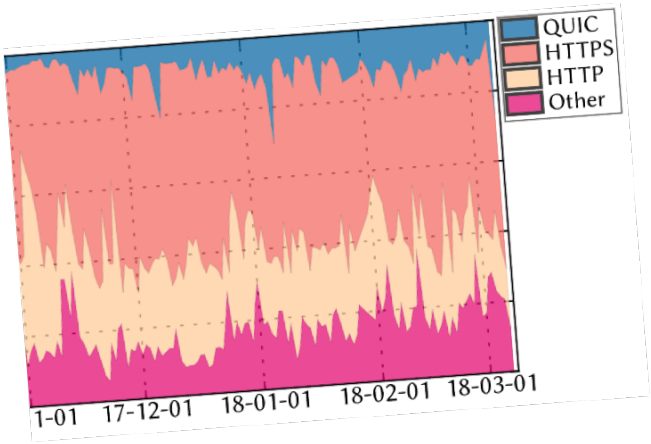

A First Look at QUIC in the Wild

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London / IETF-101
~~Berlin / PAM~~, March 2018

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The Internet is subject to a major change

- **TCP is difficult to extend**
  - Only a couple of bytes left to modify
  - Middleboxes ossify the protocol evolution
- **QUIC is UDP + TCP-like CC + loss recovery + TLS 1.3**
  - Everything is encrypted → Goodbye middleboxes
  - QUIC guarantees evolution
- **There is Google QUIC and IETF QUIC**
  - gQUIC evolves to IETF QUIC when standardization progresses

How much gQUIC is already out there?

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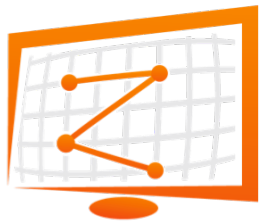
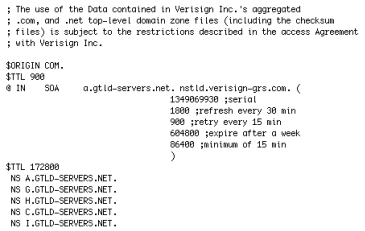
Measuring the QUIC Internet

- **What infrastructures support QUIC?**
  - Perform ZMap scans over IPv4



- **Is it (practically) used by any website?**
  - Scan full .com / .net / .org zones
  - Scan Alexa Top 1M for “popular” domains



- **How much QUIC traffic is there?**
  - in a university network
  - in a major European Tier-1 ISP
  - in a major European mobile network
  - in a major European IXP

Picture by Seth Stoll (CC BY-SA 2.0):
https://www.flickr.com/photos/sethstoll/4079897275

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Enumerating QUIC IPs with ZMap

- **QUIC has a version negotiation feature (evolution!)**
  - Send version in first Client Hello (CHLO/Initial)
  - If supported, server continues handshake
  - Otherwise, sends version negotiation packet

- **Use ZMap to test for gQUIC support + version support**
  - Send a valid CHLO packet
  - Include an unused version number that the server does not support
  - Module available on github

