SCION: A Secure Internet Architecture

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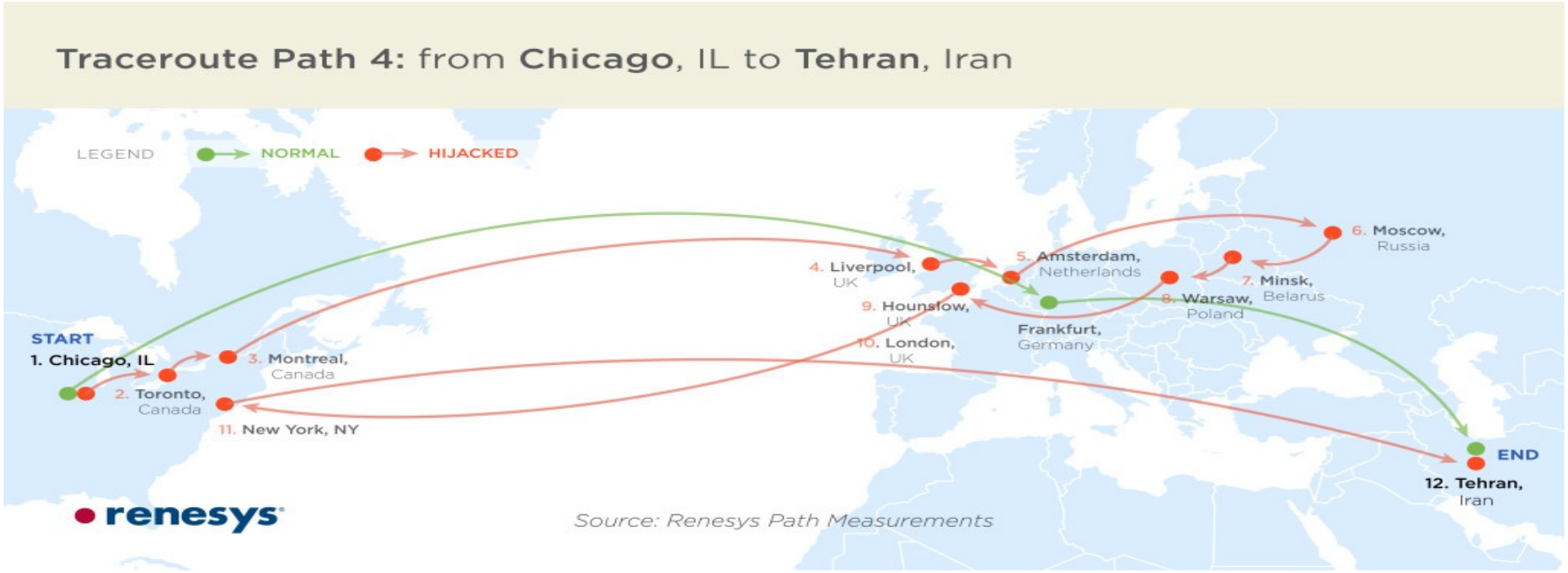
Internet Weakness: DoS and DDoS Attacks

- Expensive and difficult to protect against DoS und DDoS attacks
- Despite large investments, attacks continue to be successful
  - **November 2015: Protonmail attacked during 1 week**
  - **March 2016: CH e-commerce under attack: Digitec, Galaxus, SBB, Migros, etc.** (Hackers demanded 25 Bitcoins to stop attacks)
  - **Fall 2016: Global Mirai botnet attacks, e.g., OVH, Dyn, russian banks**
  - June 2017: Northkorea “Hidden Cobra” botnet uncovered
  - September 2017: Global airport chaos, DDoS paralyzes checkin systems
- **Can we reliably defend against DDoS attacks?**

Internet Weakness: Communication Path Hijacking

- Sender und receiver have limited control over routing paths
- Attacks can hijack and relay paths
- **How can we guarantee communication paths?**



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Internet Weakness: Kill Switch ruptures Sovereignty

- Current Internet suffers from several “Kill Switches”, which can halt communication within a geographical area
- Several attack avenues exist: DDoS, BGP hijacking, DNS redirection, BGPSEC / DNSSEC / TLS certificate revocation
- Example August 2017: An erroneous route injected by Google prevents communication for 50% of Internet in Japan during 40 minutes
- **Can we construct an Internet without Kill Switches?**

SCION Architecture Design Goals

- High availability, even for networks with malicious parties
  - Adversary: access to management plane of router
  - Communication should be available if adversary-free path exists
- Secure entity authentication
  that scales to global heterogeneous (dis)trusted environment
- Flexible trust: enable selection of trust roots
- Transparent operation: clear what is happening to packets and whom needs to be relied upon for operation
- Balanced control among ISPs, senders, and receivers
- Scalability, efficiency, flexibility

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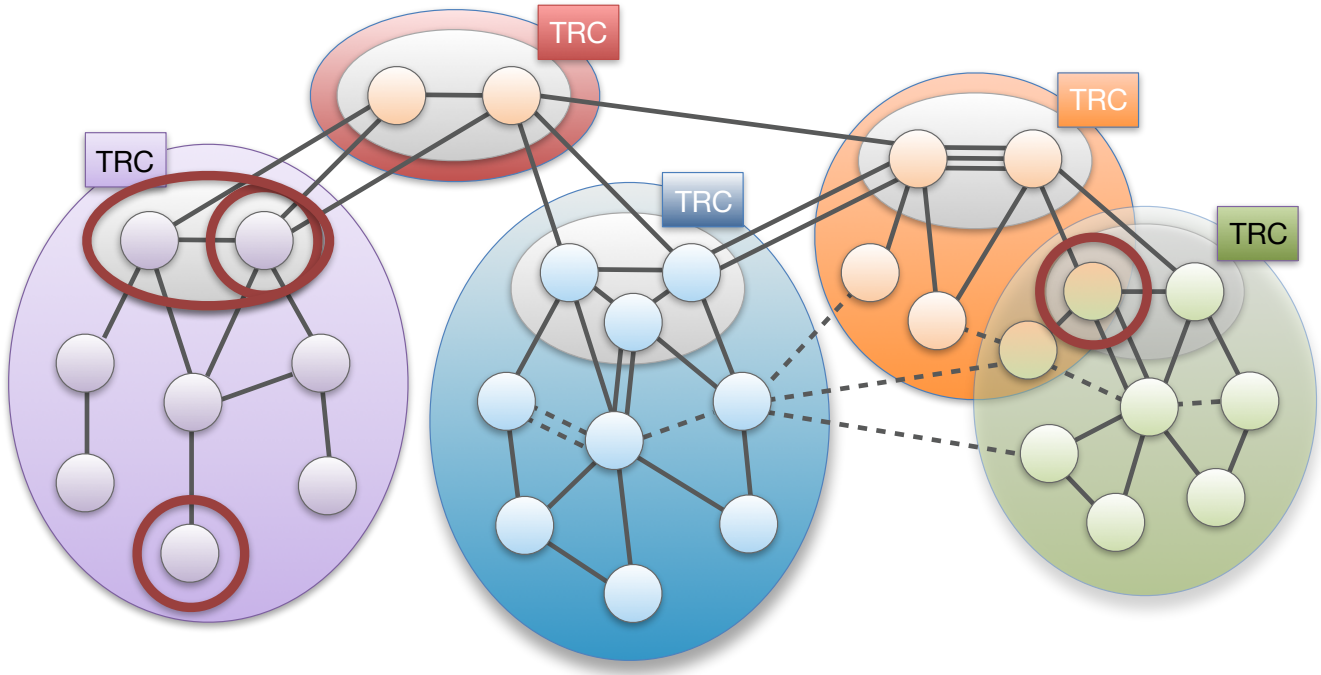
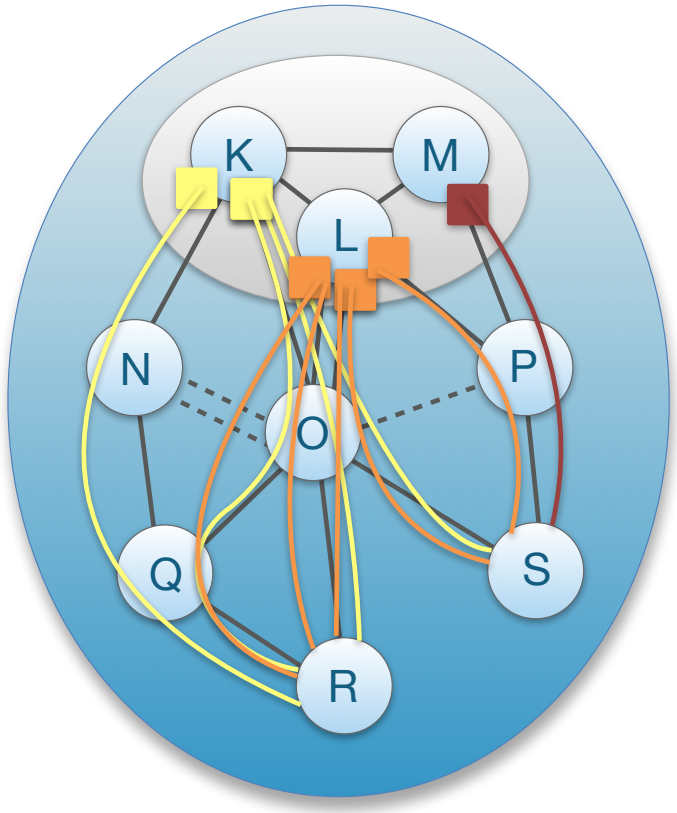
Approach for Scalability: Isolation Domain (ISD)

