



copycat: Testing Differential Treatment of New Transport Protocols in the Wild

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measurement and architecture for a middleboxed internet

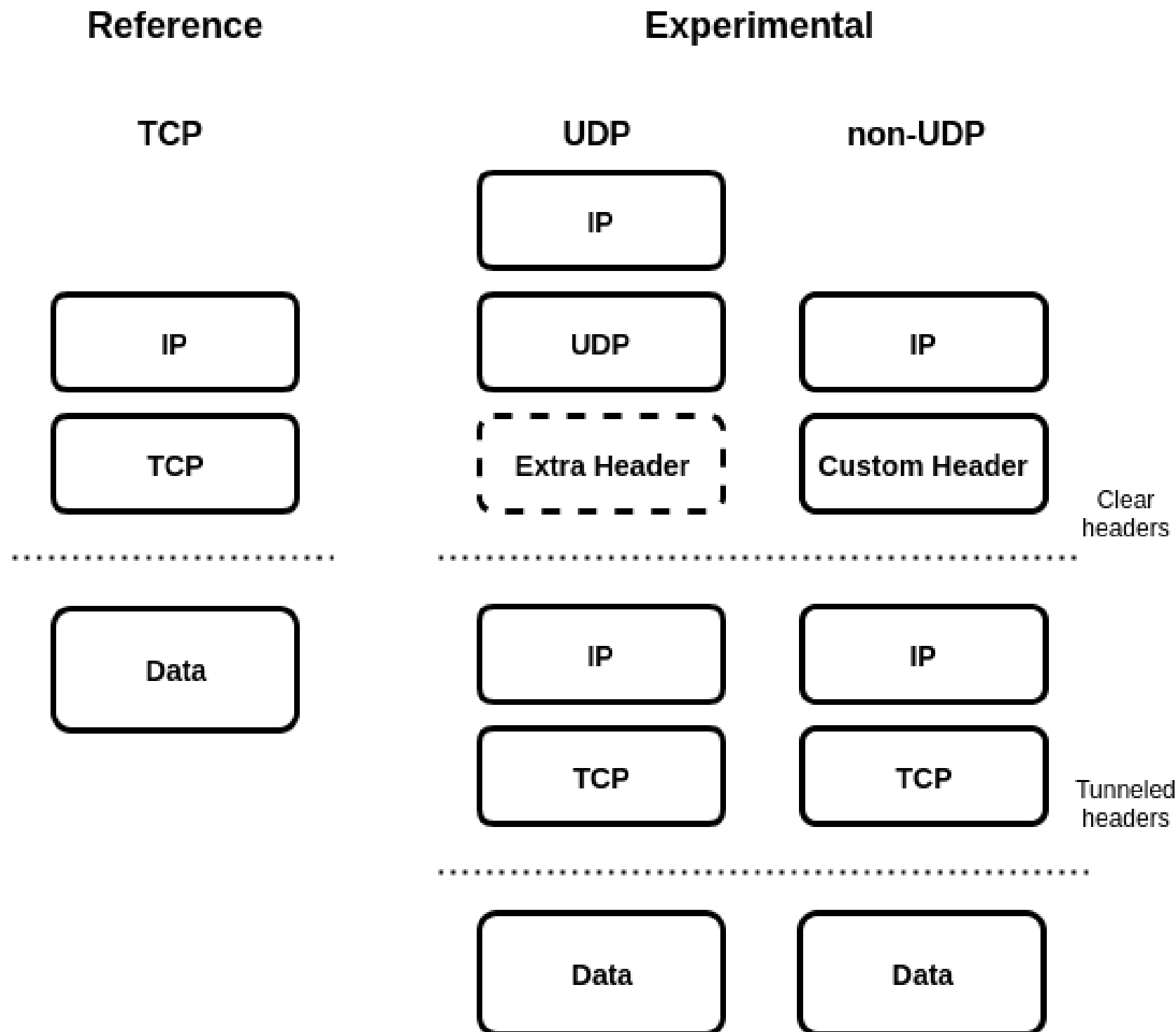


Overview



- Testing new extensions/protocols:
 - Simulator
 - Controlled environment
 - In the wild (req. patching endpoints)
 - “stateless” testing