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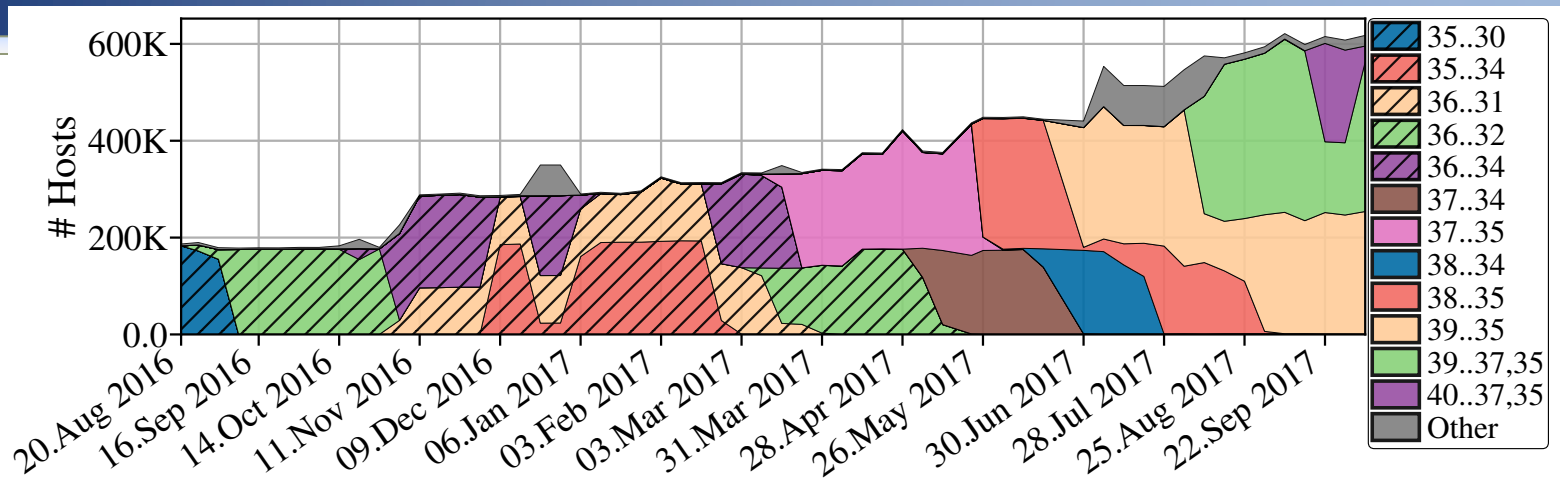
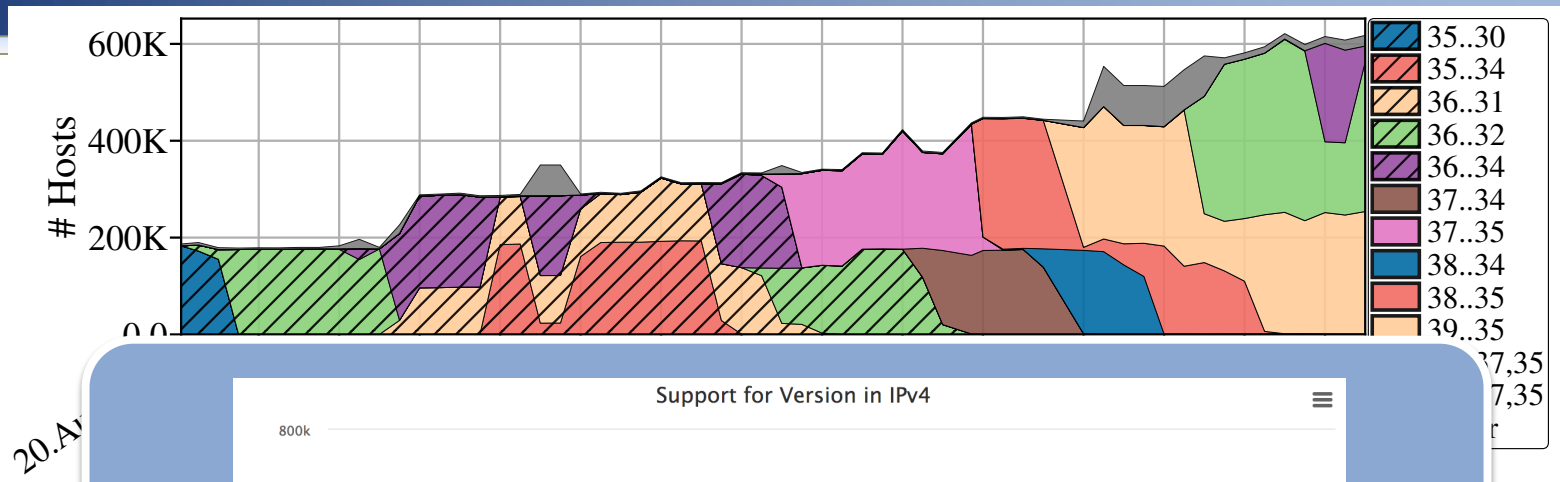
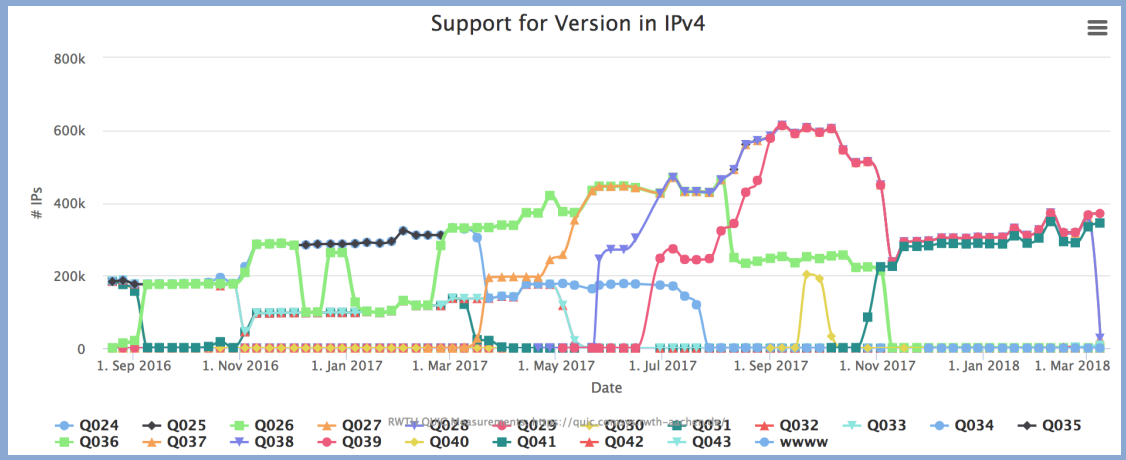
QUIC in IPv4