- Isolation Domain (ISD): grouping of ASes
- ISD core: ASes that manage the ISD
- Core AS: AS that is part of ISD core
- Control plane is organized hierarchically
  - Inter-ISD control plane
  - Intra-ISD control plane



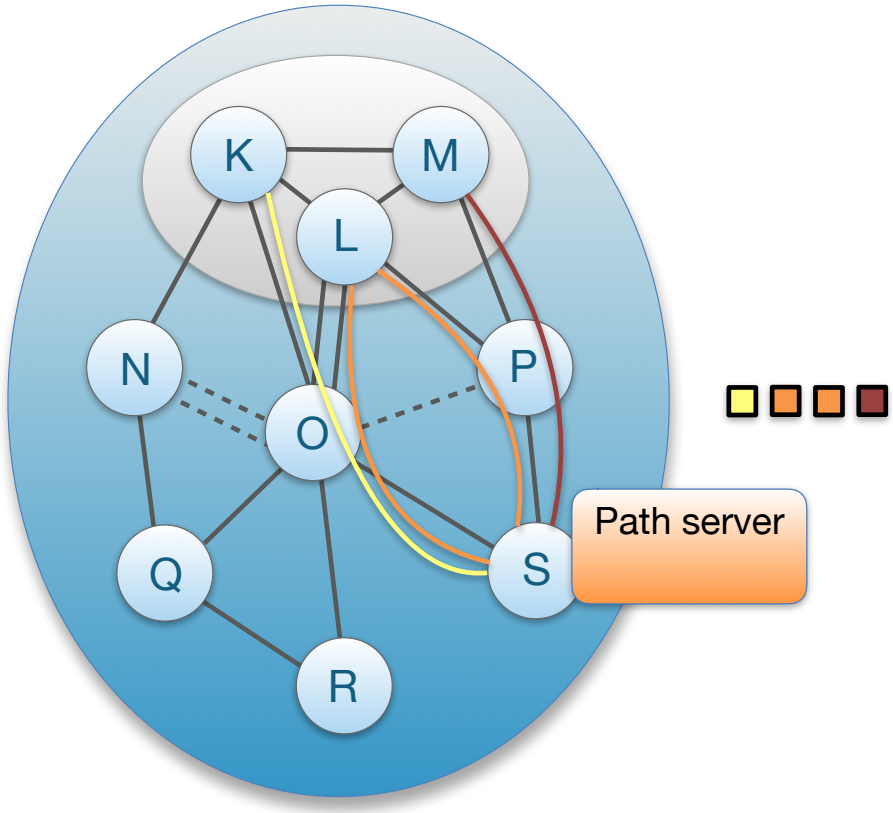
Intra-ISD Path Exploration: Beaconing

- Core ASes K, L, M initiate Path-segment Construction Beacons (PCBs), or "beacons"
- PCBs traverse ISD as a flood to reach downstream ASes
- Each AS receives multiple PCBs representing path segments to a core AS



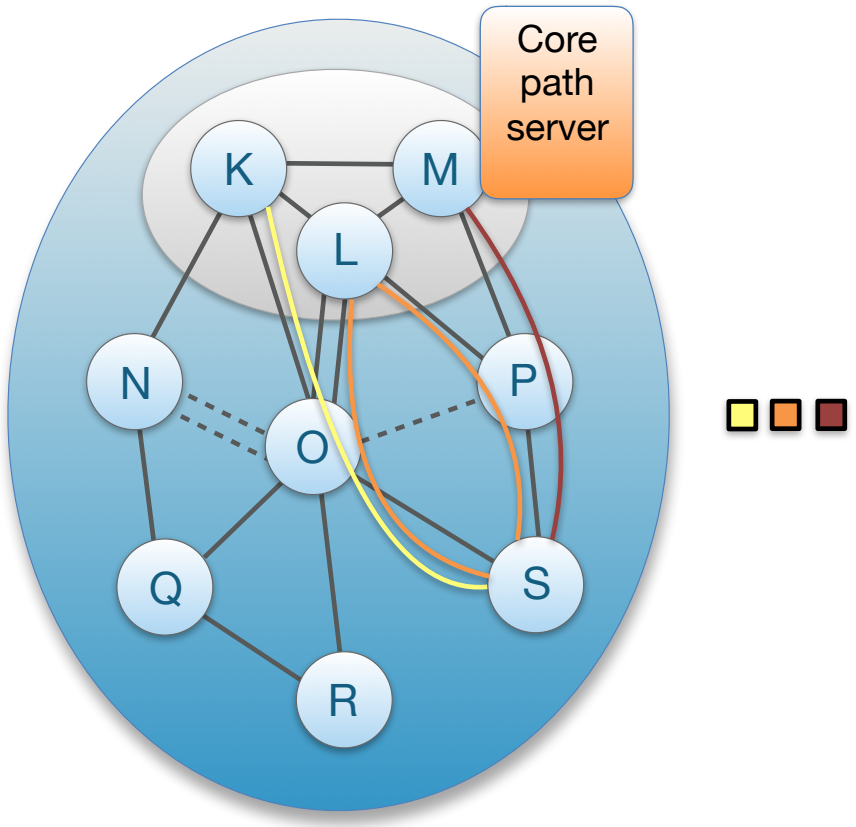
Up-Path Segment Registration

- AS selects path segments to announce as up-path segments for local hosts
- Up-path segments are registered at local path servers



