SCION, hitting the future Internet road: Next-generation Internet ecosystem and burgeoning opportunities

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What is SCION?

Clean design of an Inter-domain network architecture that considers security from design to achieve:

• Availability
• Transparency and control
• Reliability and scalability

Open-source project: https://github.com/scionproto/scion
Why SCION?

Alternative to our old friend BGP/IP Internet.

SCION incorporates these security requirements from the inception.

Two-napkin original BGP protocol
Why SCION?

The network must provide availability even under the presence of malicious actors.
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Digging into the Orange España Hack

By Doug Madory on 26 Jan 2024

Category: Tech matters

Tags: Guest Post, outages, RPKI, security

On 3 January 2024, Spain’s second-largest mobile operator, Orange España, experienced a national outage spanning multiple hours. The cause? A compromised password and an increasingly robust routing system. It turns out that the network operator’s favourite defence tool (RPKI) can be a double-edged sword.
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Attackers exploit fundamental flaw in the web’s security to steal $2 million in cryptocurrency

MARCH 9, 2022 BY HENRY BIRGE LEE

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Hungry? Stay for SCION real-world feast

SCION is deployed in practice, not only a research project

Yummy desserts:
- Browsing the next-gen Internet
- SCION first-person Shooter
- SCION Walkthrough for Developers

But first the main course...
SCION ecosystem

- Research
- ISPs
- Vendors Integrators
- Users
SCION’s distinctive aspects

- Path-aware Internet Architecture
- Scalable trust infrastructure for the heterogeneous world via Trust Domains
- Scalable path discovery for rapid global connectivity
- Highly dense multipath for fine-grained path optimization
- Real-world deployment
Grouping of Autonomous Systems (AS) that share a common TRC.

Trust Root Configuration (TRC)
- Set of signed certificates and policies

Core AS
- AS that provides ISD connectivity and participates in the TRC management.
SCION Control Plane

Path Dissemination for Rapid Global Connectivity
SCION Control Plane

Path Dissemination for Rapid Global Connectivity

• Beacons (Routing info messages)
• Beacons authenticated at every hop
SCION Control Plane

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To achieve:

- **Rapid path exploration**
- **Scalability** (processing, communication and state overhead)

Exhaustive evaluation:

Deployment and Scalability of an Inter-Domain Multi-Path Routing Infrastructure; Krähenbühl et al.; CoNEXT 2021
Highly dense Multipath

Endhosts benefit from simultaneous multipath for fine-grained optimization:

- Low latency, jitter
- High bandwidth
- Privacy, anonymity
- Low CO2 footprint
- Jurisdiction
Highly dense Multipath

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- Low latency, jitter
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Dozens or even **100+ different** paths in the production SCION Network

- Likely to find the best path
Path-based Network Architecture

Control Plane - Routing
- Path information discovery (as seen previously)

Data Plane - Packet forwarding
- Combine Path Segments to Path
- Packets contain Path
- Routers forward packets based on Path
  - Simple routers, stateless operation
Real-world Deployment

Global SCION Internet (some parts):
- SCIERA: SCION Education, Research and Academic Network
- Secure and resilient communication fabric for industries
  - SSFN
  - SSHN
- ...

SCIONLab Testbed Network
SCION Production Network

BGP-free global communication (Not an overlay!)

- BGP fault independent
- Deployment with international ISPs around 100+ ASes
  - CH, EU, NA, Asia, ...
- SCION cloud-based access offered by some CSP (currently AWS).
Universities:
• Princeton University, OVGU Magdeburg, KAUST, Korea University, University of Virginia, NCSR-Demokritos
SCIERA: Education & Research ISD

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Research institutions:
• SIDN, CSCS, KISTI, CyberEX
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Research institutions:
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Research and Education Networks:
• SWITCH, GÉANT, KREONET, RNP, WACREN, BRIDGES
SCIERA: Education & Research ISD

Main networks providing connectivity: GÉANT, Kreonet, SWITCH
SCION Industry Networks

SSFN: Secure Swiss Finance Network

Launched in 2021 by SIX and SNB.

Facilitates sound Interbank Payments, phasing out previous Finance IPNet by June 2024 and connecting ~120 participants
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SSHN: Secure Swiss Healthcare Network

HIN Trust Circle (HIN Vertrauensraum) provides connectivity based on SCION to ~50,000 health professionals since December 2022
SCIONLab testbed

Globally distributed testbed to conduct experiments and test deployments

Anyone can join the network only downloading a VM.
For you, developers!
SCION is getting awesome

- Curated list of awesome SCION projects
  (https://github.com/scionproto/awesome-scion)
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- Infrastructure
  - Tofino SCION Router, eXpress router (XDP/P4),...
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  - Applications
    - Browser-extension, (SCION-aware) QUAKE III,...
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  - Go, Java (WIP), Rust, Bindings
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- Applications
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- Libraries
  - Go, Java (WIP), Rust, Bindings
- Tools
  - SEED Emulator, scapy library, Wireshark
SCION-enabled Browser Demo on macOS
SCION-aware QUAKE III?
Getting started – Your own project

- Go API: [https://pkg.go.dev/github.com/netsec-ethz/scion-apps/pkg/pan#DialUDP](https://pkg.go.dev/github.com/netsec-ethz/scion-apps/pkg/pan#DialUDP)
  
  ```go
  func DialUDP
  func DialUDP(ctx context.Context, local netaddr.IPPort, remote UDPAaddr, policy Policy, selector Selector) (Conn, error)
  ```

  DialUDP opens a SCION/UDP socket, connected to the remote address. If the local address, or either its IP or port, are left unspecified, they will be automatically chosen.