- **Number of QUIC IPs tripled to 617K IPs**
  - Classification using AS, certificate data, and reverse DNS
  - 330K (53.53%) IPs can be attributed to Google
  - Akamai: 983 in Aug., 44K in Nov. 2016, 251K (40.71%) October 2017
- **HTTP via TCP on the remaining IPs reveal**
  - many timeouts and further Google and Akamai servers
  - 7.34K using LightSpeed webserver
  - 356 Caddy webservers

QUIC in IPv4





Weekly raw data available on
https://quic.netray.io

- **Numb**
  - Cla
  - 330
  - Aka
- **HTTP**
  - ma
  - 7.34K using LightSpeed webserver
  - 356 Caddy webservers

r 2017

QUIC website support

- **There are ~150M domains in .com/.net/.org**
  - There are no tools to investigate QUIC
- **We build upon quic-go to build a scanner**
  - We modify the library to trace the whole handshake
  - We enable to dump all connection parameters that are exchanged
    - Certificates, server config, buffer settings, …
  - Also available on github
- **We can efficiently scan TLDs for QUIC support**
  - We can further analyze the connection parameters
    - Certificates valid?

QUIC in TLDs

	06. Oct 2017 .com		03. Oct 2017 .net		04. Oct 2017 .org		08. Oct 2017 Alexa 1M	
# Domains	129.36 M	(100.0%)	14.75 M	(100.0%)	10.37 M	(100.0%)	999.94 K	(100.0%)
QUIC-enabled	133.63 K	(0.1%)	8.73 K	(0.06%)	6.51 K	(0.06%)	11.97 K	(1.2%)
Valid Certificate	2.14 K	(0.0%)	181	(0.0%)	159	(0.0%)	342	(0.03%)
Timeout	114.63 M	(88.61%)	10.80 M	(73.23%)	8.09 M	(78.06%)	826.67 K	(82.67%)
Version-failed	29	(0.0%)	6	(0.0%)	1	(0.0%)	5	(0.0%)
Protocol-error	606	(0.0%)	222	(0.0%)	0	(0.0%)	1	(0.0%)
Invalid-IP	322.24 K	(0.25%)	59.24 K	(0.4%)	40.15 K	(0.39%)	15.42 K	(1.54%)
DNS-failure	13.76 M	(10.64%)	2.40 M	(16.26%)	1.18 M	(11.41%)	49.34 K	(4.93%)

- Timeout → No QUIC support

- **In total: 161K domains**
  - 10% do not deliver any data
  - 2.8K with valid certificate
  - Only a fraction presents QUIC discovery headers via HTTP(s)

