



Hello everyone

We hope you all had an enjoyable Autumn, despite the ongoing situation. At least we hope you've been spared from too many disturbances due to network troubles now that video conferencing is more important than ever. In case you did experience problems, we hope that SCION will help to reduce such issues in the future and allow you to focus on long-term challenges instead of resolving the emergency of the moment.

We continue to witness attacks and outages that SCION would have prevented. One key reason why SCION excels at mitigating such attacks is its multi-path capabilities, which leads us to the topic of this newsletter:

Multipath routing is not a luxury, but a necessity for high availability communication.

On the research side, Claude discusses the necessity of a multi-path Internet and Ali follows with an analysis on how SCION, an architecture with built-in multi-path support, scales in comparison to BGP. In the education category, Markus reports on the SCIONLab Tutorial that was hosted at this year's SIGCOMM conference. Finally, we report about media coverage, attended conferences, and recently accepted papers—where one of highlights was that the SCIONLab paper received the best paper award at the IEEE ICNP conference.

RESEARCH

Multi-path Routing is not a Luxury, but a Necessity

Claude Hähni

To see why a multi-path routing protocol is crucial for achieving availability on the Internet, we first need to understand why a single-path routing protocol is insufficient for achieving this property. Malicious activities, such as daily BGP hijacking incidents, or simple equipment failures require a single-path protocol to update its routing information. Typically routing convergence takes several minutes, during which time no path may be available. The resulting outage potentially affects thousands of end-hosts which then are no longer able to communicate over the Internet. Even if connectivity is not broken, but suffers from severe packet loss, end-hosts are forced to wait until connectivity is restored.

An example of this was witnessed on July 12th when a misconfiguration in Cloudflare's backbone redirected large amounts of traffic over a small link with insufficient capacity. As a result, many major websites and services were unavailable for 27 minutes.¹ A compromise that every single-path protocol has to make is an assumption about which path is the overall "best" path and then use it for all communication. In the case of BGP, this best path often means the cheapest path. Such a system is, by design, ignoring the fact that different applications have different needs and require different properties from the network.

A protocol like SCION on the other hand, which supports true multi-path routing, enables rapid failover to functioning paths in case of an outage. There is no need to wait for network convergence: As long as there exists a single working path, end-to-end connectivity is retained.

Furthermore, applications can choose the most efficient path given their purpose. A voice-over-IP (VoIP) application, which benefits from low latency, would choose a different path than an application for high-bandwidth transmissions. With SCION, both applications can select their optimal path.

Having several paths available also means that naturally there is more network capacity available for end-hosts. For instance, enterprises can make full use of their backup links that would otherwise be idle. Another use case is high-bandwidth file transmission simultaneously using multiple paths.

Talking about security, it is also apparent why a multi-path routing protocol is superior to its single-path sibling. One of the most common attacks on the Internet are DoS attacks with an ever increasing annual damage. With SCION, an adversary would need to congest all links towards an entity in order to cut off all communication. Of course this is much more difficult for an attacker to accomplish. In case hidden paths are used, an attacker cannot congest them—enabling legitimate users with access to the hidden paths to communicate despite attacks.

The insight that we gain from these observations is that for a modern and highly available Internet, multi-path is not a luxury but truly a necessity.

SCION Routing Scalability Analysis

Seyedali Tabaeiaghdaei

SCION addresses many scalability issues from which the legacy Internet is suffering. From the control-plane (routing protocol) perspective, there are two main problems in today's inter-domain routing protocol BGP: (1) Routing Table Size: Routing tables are stored in TCAM memories, which are fast but expensive and power-hungry. As the number of allocated IPv4 and IPv6 address blocks increases, the size of BGP routers' routing tables increases. The number of allocated IPv4 and IPv6 blocks has shown a linear growth in recent years. This causes scalability problems for routers due to the limited size of TCAMs. (2) Churn, or the number of control plane / routing messages. Many researches have shown

¹ <https://blog.cloudflare.com/cloudflare-outage-on-july-17-2020>

that BGP churn grows linearly as the number of ASes in the Internet grows. In recent years, the number of ASes indeed grew linearly. This also gives rise to another scalability issue as the control-plane messages consume large amounts of bandwidth on links between BGP speakers, especially during periods of routing instabilities.

The first problem is solved by SCION by eliminating the need for inter-domain routing tables. Since every SCION packet carries its own AS-level path, there is no need for a routing table that stores the path to every network in the world.