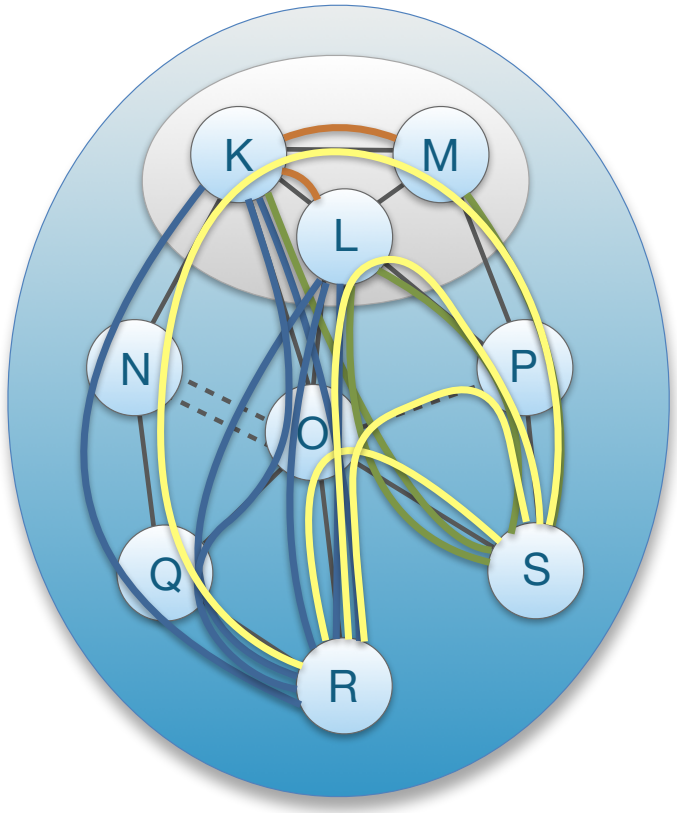
Down-Path Segment Registration

- AS selects path segments to announce as down-path segments for others to use to communicate with AS
- Down-path segments are uploaded to core path server in core AS

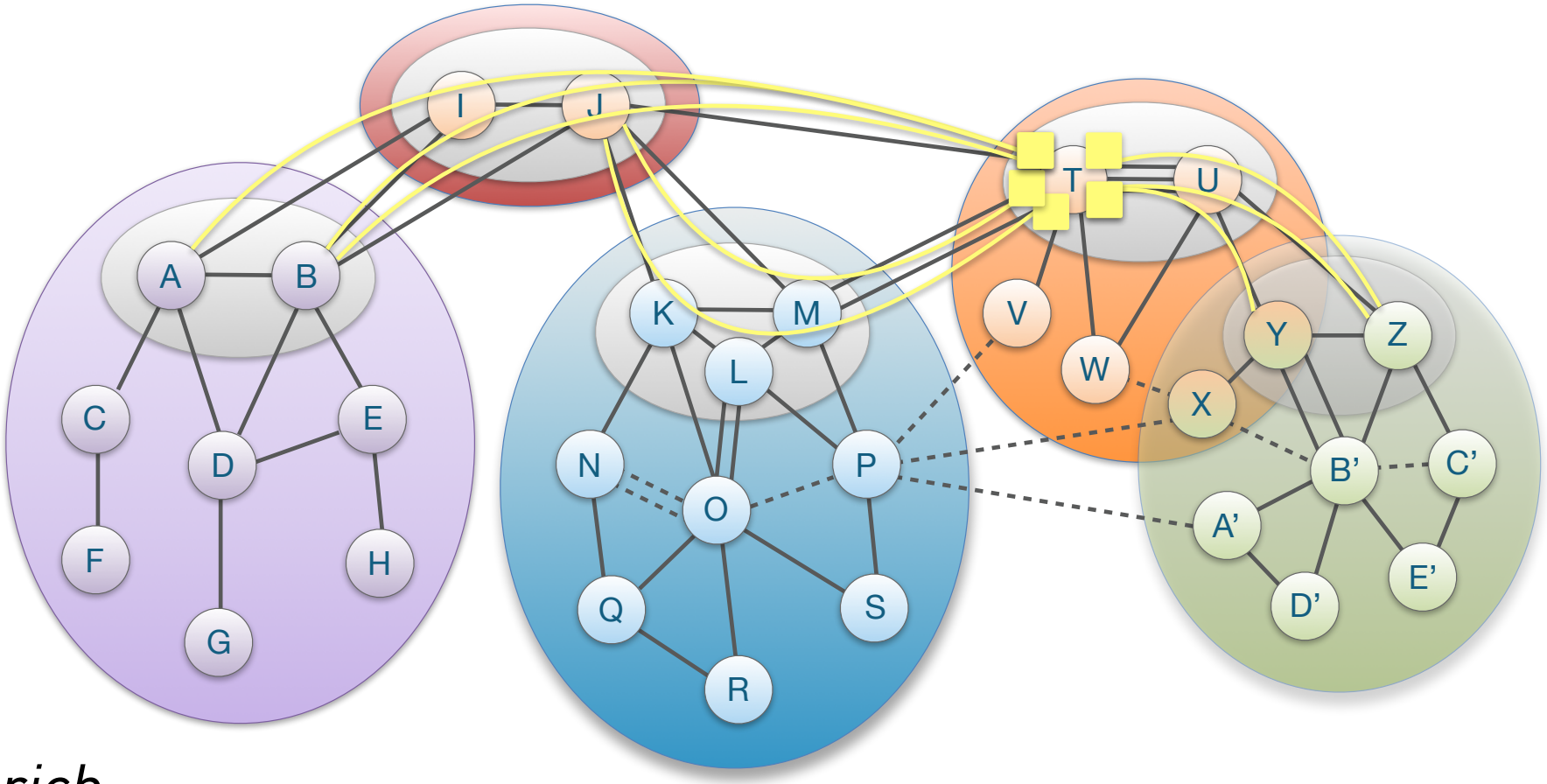


Path Creation: Local ISD

- Client requests path segments to <ISD, AS> from local path server
- If down-path segments are not locally cached, local path server send request to core path server
- Local path server replies
  - Up-path segments to local ISD core ASes
  - Down-path segments to <ISD, AS>
  - Core-path segments as needed to connect up-path and down-path segments



