Path Validation in SCION

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Motivation and background

- SCION is a path-aware inter-domain architecture that provides:
  - Path authorization
  - High assurance that packet follows desired path
  - Proof-of-transit (as an extension)
- Existing work focuses on intra-domain path validation

SCION Overview
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SCION Component Analysis
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Control Plane PKI
Authentication
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Control Plane
Routing
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Data Plane
Packet forwarding
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Background: the SCION *inter-domain* routing architecture

Feature	Property
Endpoint path control: source endpoints select AS path and include it in packet header	• performance-based routing • **Geofencing**
Inter-domain multipath allows immediate failover	• Availability
Paths are authenticated at discovery and **verified at forwarding**	• **Path authorization** • Hijacking prevention • **Path validation (extension)**

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SCION: Approach

Property	Approach	Component
Path authorization (hop by hop)	Information at **each hop is authenticated with a MAC** (Message Authentication Code), checked by border routers at forwarding. Each AS only forwards traffic on paths that are explicitly authorized by the AS.	Standard SCION
Proof of Forwarding	EPIC adds **short *per-packet* MACs at each SCION hop**. Source authentication and path validation are enabled by the additional use of efficiently derivable symmetric keys.	EPIC extension, L3 [1]
Trust-enhanced networking	Extended **path policies include attributes about border routers**, so that endpoints can select routers/ASes with bases on specific path policies. Approach takes care of inter-domain paths, that are mapped to policy-compliant intra-domains paths. are attested by a third party, specific to each AS.	FABIRD extension [2]

1. Legner, Markus, et al. "EPIC: every packet is checked in the data plane of a Path-Aware Internet." 29th USENIX Security Symposium (USENIX Security 2020).
2. Krähenbühl, C., Wyss, M., Basin, D., Lenders, V., Perrig, A. and Strohmeier, M., 2023. FABRID: Flexible Attestation-Based Routing for Inter-Domain Networks. (USENIX Security '23)

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SCION: some use cases & adopters

- Internet-based enterprise communication for critical infrastructure
  - Connect multiple organizations, branches with performance-based routing, path control and inter-domain multipath (e.g. finance, power, blue lights, government, …)
- Geofencing: keeping traffic in a trusted area of the network

Some adopters:

- Swiss inter-banking network SSFN, Swiss healthcare network
- Swiss Internet Exchange
- Global education network
- Sui validator network
- and others being tested

Path validation: use cases in combination with inter-domain path-aware networking?

Why **is path validation** especially interesting for path-aware architectures?

- **Geofencing** (use only paths with routers in a given area, based on geolocation, jurisdiction, …)
- **Trust-enhanced networking:** Route based on attested router policies (e.g. vendor, patch level, ...)
- **Path stability** can be assured over time

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Conclusion

- Path validation provides interesting use cases in combination with inter-domain path-aware networking (geofencing, trust-enhanced networking)
- We see a gap in inter-domain path validation
  - SCION is inter-domain only, therefore It can can potentially reuse or build on top of other intra-domain path-validation techniques
  - Further work is required in this area (e.g. building on top of RATS)

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Questions?

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