

SOPHIA: Self-Optimizing Path-aware High-performance Intelligent Architecture



Collecting, predicting, and disseminating multi-dimensional path information



Intelligent, per-application, multi-criteria path optimization

AI-Powered SCION: Multi-Criteria Path Optimization

- Optimizing path selection considering application-specific performance criteria
 - Latency-optimized paths: Web, VoIP, DNS traffic, gaming
 - B/W-optimized paths: streaming traffic, bulk transfer
 - Jitter-optimized paths: mission-critical traffic
- Multi-criteria optimization
 - Some applications seek paths jointly optimized for different network criteria
 - Deep-learning based inference models

AI SCION: Synergies

SCION support for AI

- Optimize distributed training, potential cost reduction
- Low-latency and high-availability access to inference engine
- Control of information disclosure through geofencing
- Bandwidth guarantees for learning / model downloads / inference with Hummingbird

AI support for SCION

- Link metric prediction (latency, bandwidth, jitter, loss)
- Prediction of application network needs (bw distribution, connection duration, metric to optimize)
- Optimization for path selection
- Code generation: application code update for transition to SCION

Native SCION Adoption



Happy
Eyeballs

QUIC(-MP)

IPv6

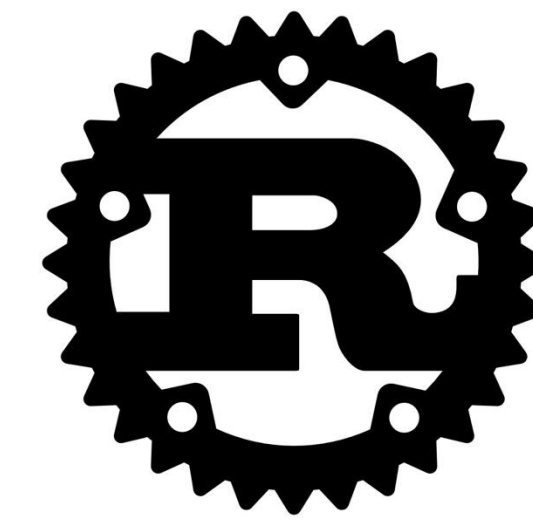
IPv4

Native
SCION

SCION-enabling Applications

For developers

- Drop-in socket libraries
- Typically < 20 lines of code to SCION-enable application (e.g., netcat)
- Caddy < 100 lines of code
- **Application library will perform bootstrapping, even without any installed prerequisites in OS**



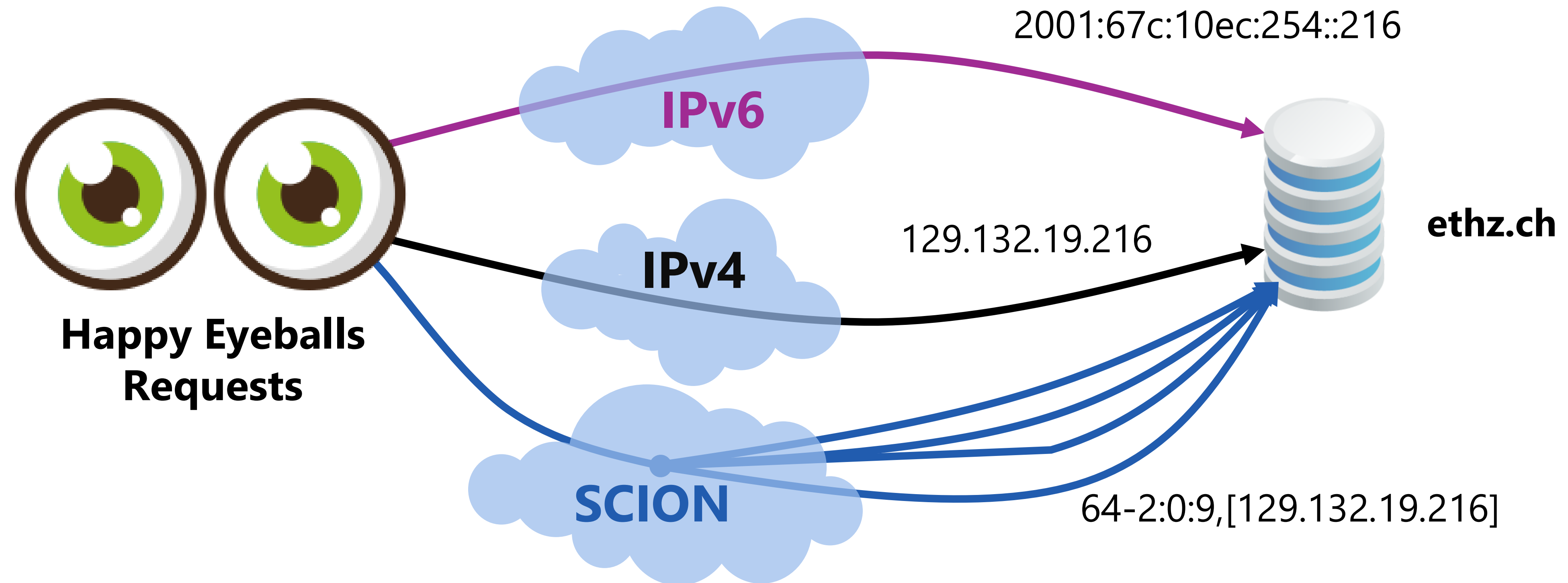
**The Rust
Programming
Language**



Java



IPv6 paves the way for native SCION



QUIC-MP library can use all (SCION) paths at the same time!

Ambition

SCION as a **core connectivity technology** next to IPv4 and IPv6 available on **hundreds of millions** of devices **within 3-5 years**

Steps to reaching this goal

- Specification, standardization
- Availability of native connectivity
- Extension of QUIC and HE libraries

Call for help: we can reach this as a community!



Posters and Demos (not to miss)

- Clockwire (Marc Frei): secure global time synchronization
- SCION browser plugin (François Wirz): native SCION access from Brave, Chromium, Opera
- Hummingbird global QoS (Juan Garcia, Karl Wüst): bandwidth marketplace