Inter-ISD Path Exploration: Sample Core-Path Segments from AS T



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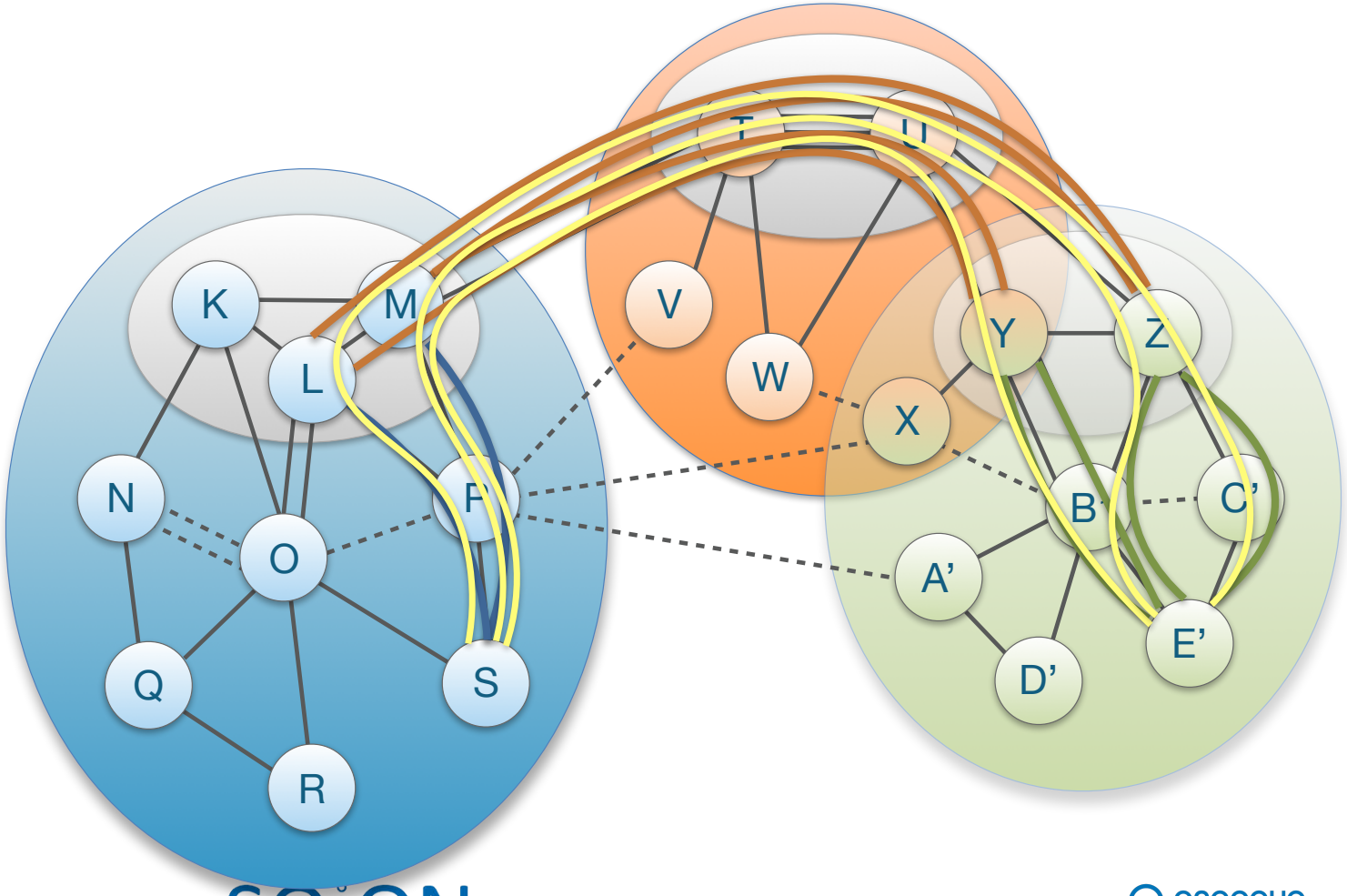
Path Creation: Remote ISD

- Host contacts local path server requesting <ISD, AS>
- If path segments are not cached, local path server will contact core path server
- If core path server does not have path segments cached, it will contact remote core path server
- Finally, host receives up-, core-, and down-segments



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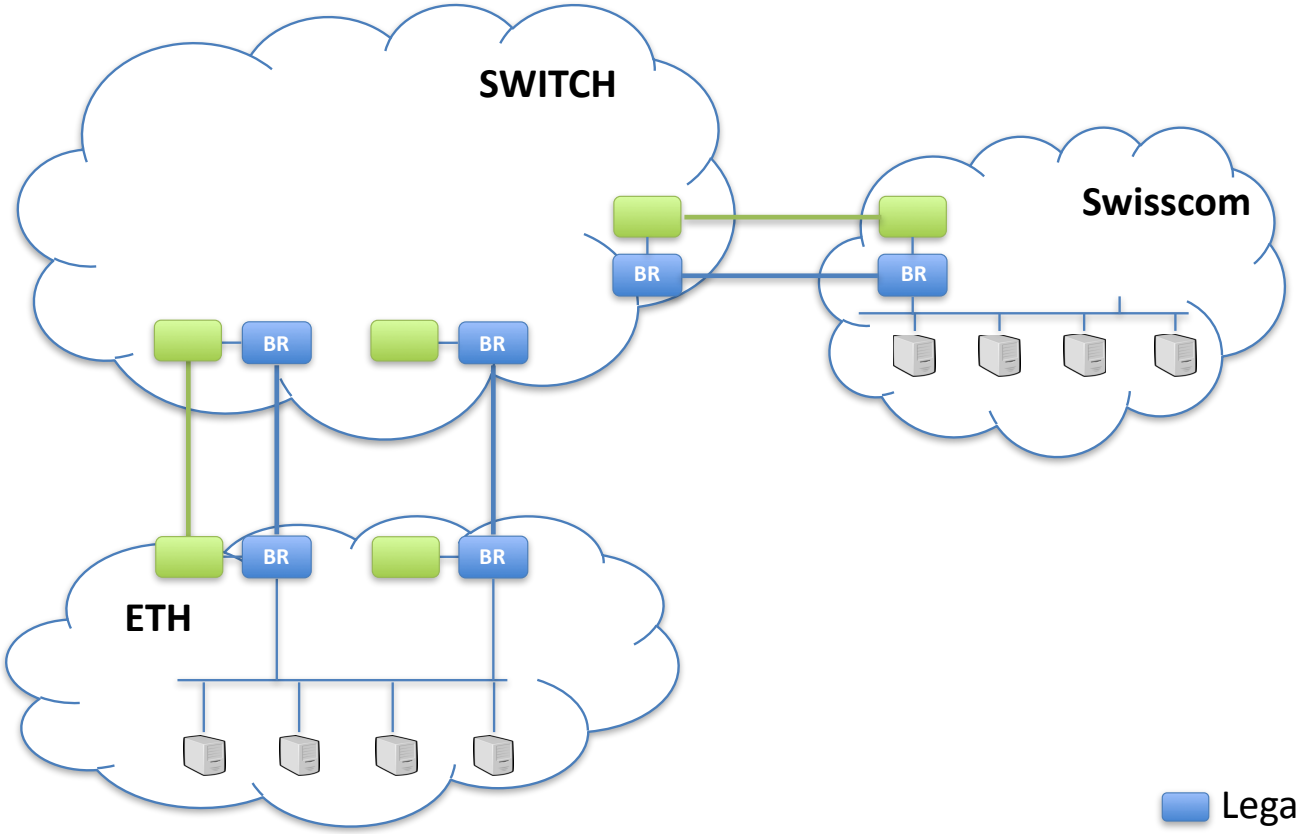
No Global Coordination Required for Adoption

- SCION re-uses current local network infrastructure
- Requires setup of routers and servers (commodity HW)
  - SCION border router
  - Beacon, certificate, and path servers
- Border routers of different ASes connect natively or using as overlay over the Internet
- For fault tolerance, multiple servers and border routers can be set up
- Minimal deployment: single commodity host per domain, implementing border router and all servers