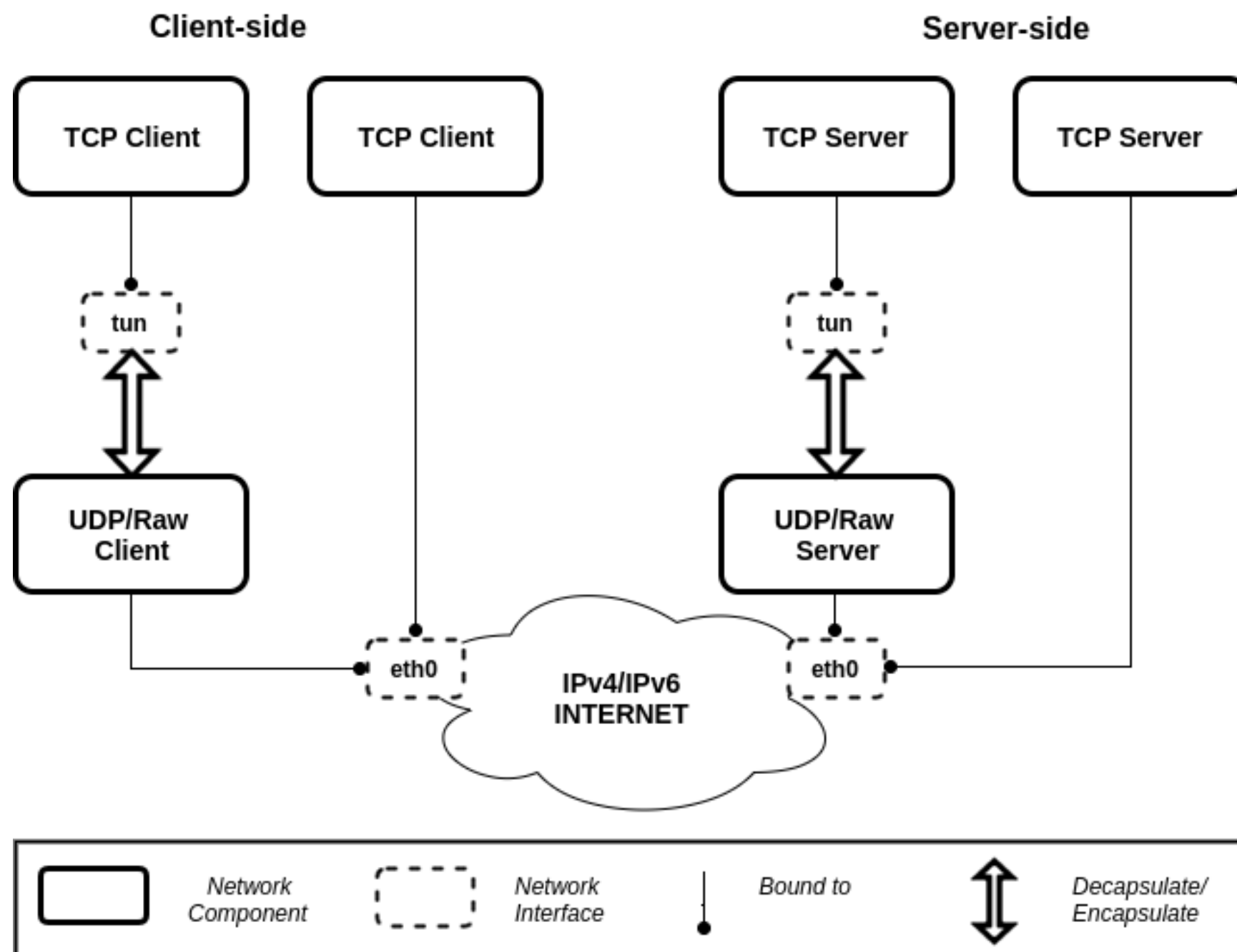
Encapsulation



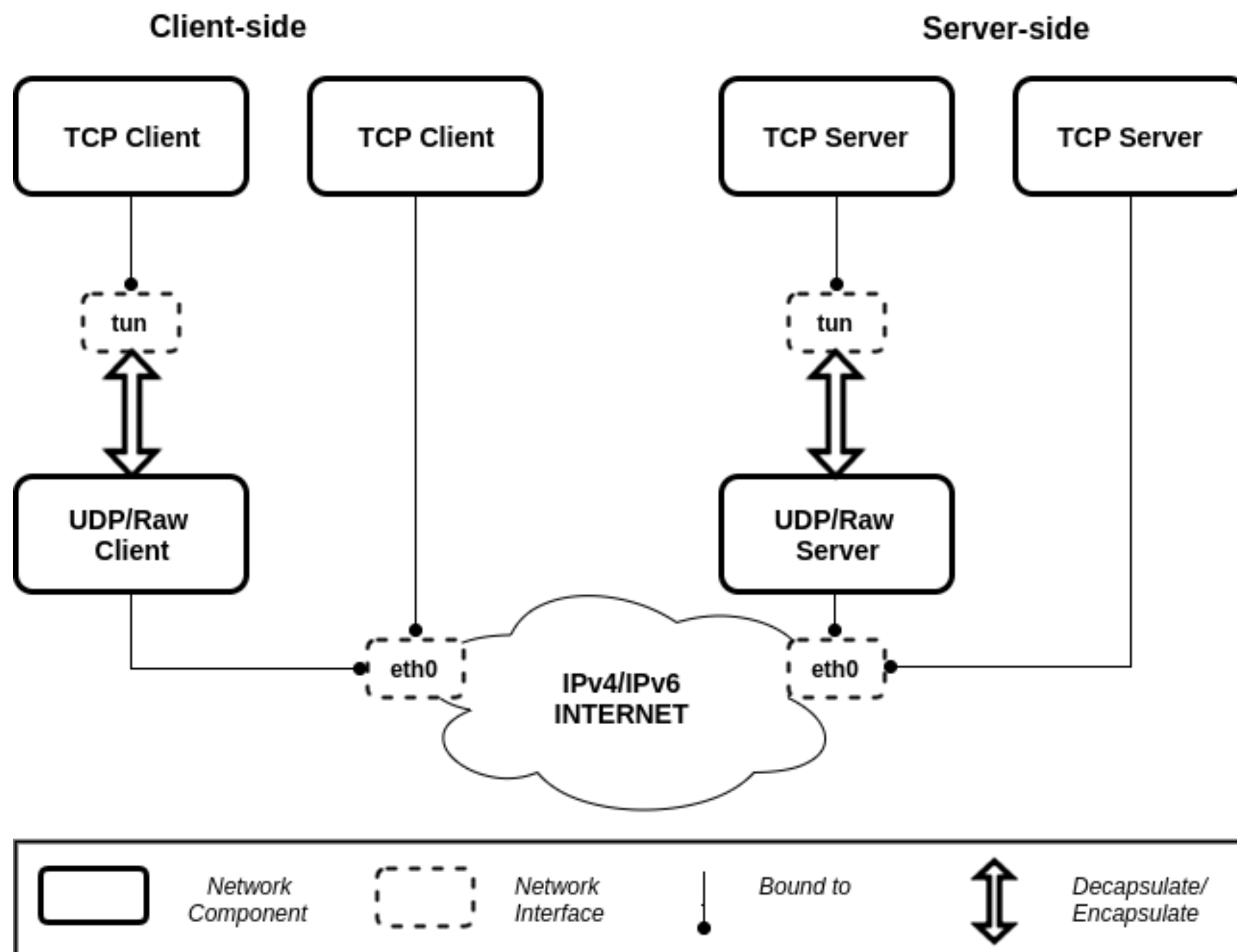
Example use cases:

- UDP: QUIC, PLUS
- Non-UDP: DCCP, SCTP, any

Architecture



Architecture



Features:

- Flow scheduling
- Network layer (IPv4, IPv6, IPv4 vs IPv6)
- Linux, FreeBSD, NetBSD, PlanetLab



Use Case: UDP for Internet Transport Evolution

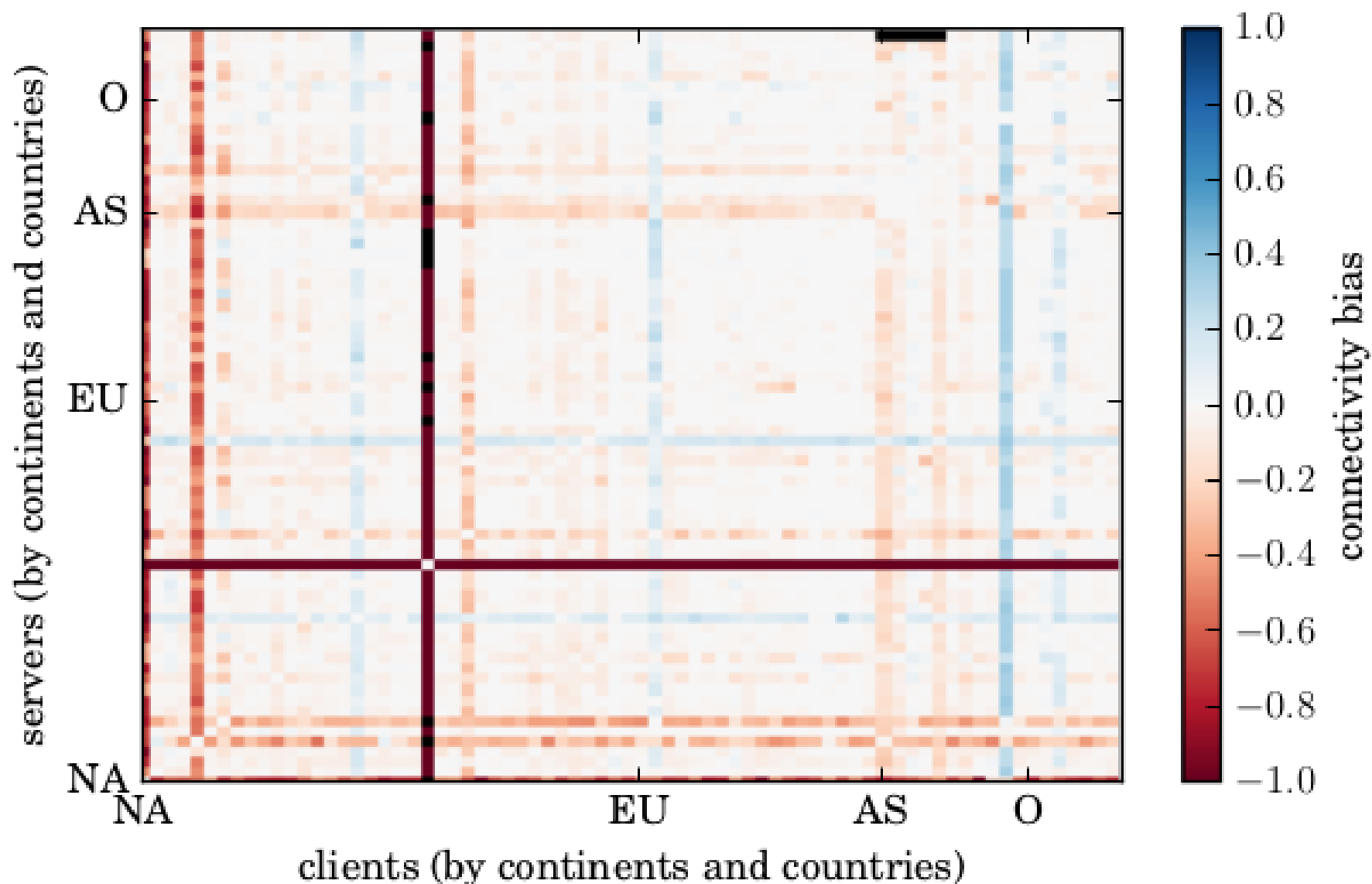
Measurement Setup:

- UDP with no extra header
- 93 PlanetLab nodes (IPv4), 6 Digital Ocean nodes (IPv6)
- 53, 443, 8008, 12345, 33435, 34567, 54321
- Flow sizes: 1 TCP IW, 3, 30, 300, 1500
- 1.6M IPv4, 32K IPv6 flows



UDP for Internet Transport

Evolution: Blocking

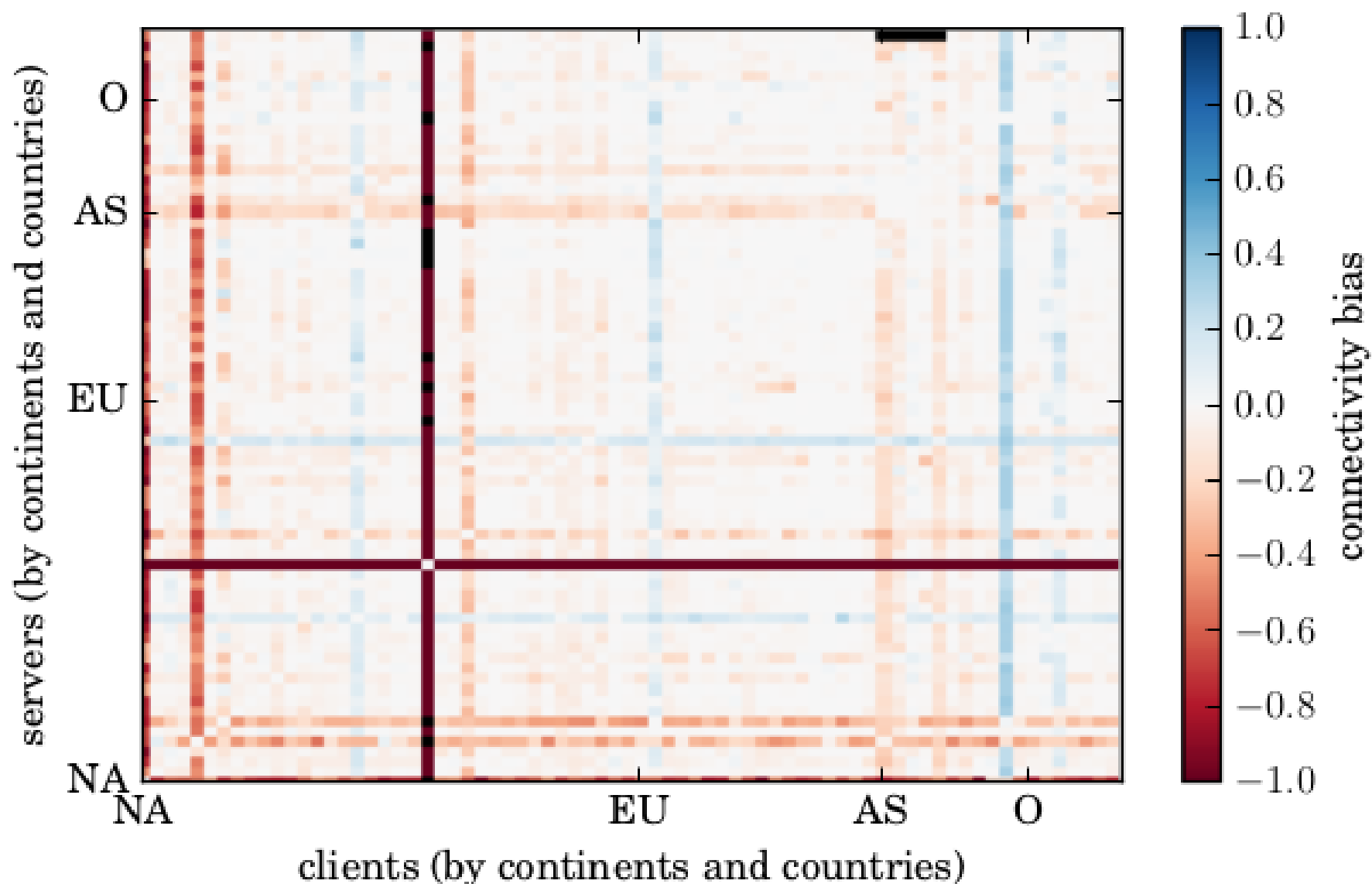


