Exploring the Deployability of Intra-AS Protocols through Network Simulation in SCION

Bachelor's Thesis Proposal

Currently, there are two ways to test new SCION [1] features: first, the SCIONLab [2] testbed allows users to connect and interact with the global SCIONLab network, and second, users can locally simulate arbitrary network topologies through SCION Proto. These local topologies consist of a number of inter-connected SCION ASes. The second approach is especially useful when testing features that require a specific network topology that cannot be found in the SCIONLab testbed.

Recently, support for simulating intra-AS networks based on Mininet [3] was added to the SCION simulation framework. This allows connecting SCION border routers, various SCION services, and endpoints, within a single SCION AS over a concrete internal topology, which greatly improves the realism of the simulation setup. However, the current intra-AS simulation is still quite limited in terms of supported protocols, functionalities, and evaluated topologies and use cases.

The goal of this thesis is to extend this intra-AS simulation. The tasks of this thesis would therefore roughly be as follows: (i) get familiar with the simulation framework of SCION and related technologies such as Mininet, (ii) choose one or multiple concrete extensions to analyze, (iii) implement the chosen extensions and evaluate them.
To give you an idea what kind of extensions could be interesting to look at, below are some suggestions.

- Support for different routing protocols (e.g., IS-IS [4])
- Support for path control (e.g., MPLS [5] or Segment Routing [6])
- Offering intra-AS multipath to complement SCION's multipath capabilities or do load-balancing (e.g., via ECMP)
- Support for SCION's bandwidth reservation system COLIBRI [7]
- Analyzing different (real-world) intra-AS topologies and their impact on SCION
- Time synchronization in intra-AS networks with different topologies

Topics

- Linux networking stack
- Routing Protocols
- Simulations and Emulations

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References

[1] L. Chuat et al., *The Complete Guide to SCION*. Springer International Publishing, 2022. https://doi.org/10.1007/978-3-031-05288-0.

[2] J. Kwon et al., "SCIONLab: A Next-Generation Internet Testbed," 2020. https://doi.org/10.1109/ICNP49622.2020.9259355

[3] Mininet. *Mininet: An Instant Virtual Network on Your Laptop (or Other PC)*, http://mininet.org/

[4] ISO Central Secretary, "Information technology – Telecommunications and information exchange between systems – Intermediate System to Intermediate System intra-domain routeing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network service," International Organization for Standardization, Geneva, CH, Standard ISO/IEC 10589:2002, Nov. 2002. https://www.iso.org/standard/30932.html

[5] E. Rosen, A. Viswanathan, and R. Callon, "Multiprotocol Label Switching Architecture," IETF, RFC 3031, Jan. 2001. http://tools.ietf.org/rfc/rfc3031.txt

[6] C. Filsfils, S. Previdi, L. Ginsberg, B. Decraene, S. Litkowski, and R. Shakir, "Segment Routing Architecture," IETF, RFC 8402, Jul. 2018. http://tools.ietf.org/rfc/rfc8402.txt

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