Deployment @ ETH



Legacy device
SCION border router

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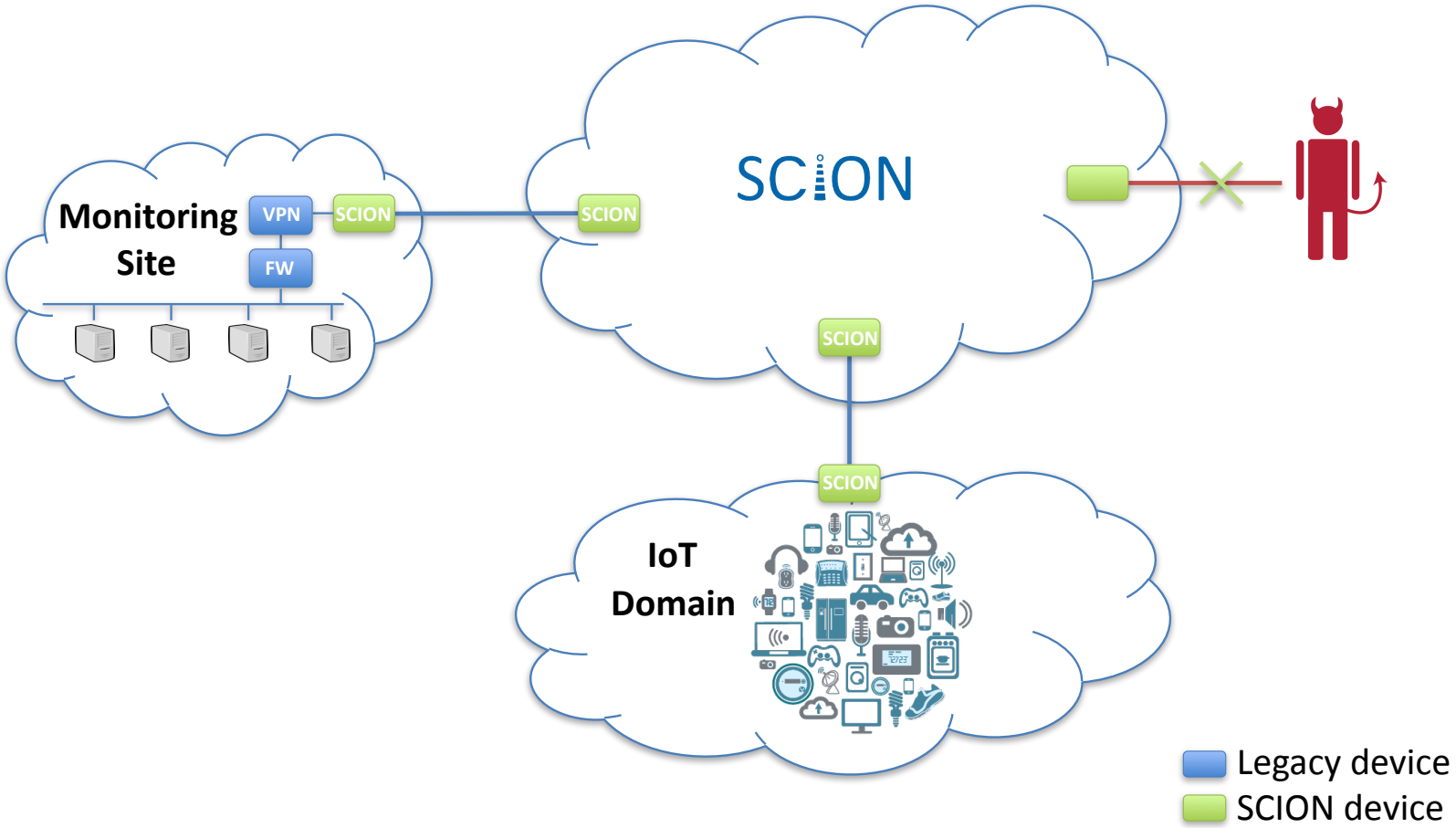
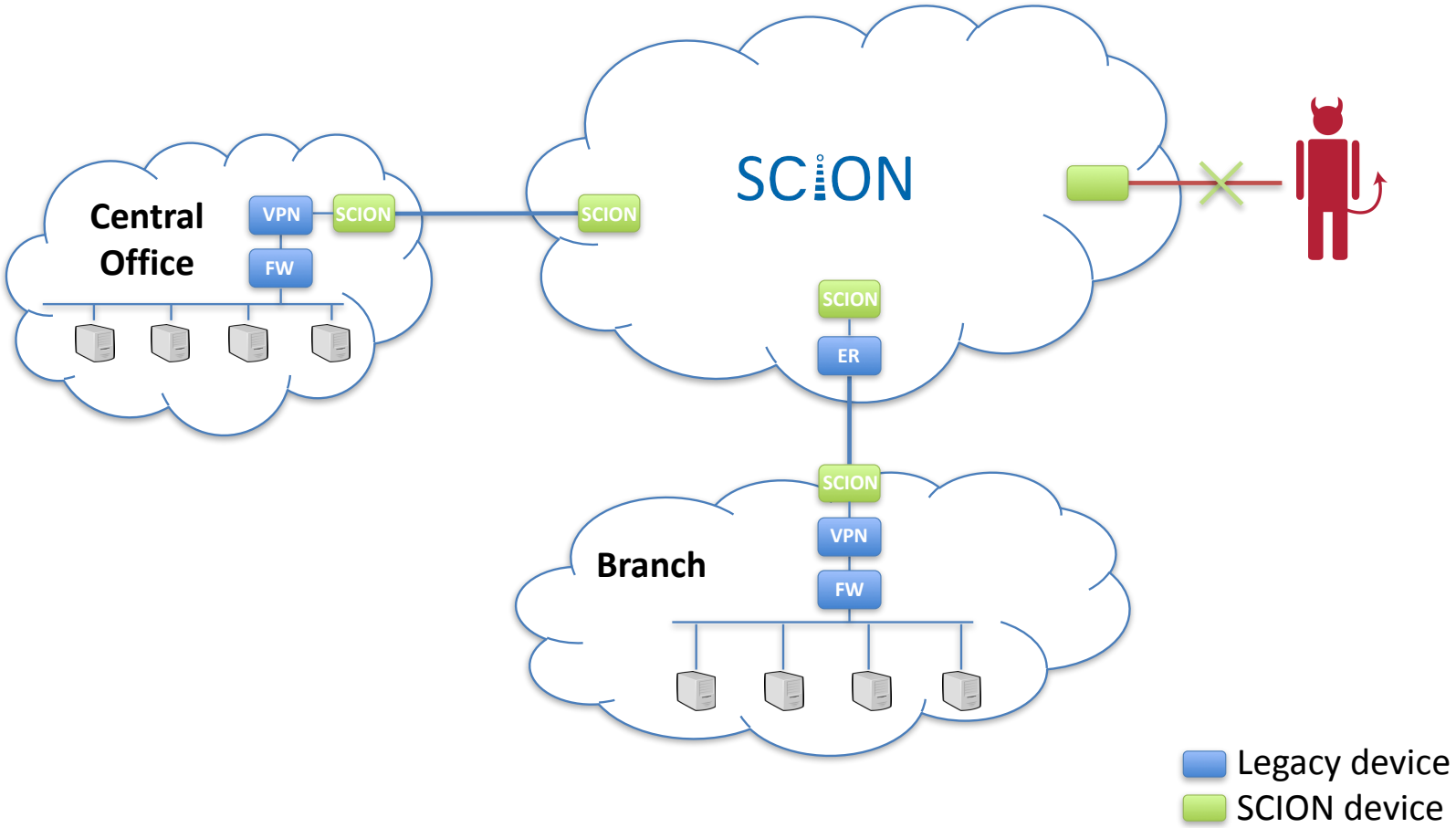
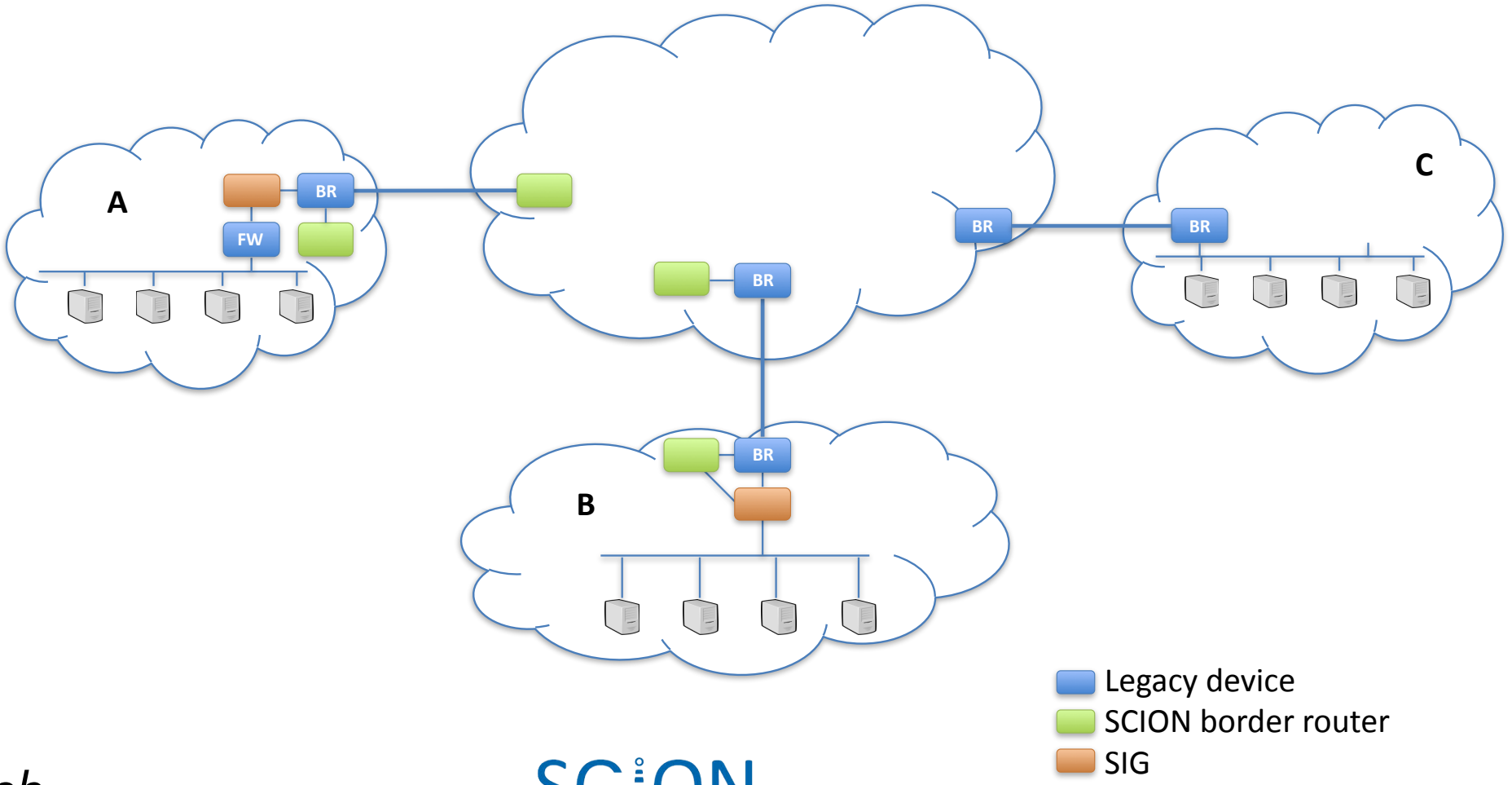
Use Case: IoT Protection through Default Off



