Evaluation of SCION for User-driven Path Control: a Usability Study

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The **Responsible Internet** [1] is a novel security-by-design concept and extension to the internet that enables higher levels of trust and data autonomy.

It turns the Internet infrastructure from a black box to a ‘glass box’

It brings Transparency, Controllability and Accountability to the Internet

The UPIN project

UPIN: User-driven Path verification and control for Inter-domain Networks enables users to control and verify paths that their data travels through [2]

Path characteristics include locations, manufacturers, jurisdictions applied, VNFs, ...

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As a path-based architecture, SCION end hosts learn about available network path segments, and combine them into end-to-end paths that are carried in packet headers. This approach enables path-aware communication, an emerging trend in networking.

\textsuperscript{[3]} Xin Zhang, Hsu-Chun Hsiao, Geoffrey Hasker, Haowen Chan, Adrian Perrig, and David G. Andersen. \textit{SCION: Scalability, Control, and Isolation on Next-Generation Networks}. 2011
Our testbed: SCIONLab

SCIONLab provides a fully distributed SCION network infrastructure, made up by different ASes organized in ISDs.

Researchers can define their own ASes and connect them to the SCION network, for running experiments.
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Our AS connected to the testbed. We will run tests from there.
Goals and experiments

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• This is an overview of our 3-tier software architecture
  • Paths collection: we gather what paths are available from our client to each destination or server
  • Path test execution: we test each path performance
  • Stats storage: we store data in a database
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  • Stats storage: we store data in a database
• Then we can query our DB to provide users with the path they need
Database structure

paths_stats
- _id
- avg_latency
- avg_bandwidth_cs_64
- avg_bandwidth_sc_64
- avg_bandwidth_cs_MTU
- avg_bandwidth_sc_MTU
- hops
- isolated_domains
- avg_loss
- timestamp
- hops_number

paths
- _id
- hop_predicates
- MTU
- expected_min_latency
- active
- destination_address
- source_address

availableServers
- _id
- source_address
Implementation

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• `scion showpaths --extended --m 40`

  This command provides a maximum of 40 paths for each destination, ranked by hop count, along with hops predicates (hops traversed in the path), MTU, path status and minimum latency expected over the path. We use this command for paths collection.
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• **scion ping {server_address} --c 30 --sequence '{hop_predicates}' --interval 0.1s**
  
  From the output of this command we calculate the average latency measured by the 30 packets sent in milliseconds and the packet loss percentage. We run this command in 3 nested loops: per each path, per each destination, ‘iteration’ number of times.
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• **scion-bwtestclient -s {server_address} -cs 3,64,?,12Mbps -sequence '{hop_predicates}'**

  For the bandwidth we add the test duration (3s), the packet size (64 bytes), a wildcard for the number of packets automatically computed by the application, and the desired bandwidth to achieve (in this case 12Mbps). Downlink and uplink are saved as different values.
Results: Latency

Average Latency Values measured for each path of destination 16-ffaa:0:1002,[172.31.43.7] (AWS - Ireland). Box plots are split into 6 hops paths length, in red, and 7 hops paths length, in purple.
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If we need to satisfy strong requirements on latency, we know what paths to avoid
Results: Latency

Average latency for each ISD set grouped by hop count. On the left side, the plot includes all the measurements. On the right side, long distance paths have been excluded from the second ISD set.
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The hops number alone is not enough to determine the latency variance or increment. The physical distance between hops confirms to be the predominant component in the latency assessment.
Average bandwidth values for each path, requiring a bandwidth of 12Mbps from and to a Server in Germany (address on the top). On the left side there are the upstream measurements, while on the right side the downstream ones.
• Average bandwidth values for each path, requiring a bandwidth of 150 Mbps from and to a Server in Germany (address on the top). On the left side there are the upstream measurements, while on the right side the downstream ones.
• Average packet loss percentage for each path of AWS US N. Virginia AS. Each dot color represents a path and its size the number of measurements having the same loss ratio. Dots legend is on the upper right corner.
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• The software design is based on a **database** where we store data gathered on many paths, that we then query to select the best one to give to a user.
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• We confirmed that **latency** in SCIONLab is affected mostly by the physical distance among the nodes building the path, rather than and that the number of hops or the ISDs traversed.
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The path selection feature of SCION, when coupled with a robust test-suite and data analysis techniques, blends into a powerful tool that helps to fulfill the controllability requirement of a UPIN user.
Thank you