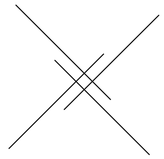

Analyzing The Adoption of QUIC From a Mobile Development Perspective

In Workshop on Evolution, Performance, and Interoperability of QUIC (EPIQ '20)

DIEGO MADARIAGA LUCAS TORREALBA JAVIER MADARIAGA
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OUTLINE

1 CONTEXT AND MOTIVATION

2 NETWORK MEASUREMENT METHODOLOGY

3 DATA ANALYSIS

4 CONCLUSIONS

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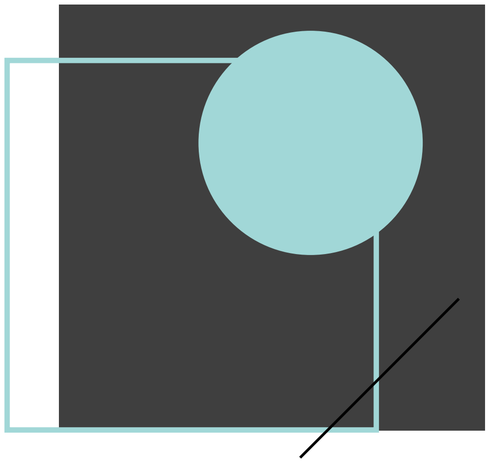

1. CONTEXT AND MOTIVATION

CONTEXT AND MOTIVATION

- Google introduced QUIC in 2013
- QUIC has been adopted by the IETF since 2016
- QUIC outperforms TCP/TLS in unstable wireless networks [1]

[1] Sarah Cook et al. “QUIC: Better for what and for whom?”. In *International Conference on Communications*. 2017.

CONTEXT AND MOTIVATION

- 2017-2018: QUIC accounted for 7-9% of total traffic volume [2, 3]

- Today: more companies started adopting QUIC
  - Facebook (IETF QUIC)
  - Uber Technologies Inc. (gQUIC)

[2] Jan Rüth et al. "A First Look at QUIC in the Wild". In *International Conference on Passive and Active Network Measurement*. 2018.
[3] Feng Li et al. "Who is the King of the Hill? Traffic Analysis over a 4G Network". In *International Conference on Communications*. 2018.

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Profile QUIC traffic from network measurements taken by mobile end-user devices

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Profile QUIC traffic from network measurements taken by mobile end-user devices

Measurements in user-space

Allows to identify applications using QUIC

Mobile devices

Performance of QUIC can be of particular interest for wireless networks

Wireless networks

By 2022, 71% of total IP traffic is expected to be wireless (51% WiFi and 20% Mobile)

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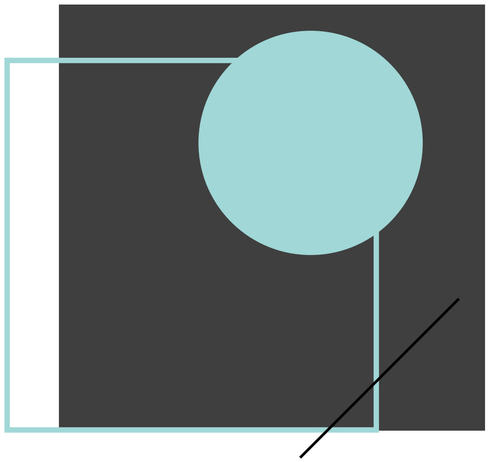