Use Case: VPN-based Deployment



SCION-IP Gateway (SIG) Deployment



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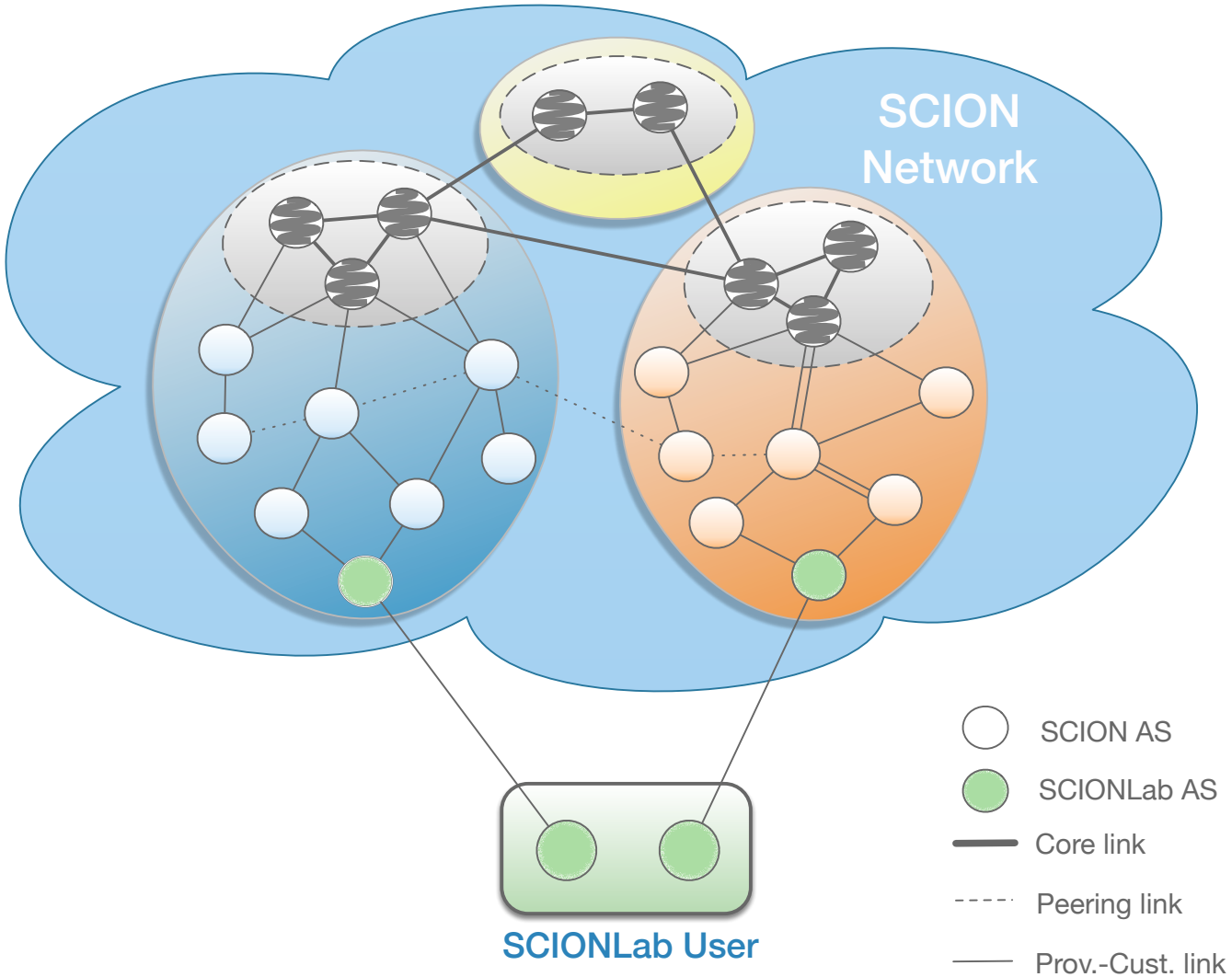