- +1: all UDP succeeded, all TCP failed.
- -1: all UDP failed, all TCP succeeded.



UDP for Internet Transport

Evolution: Blocking

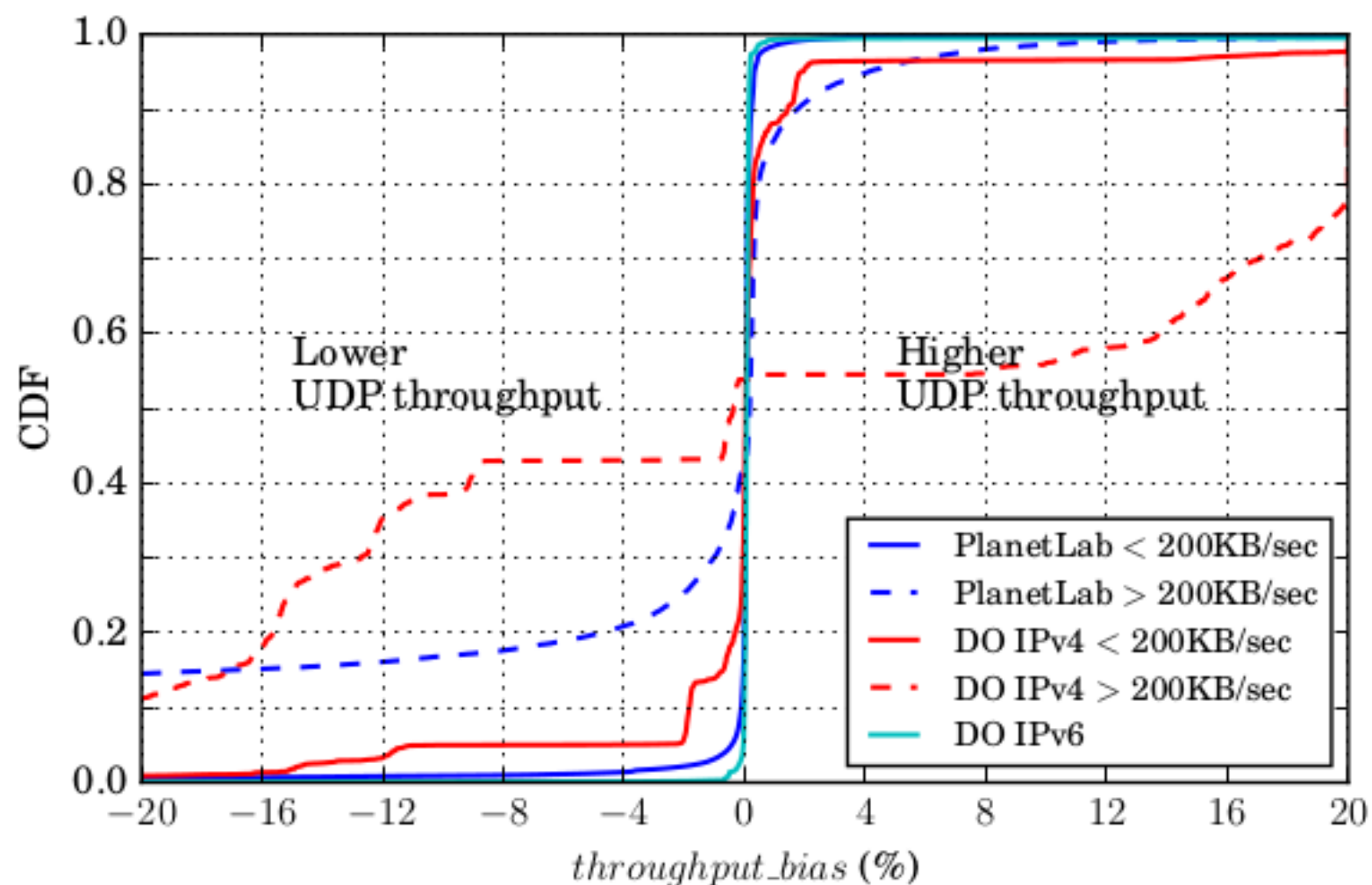


- +1: all UDP succeeded, all TCP failed
- -1: all UDP failed, all TCP succeeded
- *Access-Network linked impairments*