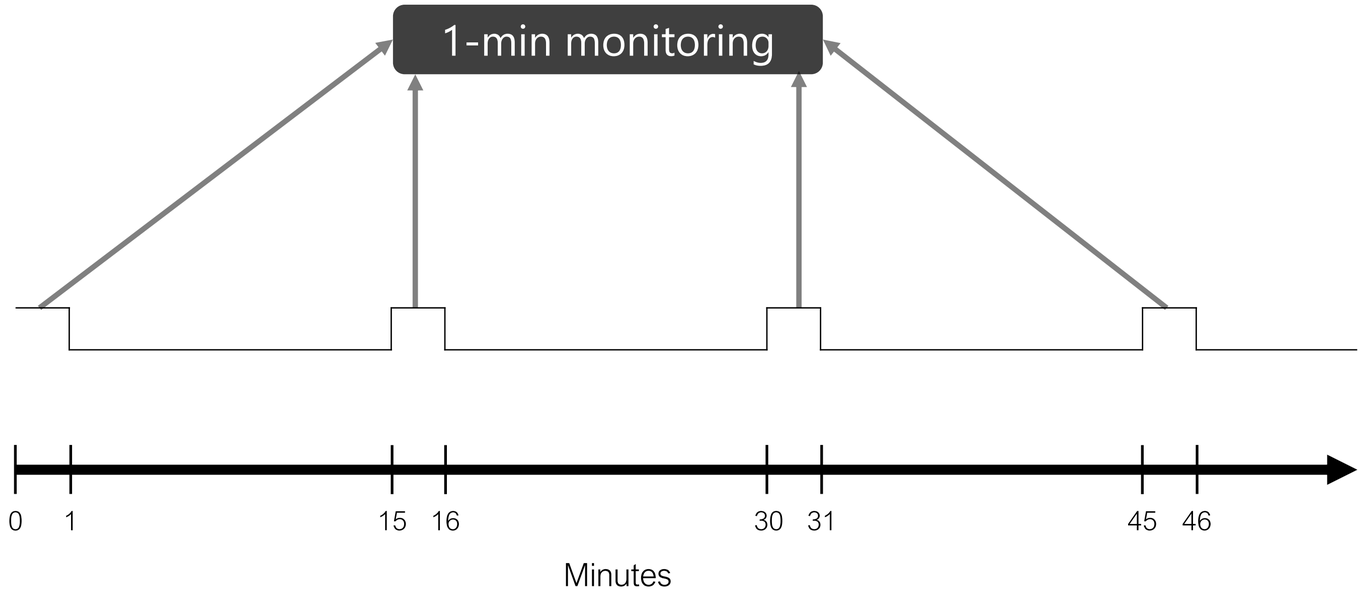
2. NETWORK MEASUREMENT METHODOLOGY

NETWORK MEASUREMENT METHODOLOGY

- Android framework to take network flow measurements
- PePa methodology
  1. Periodic behavior
  2. Passive behavior

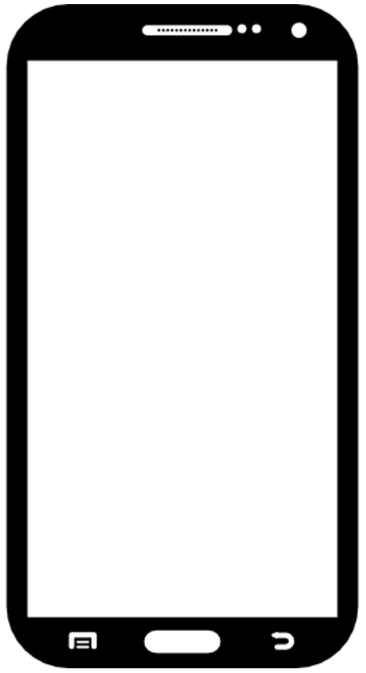
1. Periodic Behavior

- Obtain an overall of the user's network traffic without overloading the device
- Monitor user's traffic for 1-min every 15-min



2. Passive Behavior

- Use Android VpnService to implement a local VPN server
- Gains packet–level access without requiring root privileges



Local VPN server

NETWORK MEASUREMENTS

- Information from each monitored network flow

dst_ip	dst_port	protocol	start_ time	end_ time	tx_ bytes	rx_ bytes	connection_ type	package_name
157.240.204.60	443	tcp	03/26/2020 02:35:18.25	03/26/2020 02:35:37.81	839	1371	WiFi	com.whatsapp
64.233.186.95	443	udp	03/24/2020 13:13:28.45	03/24/2020 13:15:22.89	2961	4327	Mobile	com.google. android.youtube