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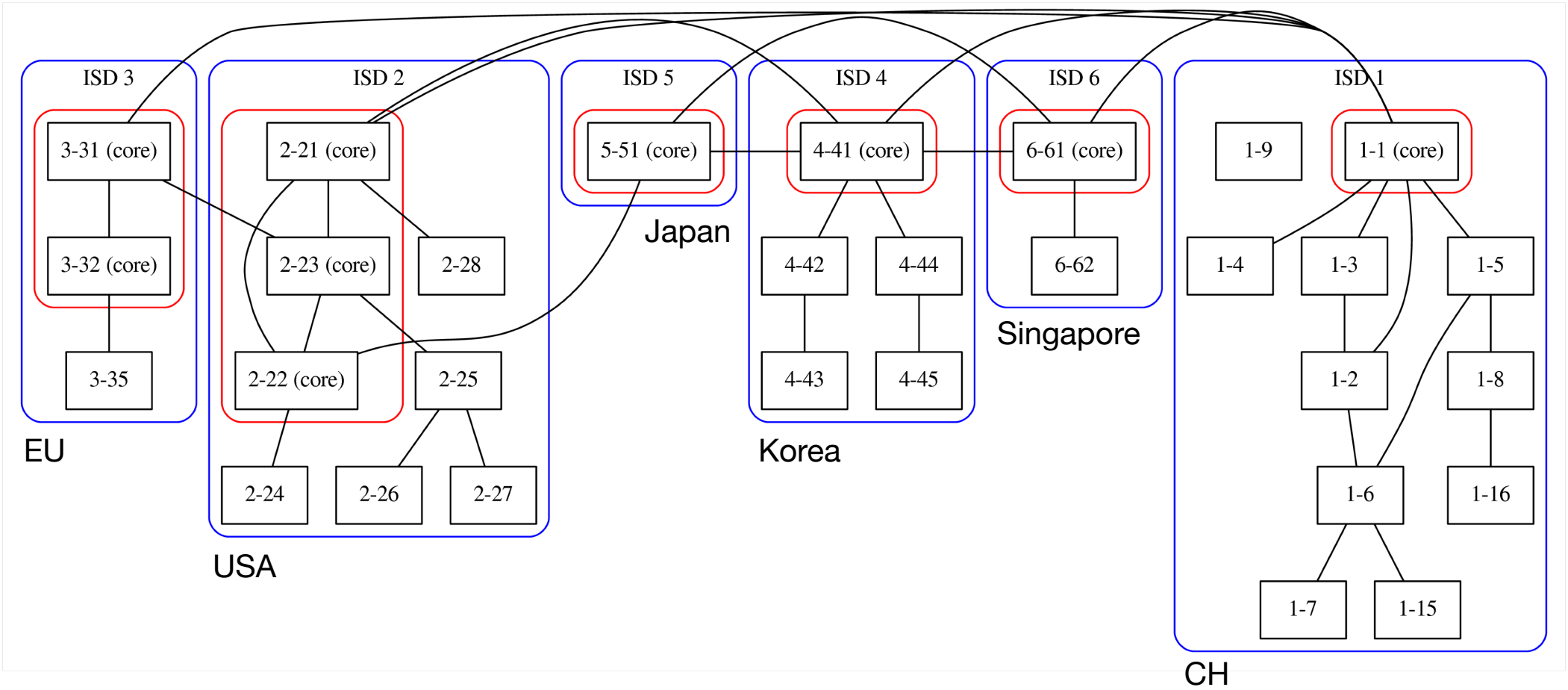
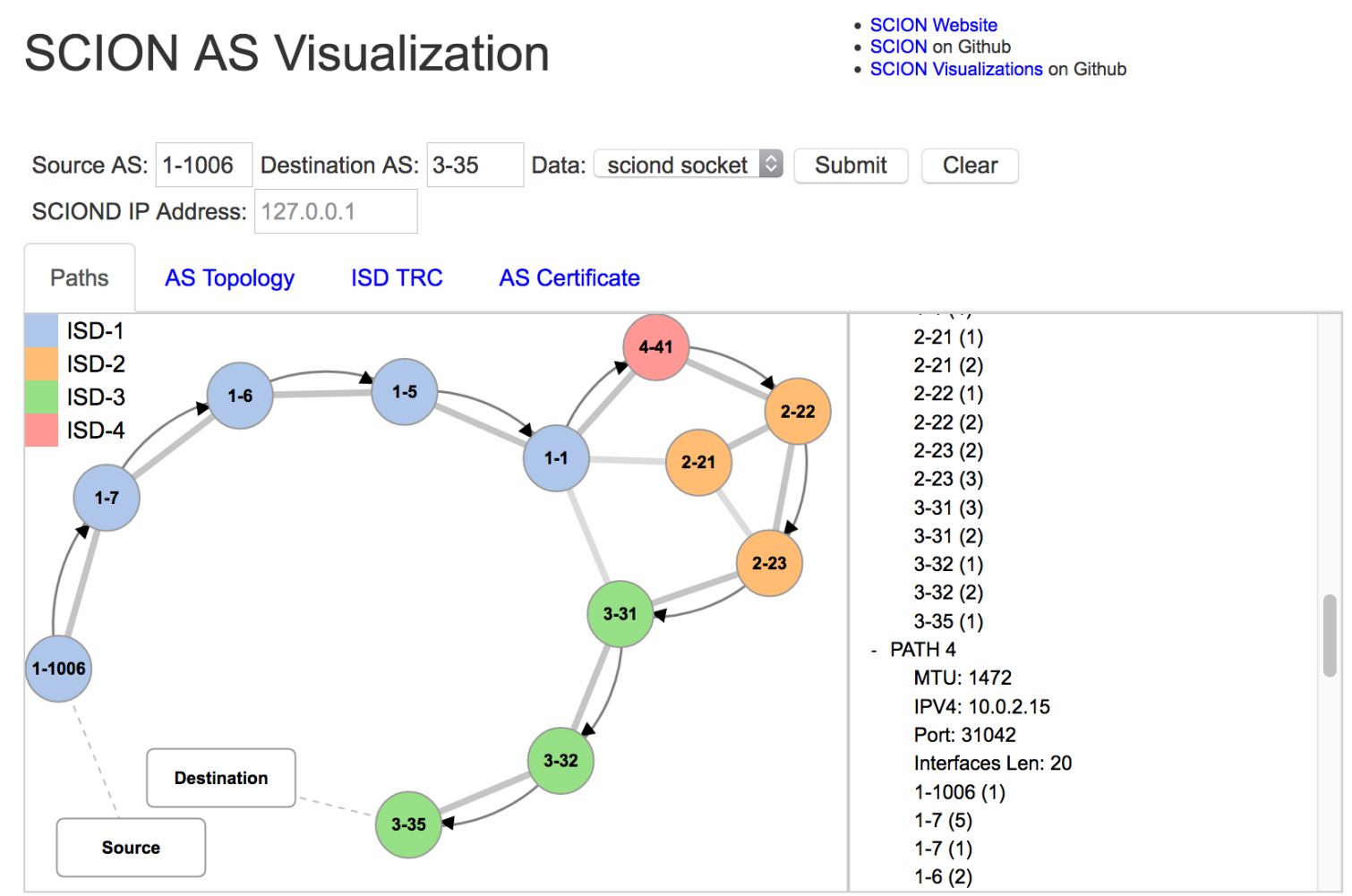
Global SCIONLab Network