UDP for Internet Transport

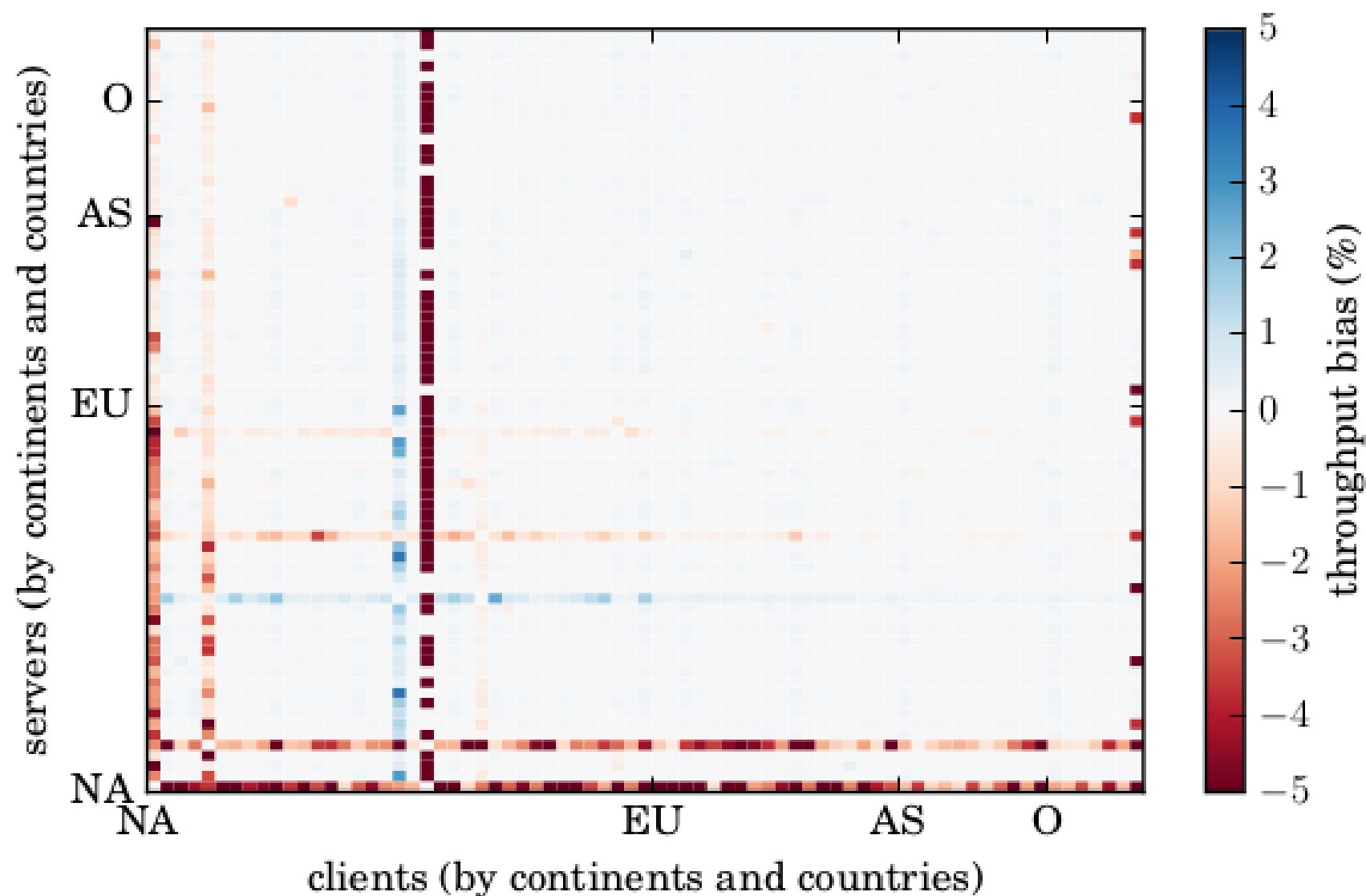
Evolution: Throughput



$$throughput_bias = \frac{throughput_{udp} - throughput_{tcp}}{\min(throughput_{tcp}, throughput_{udp})} * 100$$