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COLLECTED DATASET

February to April 2020

~160 REAL USERS

~175,000 EXECUTIONS OF THE 1-MIN MEASUREMENT SYSTEM

~1,850,000 INTERNET TRAFFIC FLOWS

831 DIFFERENT ANDROID APPLICATIONS

~35,000 DIFFERENT IP ADDRESSES

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DATA PROCESSING

Further insights into the collected network flows:
Identify web flows

- HTTP/HTTPS
  - Nmap tool to check each <IP : PORT> from the dataset

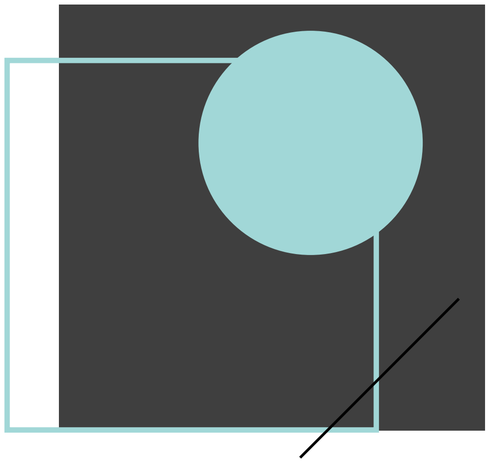
- QUIC
  - Connect using HTTP over TCP connections
    Alternative service (HTTP header)
  - LiteSpeed QUIC (LSQUIC) library

DATA PROCESSING

For each IP address running a web service (HTTP, HTTPS or QUIC):

- Establish an HTTPS connection to analyze the SSL certificate
  - Obtain server's common name and organization

- This method was successful for 82% of these IP addresses
  - Particularly, it was successful for all IP addresses running QUIC

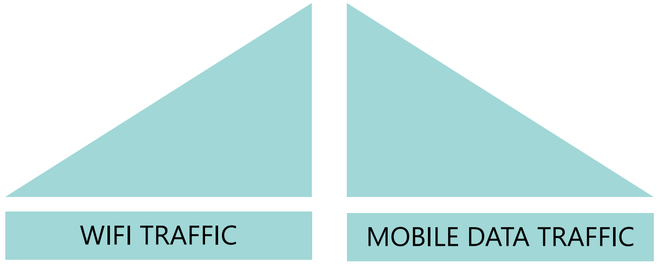


3.
DATA ANALYSIS

QUIC TRAFFIC VOLUME

23.05%

OF NETWORK TRAFFIC
FROM ANDROID DEVICES



26.16% 10.56%

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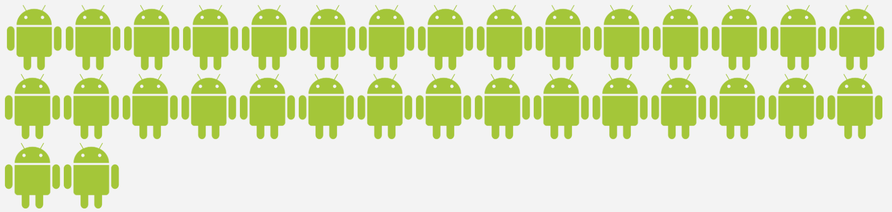
ANDROID APPS USING QUIC