SCION Visualization System



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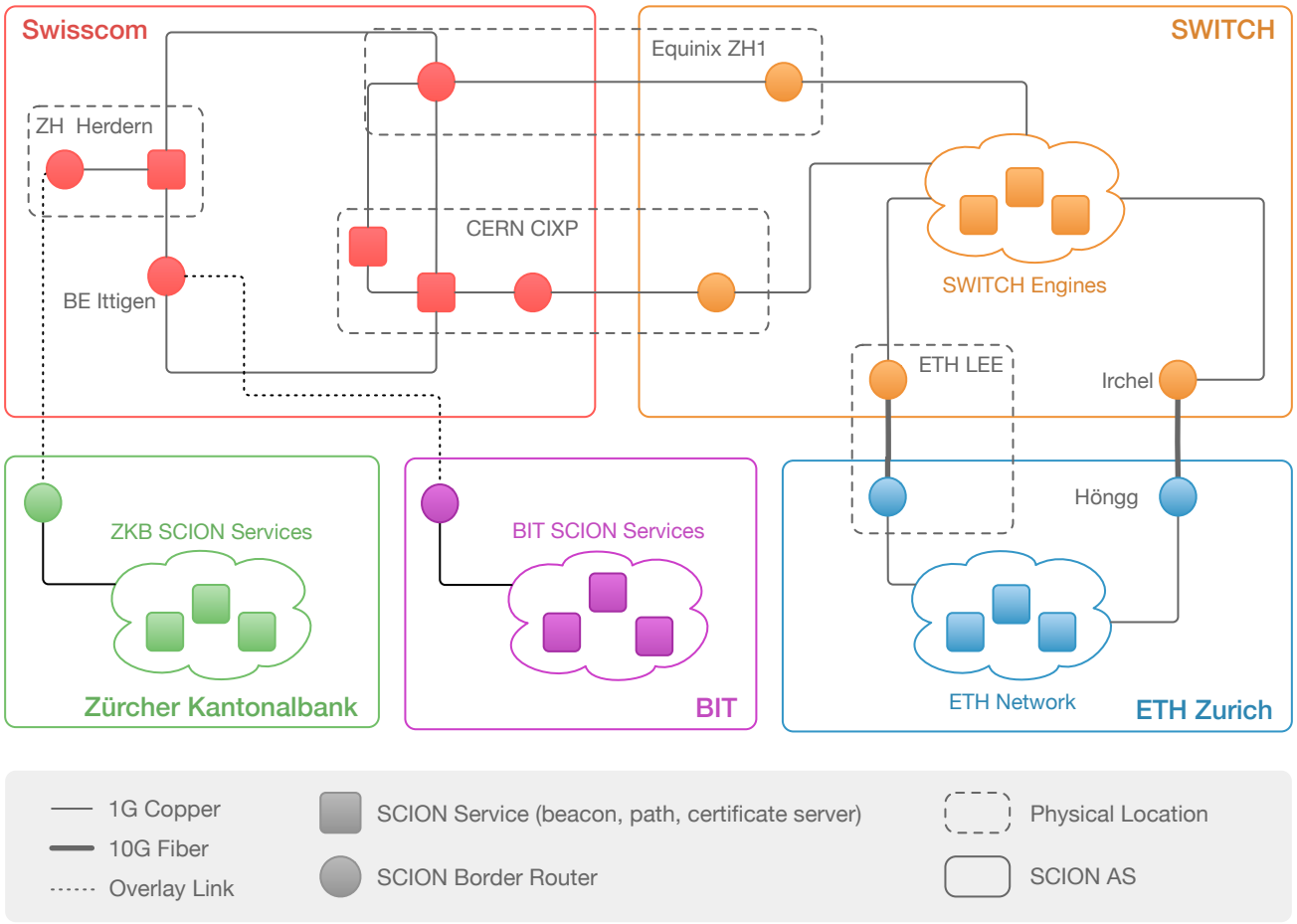
Swiss SCION Network



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Zürcher Kantonalbank

Schweizerische Eidgenossenschaft
Confédération suisse
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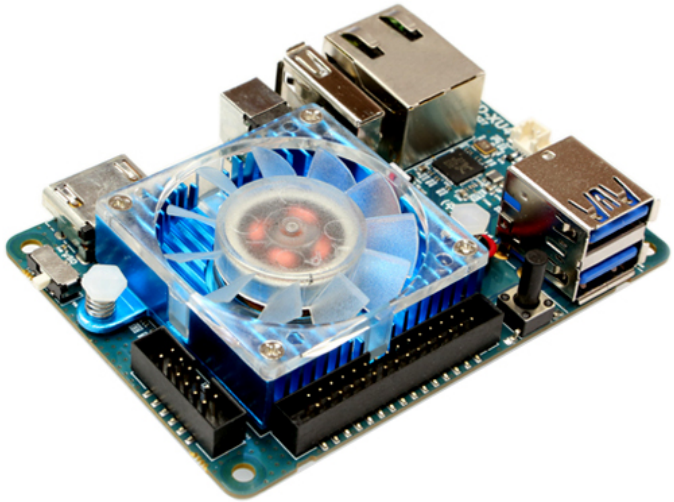
SCION AS runs on ODROID and Raspberry Pi

ODROID
Hardkernel



Raspberry Pi

Belief that Internet is Immutable

- Evidence appears overwhelming that Internet is immutable: IPv6, BGPSEC, DNSSEC, etc.
- However, benefits are limited, esp. for early deployers
- Our goal: provide many benefits, even for early adopters, such that one cannot turn back

Conclusions

- SCION is a secure Internet architecture that we can start using **today**
- Many use cases
  - Cost savings with replacement of leased lines
  - Business continuity: high-speed failover
  - Highly secure communication network
    - Strong defense against DDoS attacks, with communication guarantee
    - Path guarantee, attacker cannot re-route traffic
    - No external kill switches, regaining Internet Sovereignty

SCION Projekt Team

- Netsec: Daniele Asoni, Laurent Chuat, Sergiu Costea, Sam Hitz, Mike Farb, Tobias Klausmann, Jonghoon Kwon, Tae-Ho Lee, Sergio Monroy, Chris Pappas, Juan Pardo, Adrian Perrig, Benjamin Rotenberger, Stephen Shirley, Jean-Pierre Smith, Brian Trammell
- Infsec: David Basin, Tobias Klenze, Ralf Sasse, Christoph Sprenger, Thilo Weghorn
- Programming Methodology: Marco Eilers, Peter Müller

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SCION Commercialization

- To commercialize SCION, we have founded Anapaya Systems in June 2017
  - 4 Founders: Prof. David Basin, Sam Hitz (CEO), Prof. Peter Müller, Prof. Adrian Perrig
- We already have several bank and ISP customers
- We are starting to seek investors
- Visit us at: **www.anapaya.net**

Additional 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