UDP for Internet Transport Evolution: Throughput

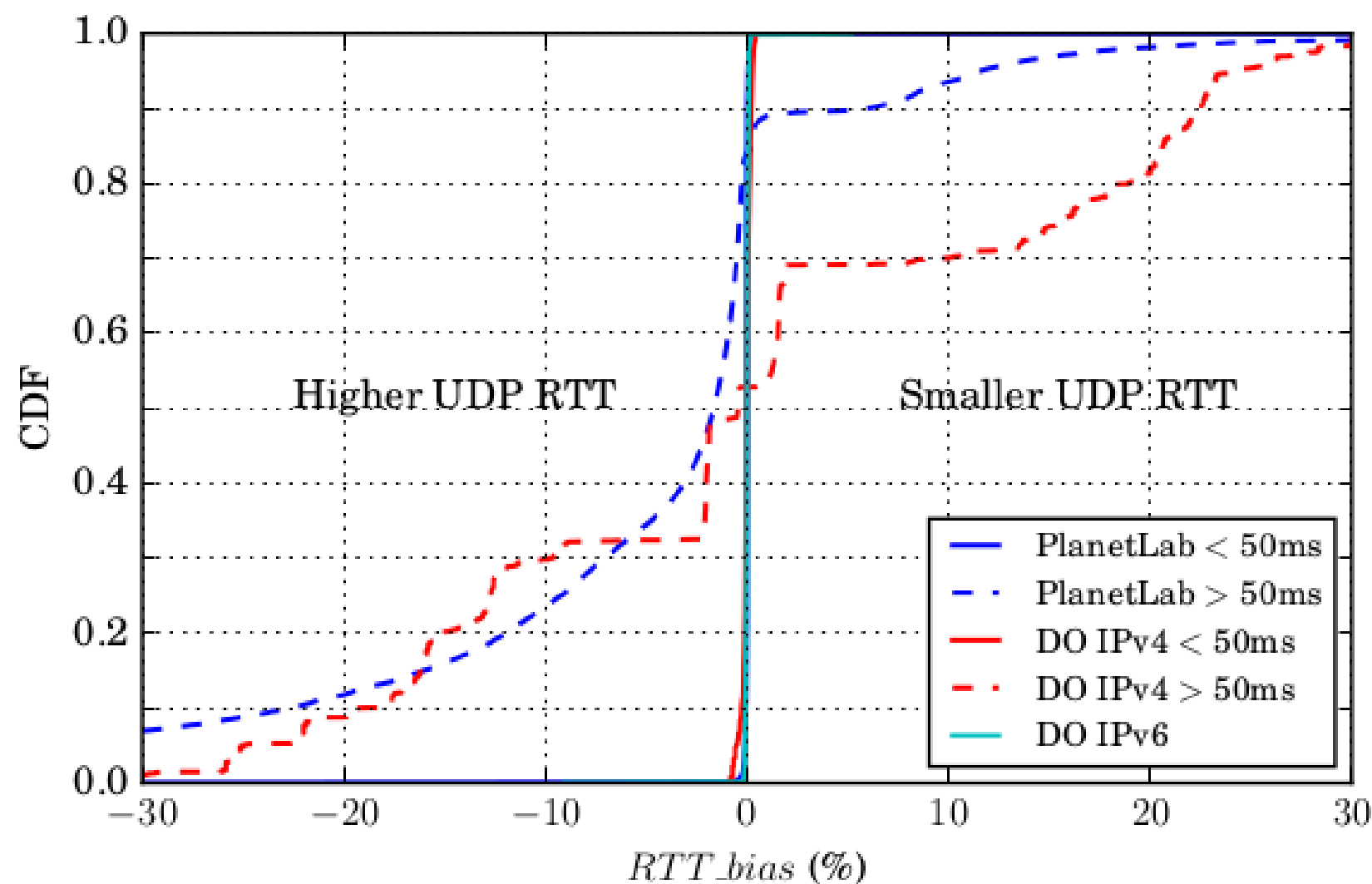


- *Consistent with connectivity bias*



UDP for Internet Transport

Evolution: Initial Latency

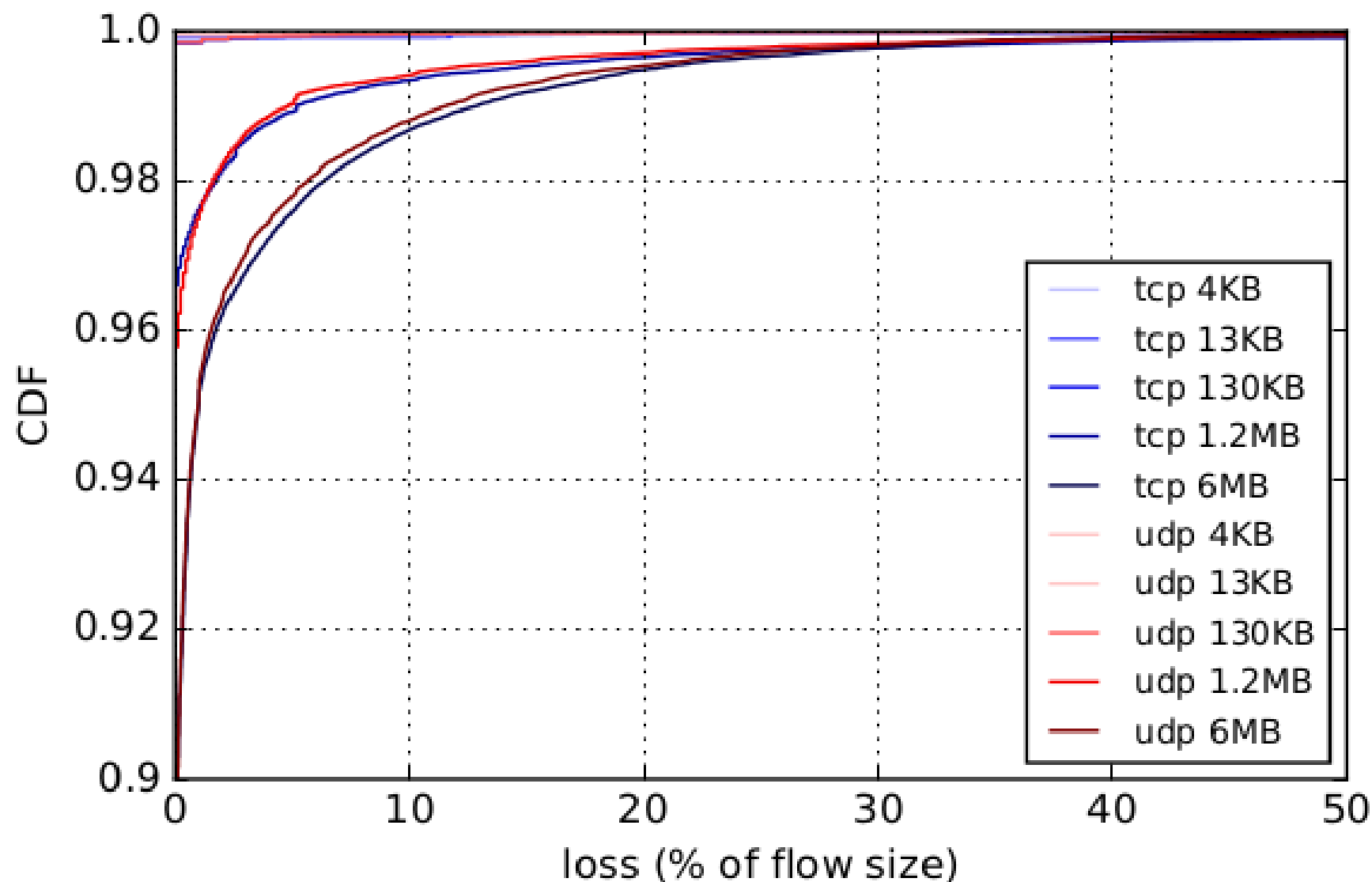


$$RTT_bias = \frac{RTT_{udp} - RTT_{tcp}}{\min(RTT_{tcp}, RTT_{udp})} * 100$$



UDP for Internet Transport

Evolution: Loss



- *No substantial differences*



UDP for Internet Transport

Evolution: Summary

Dataset	Throughput (kB/s)				Latency (ms)				Connectivity		
	< 200		> 200		< 50		> 50		# Probes		No UDP Connectivity
	# flows	median	# flows	median	# flows	median	# flows	median	total	failed	% of probes
PlanetLab	740,721	0.05	34,896	0.16	745,947	0.00	29,370	-1.65	30,778	825	2.66%
DO v4	12,563	0.03	3,637	-0.37	9,381	-0.02	6,819	-0.44	135	0	0.00%
DO v6	15,459	0.07	224	-0.16	15,656	0.00	27	3.63	135	0	0.00%

Table 1: Raw number of bias measurements (throughput and initial latency) per sub dataset (“DO” stands for Digital Ocean). The 50ms cut-off roughly corresponds to inter-continental versus intra-continental latency. Global overview of UDP blocking is also provided.

- *2.66% UDP blocking, access-network based. In those cases, a UDP-based protocol would need a fallback mechanism.*
- *Initial latency and throughput biases are small and access-network based.*



Lessons Learned

- UDP is a viable common basis for new transport protocols, *but only if an alternative exists*
- The vast majority of UDP impairments are access-network linked, subtle impairment is rare.



- copycat
 - <https://github.com/mami-project/copycat>
- Using UDP for Internet Transport Evolution:
 - <https://arxiv.org/abs/1612.07816>