Privacy-Preserving Detection of Inter-Domain SDN Rules Overlaps

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SDN inter-domain deployment is dangerous!

- SDN routing expressiveness is ***higher*** than in BGP

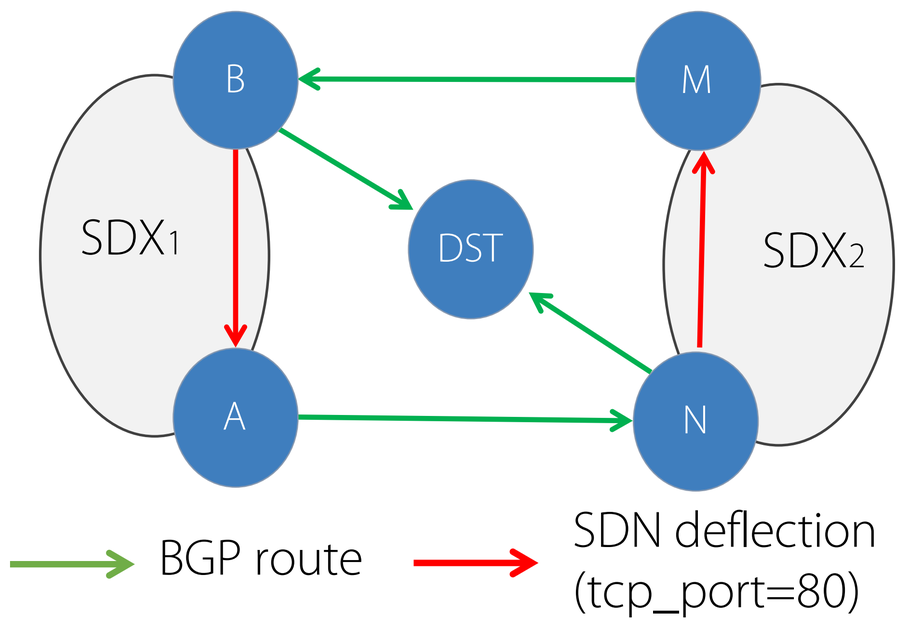
SDN source/destination IP/TCP, …

BGP destination IP only

- When deployed for inter-domain routing (e.g. at IXPs), SDN can be used to ***deflect*** specific traffic from BGP routes …with risk of permanent forwarding loops [1]

Forwarding loop example

- Networks *M* and *A* route their traffic towards a destination *DST* using paths *(M, B, DST)* and *(A, N, DST)*, resp.
- Networks *B* and *N* steer their HTTP traffic towards *A* and *M* resp. by installing SDN deflection at their Software-Defined eXchanges (SDXes)
- A loop through *M, B, A,* and *N* is created for HTTP traffic!



Detecting forwarding loops: Trading efficiency and correctness for privacy

- Detection correctness depends on the completeness of the shared forwarding information
- **Alternative #1**: One can share all forwarding information to achieve correctness at the price of privacy
- **Alternative #2**: One can hide some information to increase privacy at the price of correctness [1]
- **Our approach**: We want to **preserve correctness and privacy while still achieving practical runtimes**

DISTINCT-MATCH primitive

- A new privacy-preserving SDN verification primitive that allows any two networks, each one holding a set of SDN rules, to **verify whether the match space of the two sets of rules overlap**
- Based on Secure Multi-Party Computation (SMPC)

	match bits							
R1	1	*	*	1	0	*	1	0
R2	1	*	0	*	0	*	1	*

overlap on 1*010*10

	match bits							
R1	1	*	*	1	0	*	1	0
R2	1	*	0	*	1	*	1	*

distinct match

Practically good SMPC performance!

SDXes latency	Number of SDN rules				Baseline
	1	50	500	5000	
1 ms	5	9	24	33	3
10 ms	41	60	90	264	21
100 ms	401	599	839	2528	201

SMPC online evaluation in milliseconds

- Distinct-Match run time is comparable to network delay between the two SMPC parties

Detecting Inter-SDX forwarding loops

- We outsource SMPC to the SDXes → speed up by 5x
  - **SDXes learn whether some bits in the rules match or not but do not learn the contents of these rules**
- An SDX verifies if there exist networks downstream that deflect packets matching a given SDN rule, and iteratively follows deflections towards the next hop
  - **If a chain leads back to the SDX verifier → a forwarding loop is found**

FUTURE RESEARCH: Internet Network Verification vs. Privacy

- An operator wants to verify **general** properties of the Internet routing such as forwarding loops, blackholing, stability, and more without leaking any private information

ENDEAVOUR

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[1] R. Birkner et al. "SDX-Based Flexibility or Internet Correctness? Pick Two! ", SOSR 2017