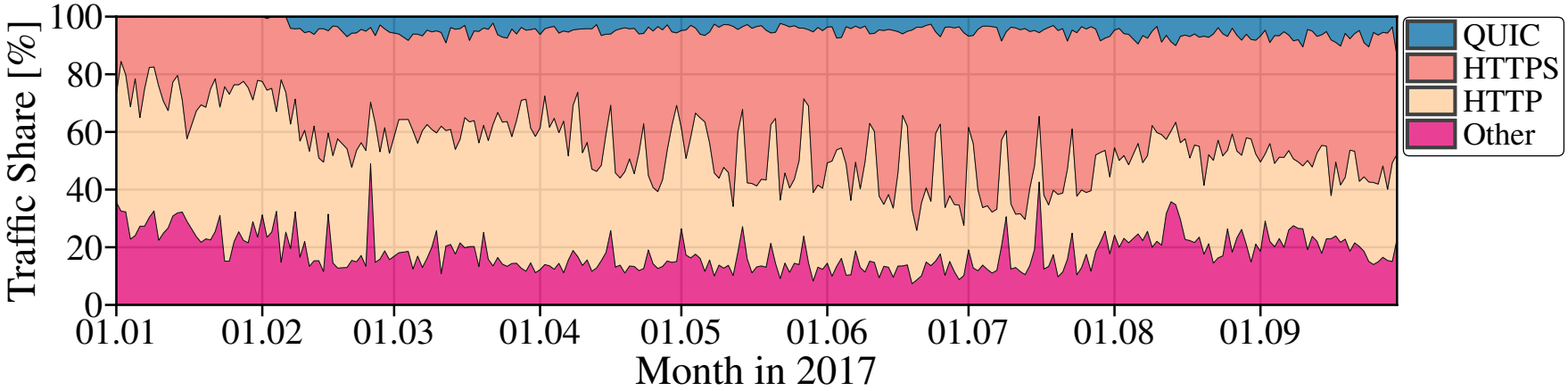
- **Is there any QUIC traffic in the Internet then?**

QUIC Traffic Shares – Classification

- **Classifying QUIC traffic**
  - Detecting QUIC on sampled (header) data is hard
- **We rely on a port-based classification**
  - UDP Port 443 → QUIC
  - TCP Port 443 → HTTPS
  - TCP Port 80 → HTTP
- **Depending on the data source we have AS-level information available**

QUIC Traffic Shares – Mawi Backbone

- **Mawi: University uplink to ISP**
  - Open dataset: http://mawi.nezu.wide.ad.jp/mawi/ (samplepoint-F)
  - Capped packet dumps of 15 minutes at 14h each day
  - Source and destination have been anonymized



  - No QUIC traffic in January last year
    - Google said activation in January for most customers
  - 5.2% QUIC in March, 6.7% in September

MAWI	6.7%

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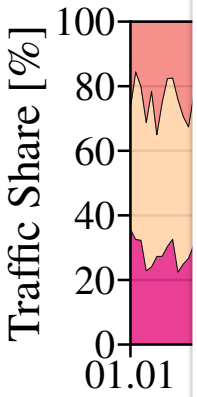
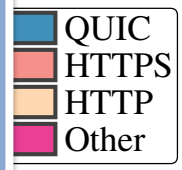
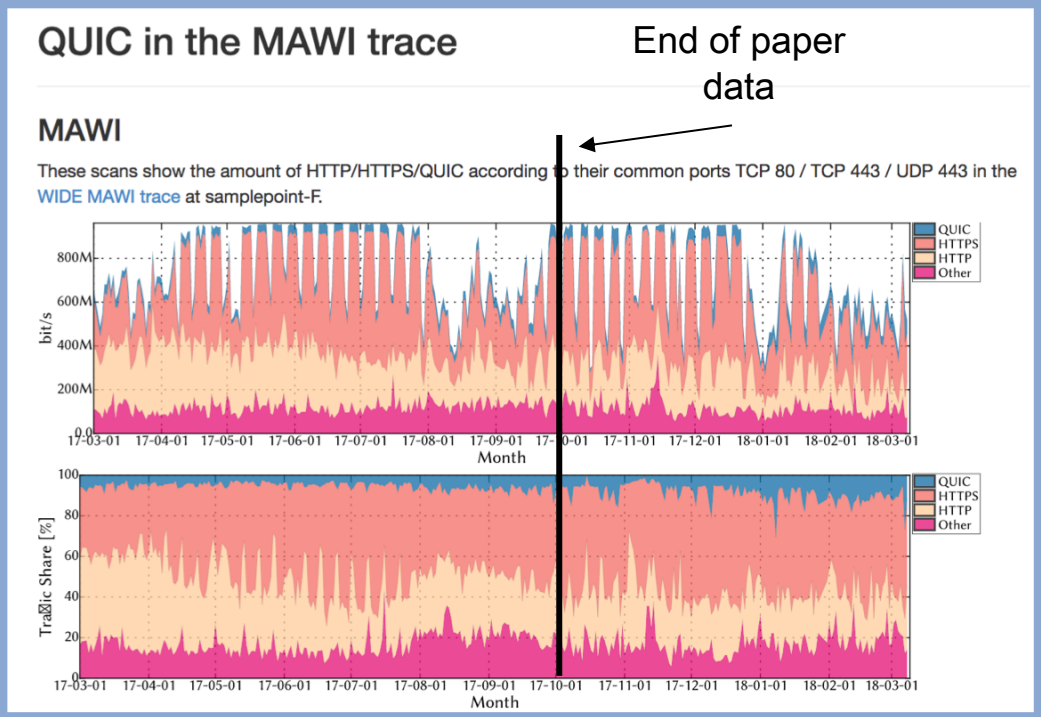
QUIC Traffic Shares – Mawi Backbone