2020

173 ANDROID APPS

2018

32 ANDROID APPS



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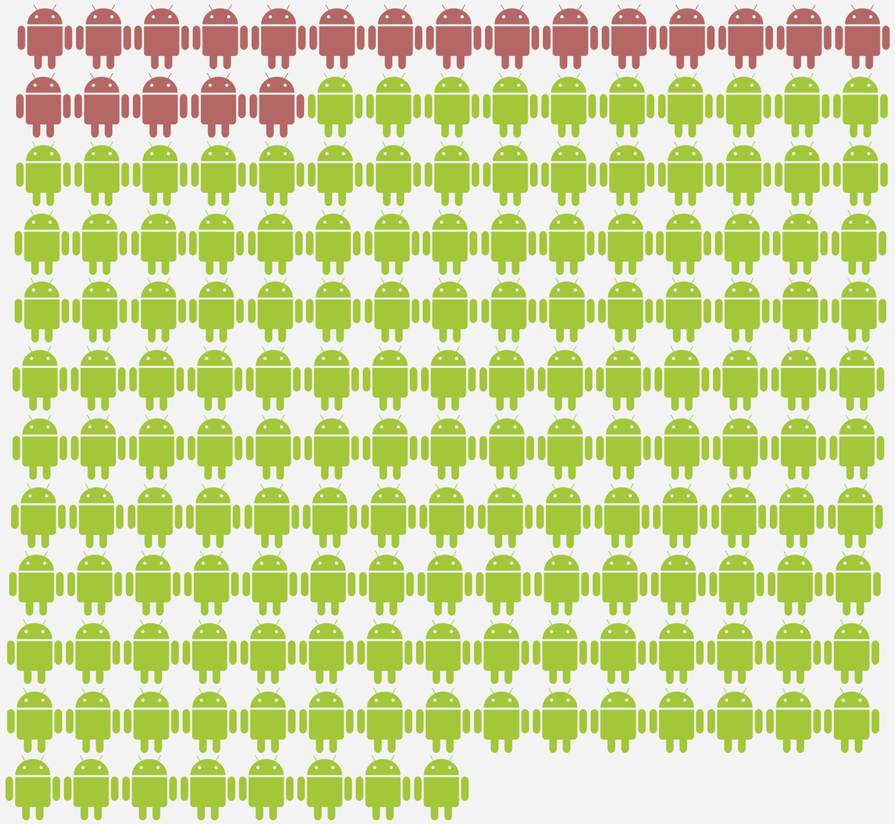
ANDROID APPS USING QUIC

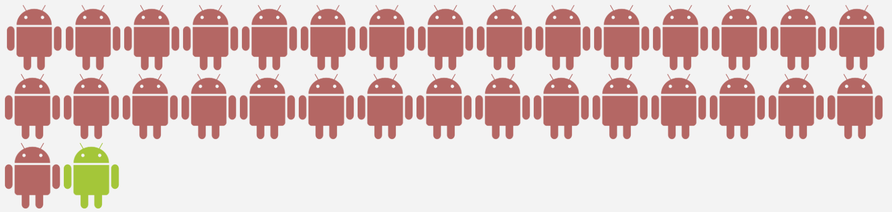
2020

173 ANDROID APPS



2018

32 ANDROID APPS



: APPS DEVELOPED BY GOOGLE

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ANDROID APPS USING QUIC

2020

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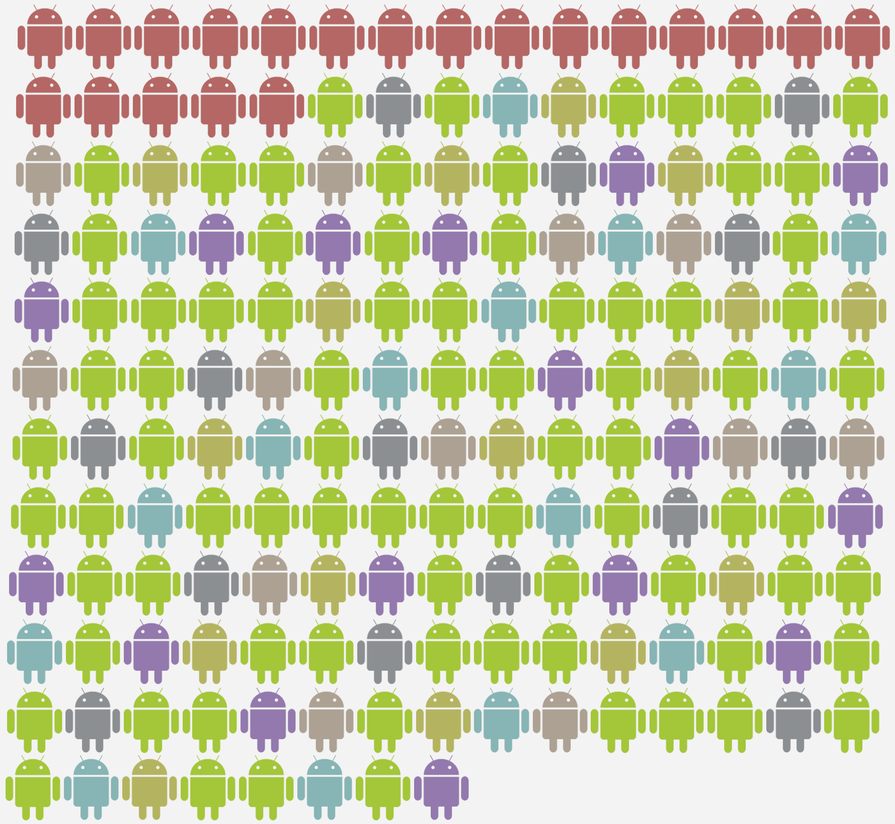
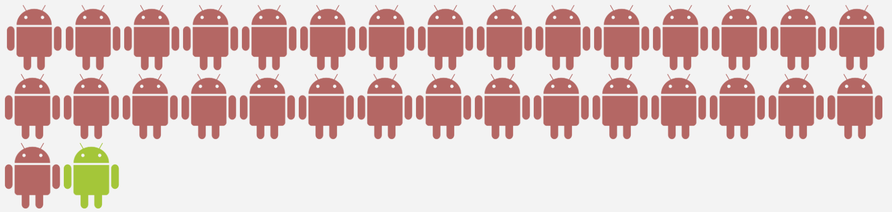