  DialUDP looks up SCION paths to the destination AS. The policy defines the allowed paths and their preference order. The selector dynamically selects a path among this set for each Write operation. If the policy is nil, all paths are allowed. If the selector is nil, a DefaultSelector is used.

- Go API also has [C, C++ and Python bindings](https://github.com/MystenLabs/scion-rs)
- Rust API: [https://github.com/MystenLabs/scion-rs](https://github.com/MystenLabs/scion-rs)
SCION Java client

- 100% pure Java client
- API similar to DatagramChannel (and DatagramSocket)
- API for path inspection and selection
- SCMP echo & traceroute (ICMP for SCION)
Basic Java client

SCION DatagramChannel can be used (exactly) as Java.nio DatagramChannel:

```java
InetSocketAddress addr = new InetSocketAddress("ethz.ch", 80);
try (DatagramChannel channel = DatagramChannel.open()) {
    channel.configureBlocking(true);
    channel.connect(addr);
    channel.write(ByteBuffer.wrap("Hello Scion".getBytes()));
    ...  
    ByteBuffer response = ByteBuffer.allocate(1500);
    channel.read(response);
}
```
Java client with PathPolicy

SCION DatagramChannel with PathPolicy:

```java
InetSocketAddress addr = new InetSocketAddress("ethz.ch", 80);
try (DatagramChannel channel = DatagramChannel.open()) {
    channel.configureBlocking(true);
    channel.connect(addr);
    channel.setPathPolicy(PathPolicy.MAX_BANDWIDTH);
    channel.write(ByteBuffer.wrap("Hello Scion".getBytes()));
    ...
    ByteBuffer response = ByteBuffer.allocate(1500);
    channel.read(response);
}
```
Java server

SCION DatagramChannel can be used similarly to JDK DatagramChannel:

```java
try (DatagramChannel channel = DatagramChannel.open()) {
    ...
    ByteBuffer request = ByteBuffer.allocate(1500);
    Path pathToClient = channel.receive(request);  // SCION specific
    ...
    ByteBuffer response = ... ;
    channel.send(response, pathToClient);
}
```

`receive()` returns a Path that can be used for `send()`
PathPolicy

Predefined algorithms

• FIRST
• MIN_HOP
• MIN_LATENCY*
• MAX_BANDWIDTH*
• IsdAllow
• IsdDisallow
PathPolicy

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Example: geofencing
PathPolicy

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Example: geofencing

PathPolicy geoFence = new IsdDisallow(99);
channel.getPathPolicy(geoFence);
Getting started – Testing

Run a local network with the reference implementation

- Code: [https://github.com/scionproto/scion](https://github.com/scionproto/scion)
- Docs: [https://docs.scion.org/en/latest/dev/run.html](https://docs.scion.org/en/latest/dev/run.html)
Getting started – Testing

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$ ./scion.sh topology -c your_topo.topo
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$ ./scion.sh topology -c your_topology.topo
$ ./scion.sh topodot your_topology.topo
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```
$ ./scion.sh topology -c your_topology.topo
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$ ./scion.sh run
```
Getting started – Testing

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```
$ ./scion.sh topology -c your_topology.topo
$ ./scion.sh topodot your_topology.topo

$ ./scion.sh run
$ scion ping 1-ff00:0:110,0.0.0.0 --sciond 127.0.0.29:30255
88 bytes from 1-ff00:0:110,0.0.0.0: scmp_seq=0 time=0.770ms
```
Getting started – Testing

- Other options for **testing**
  - Use **SEED** network emulator
  - **SCIONLab**: A world wide testbed (overlay network)
- Production network
  - Some **ISPs** and **AWS** offer SCION access
  - In a University with SCION access: **SCIERA**
- Debugging
  - Scion ping, traceroute, showpaths, ...
- Monitor traffic with **wireshark SCION plugin**
Want to contribute?

- Create **your own projects**
  - Language libraries/bindings: C, C++, C#, Swift, ...
  - Support for embedded & mobile devices
  - Network protocols (E.g. Java: TCP, HTTP1/2, …)
- Add SCION support to **other projects**:  
  - web proxies, http servers
  - chat & video conferencing
  - gaming, …
Getting started – Getting Help

slack
scionproto workspace

matrix
#dev:matrix.scion.org

stack overflow
tag questions with scion