- **Mawi: University uplink to ISP**
  - Op… …t-F)
  - Ca…
  - So…





  - No…



Daily updates available on
https://quic.netray.io

WI	6.7%

  - 5.2% QUIC in March, 6.7% in September

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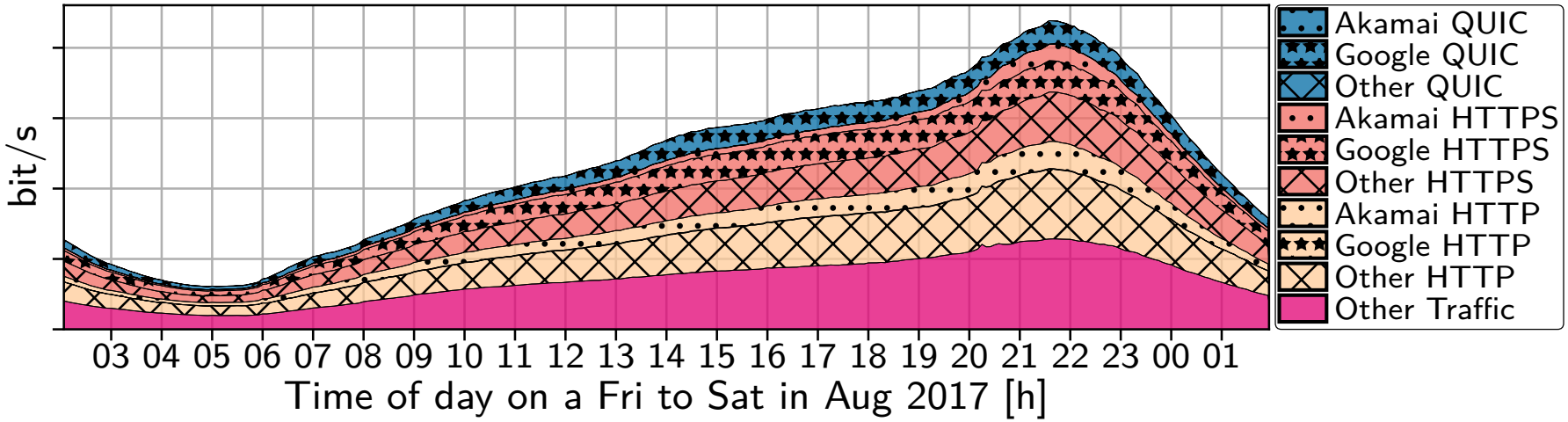
QUIC Traffic Shares – European Tier-1 ISP

- **Anonymized Netflows of all boarder routers**
  - 1 full day in August 2017 (a Friday to Saturday)
  - Netflows aggregated to 5 minute bins
  - Upstream and Downstream
  - IPs have been replaced by AS numbers
  - Contains: edge (DSL,..), cellular, and transit backbone traffic