SCION solves the churn scalability issue through several complementary approaches. The isolation-domain (ISD) approach adds a two-level hierarchy, separating path exploration within an ISD from path exploration between ISDs. Within an ISD, path construction flows from a few so-called core ASes towards end domain ASes, which dramatically reduces the overhead (in contrast, today's BGP protocol requires every AS to flood the entire Internet with a BGP update message, which in case of BGPsec cannot even be aggregated). SCION path exploration furthermore does not rely on a convergence process, which creates a lot of overhead in BGP. The end result we find from our Internet-scale simulations is quite dramatic: the effort for finding inter-ISD paths in SCION is about 6 times lower than in BGP, and the effort for finding intra-ISD paths is about 50 times lower than in BGP! When considering that in this setting, SCION found 30-50 different paths between every pair of core ASes in the inter-ISD case, SCION is about 200 times more effective than BGP in finding paths. Since in our simulations BGPsec has about 5 times the overhead of BGP, we find that SCION is about 1000 times more efficient than BGPsec. (A paper documenting these findings is in preparation and can be shared on request.)

EDUCATION

Tutorial and SCIONLab Update

Markus Legner

At this year's [SIGCOMM conference](#), the flagship annual conference of the ACM Special Interest Group on Data Communication (SIGCOMM), Adrian Perrig, Markus Legner, and Juan A. García-Pardo from the Network Security Group at ETH Zurich and David Hausheer from the Otto-von-Guericke-Universität Magdeburg hosted a [tutorial on the next-generation Internet architecture SCION](#).

Participants learned about revolutionary properties and concepts of SCION, such as path-aware networking, isolation domains, and flexible control-plane public-key infrastructures, and were able to explore the architecture in a hands-on session through the [SCIONLab testbed](#).

Both the tasks for the hands-on session and the videos are [publicly available](#).

The tutorial was well-received and attendees were excited to hear about the possibilities and benefits that a new Internet architecture can offer.

SCION IN THE NEWS

SIDN LABS

Together with partners in the 2STiC programme, SIDN Labs looked at emerging Internet infrastructures and published a blog in which they give an introduction to SCION. <https://www.sidnlabs.nl/en/news-and-blogs/new-internet-infrastructures-an-introduction-to-scion>

DFN

The news magazine "DFN Mitteilungen" includes an article about our SCIONLab testbed. DFN is the German National Research and Education Network, which is now providing a core AS in SCIONLab on top of their DFN-GVS (General-Virtualization-Service) infrastructure. The DFN-GVS platform enables its users to establish native SCION links with the global SCIONLab network.

<https://www.scion-architecture.net/newsletter/dfn.pdf>

CONFERENCES

Adrian Perrig recently delivered three keynote talks at the following conferences: ACM ASIA Conference on Computer and Communications Security (ACM AsiaCCS), IEEE International Conference on Network Protocols (IEEE ICNP), and International Conference on Applied Cryptography and Network Security (ACNS). Thanks to the online nature of conferences this year, the keynotes were recorded and are now available online.

AsiaCCS with a focus on security aspects:

Video: <https://cloud.inf.ethz.ch/s/oRCtANQCepBmFyM>

Slides: <https://cloud.inf.ethz.ch/s/ykQxPNLqx4bbJeo>

ICNP with a focus on networking aspects:

Video: <https://cloud.inf.ethz.ch/s/iF3Atz85DPMLgwc>

Slides: <https://cloud.inf.ethz.ch/s/H5x8dL2w6Lqwq5M>

RECENT RESEARCH RESULTS

EPIC: Every Packet Is Checked in the Data Plane of a Path-Aware Internet.

Markus Legner, Tobias Klenze, Marc Wyss, Christoph Sprenger and Adrian Perrig.
In Proceedings of the USENIX Security Symposium 2020.

https://netsec.ethz.ch/publications/papers/Legner_Usenix2020_EPIC.pdf

sRDMA: Efficient NIC-based Authentication and Encryption for Remote Direct Memory Access.

Konstantin Taranov, Benjamin Rothenberger, Adrian Perrig and Torsten Hoefler.
In Proceedings of the USENIX Annual Technical Conference (USENIX ATC) 2020.
<https://netsec.ethz.ch/publications/papers/srdma-final.pdf>

AWARDS

Best Paper Award at the IEEE ICNP conference

SCIONLab: A Next-Generation Internet Testbed.

Jonghoon Kwon, Juan A. García-Pardo, Markus Legner, François Wirz, Matthias Frei, David Hausheer, and Adrian Perrig.

In Proceedings of the 28th IEEE International Conference on Network Protocols (ICNP) 2020.

https://netsec.ethz.ch/publications/papers/icnp2020_scionlab.pdf

<https://icnp20.cs.ucr.edu/program.html#s4>

Thanks for your continued support and stay tuned for further updates!

The SCION team