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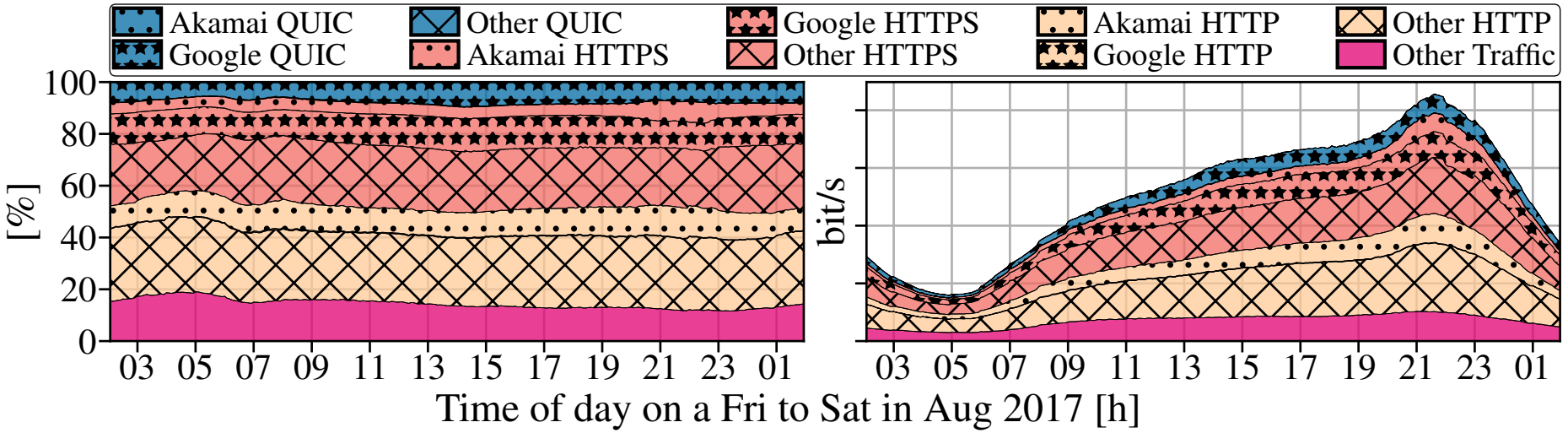
QUIC Traffic Shares – European Tier-1 ISP



- **QUIC share is stable over the day**
- **QUIC at around 7.8% (±1%)**
- **HTTP (~38%) and HTTPS (40%) dominate the shares**
- **98% of the QUIC traffic is from/to Google AS**
  - Of all Google traffic QUIC accounts for ~39% peaking at ~42%
- **Almost no QUIC traffic to Akamai (0.1%)**
  - Still Akamai causes ~15% of all traffic → Potential QUIC traffic

MAWI	**6.7%**
ISP	**7.8%**

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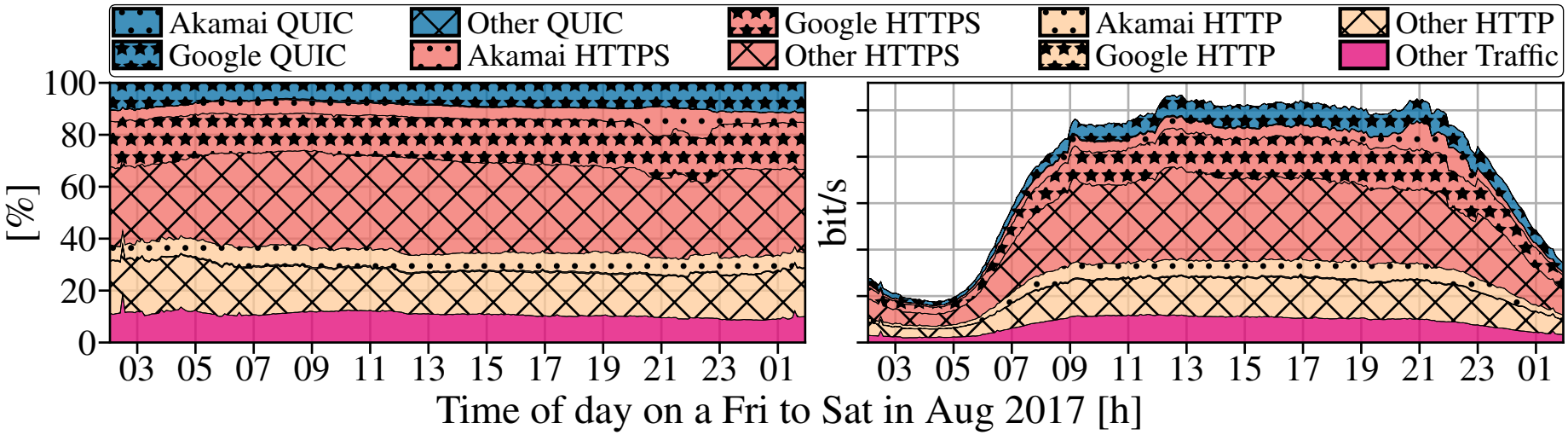
QUIC Traffic Shares – Mobile ISP



- **ISP told us how to extract mobile traffic from trace**
- **Mobile traffic pattern differs from classic daily pattern**
- **QUIC share slightly larger 9.1% (±1.4%)**
- **Google dominates again**
  - 34% of their traffic via QUIC

MAWI	**6.7%**
ISP	**7.8%**
MOBILE	**9.1%**

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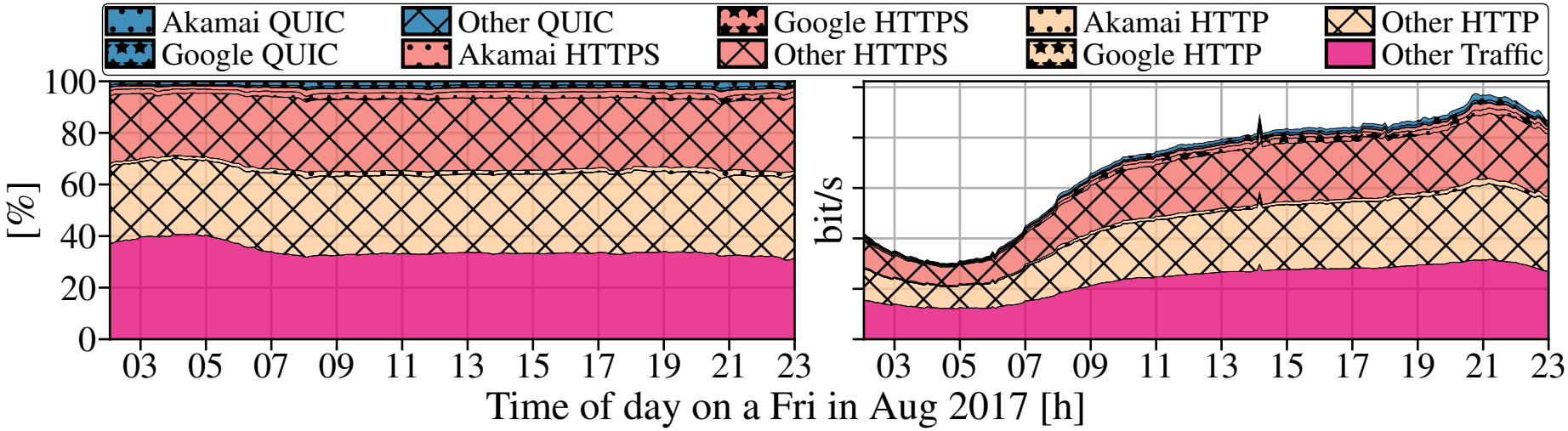
QUIC Traffic Shares – European IXP

- **Sampled flow data for the same day in August**
  - Flows annotated by customer port
  - Aggregated to 5 minute bins



- **QUIC only 2.6% overall**
- **Akamai accounts for ~60% of the QUIC traffic**
  - 33% by Google
- **Different traffic engineering strategies?**

MAWI	6.7%
ISP	7.8%
MOBILE	9.1%
IXP	2.6%

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Summary

- **QUIC is on the rise!**
  - A zoo of versions exist! Future compatibility?
  - More and more infrastructure is enabled
  - Some domains map to this infrastructure, only few can actually use it

- **Non-negligible fraction of Internet traffic is QUIC**
  - Hard to detect in sampled data
  - Very vantage point dependent
  - Single companies have potential to drastically increase QUIC share
  - How does QUIC impact Internet traffic? e.g., Fairness?

We provide our tools and measurement data, visit
https://quic.netray.io

Thank you!

Any questions?

PAM paper on arXiv: https://arxiv.org/abs/1801.05168

Thanks to RWTH Aachen ITC for enabling our measurements

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