2018

32 ANDROID APPS



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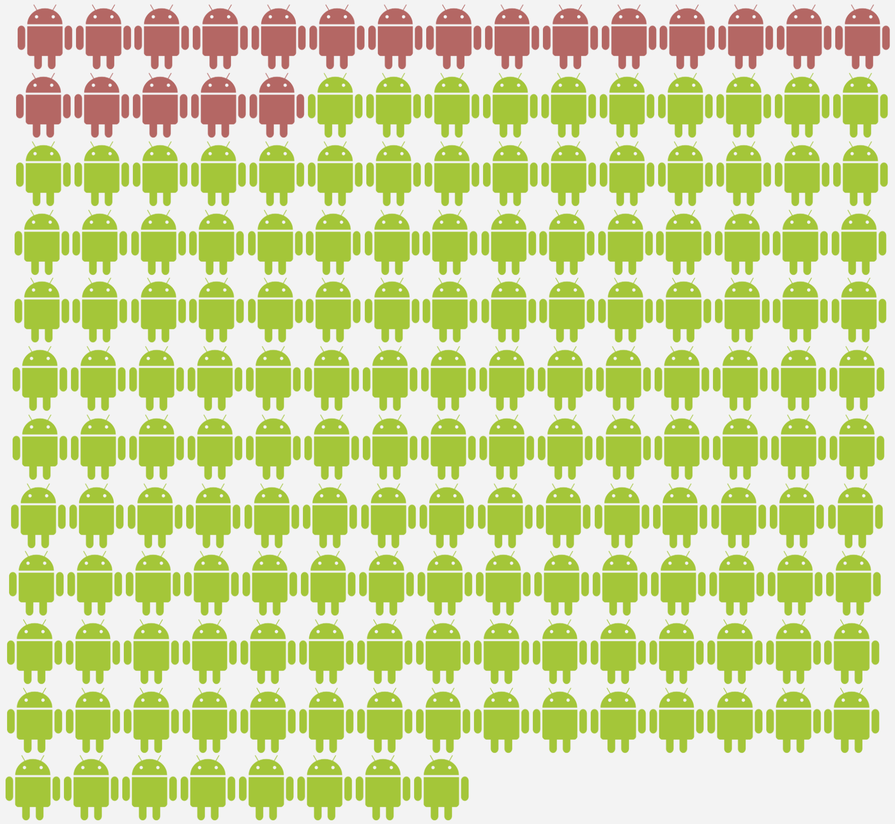

: APPS DEVELOPED BY GOOGLE

- YouTube
- Google Photos
- Google Chrome
- Maps

: APPS NOT DEVELOPED BY GOOGLE

- Facebook
- Snapchat
- Instagram
- Uber

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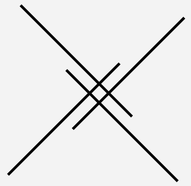
Google LLC

Facebook, Inc.



Snap, Inc.

Uber Technologies, Inc.

ORGANIZATIONS SERVING QUIC

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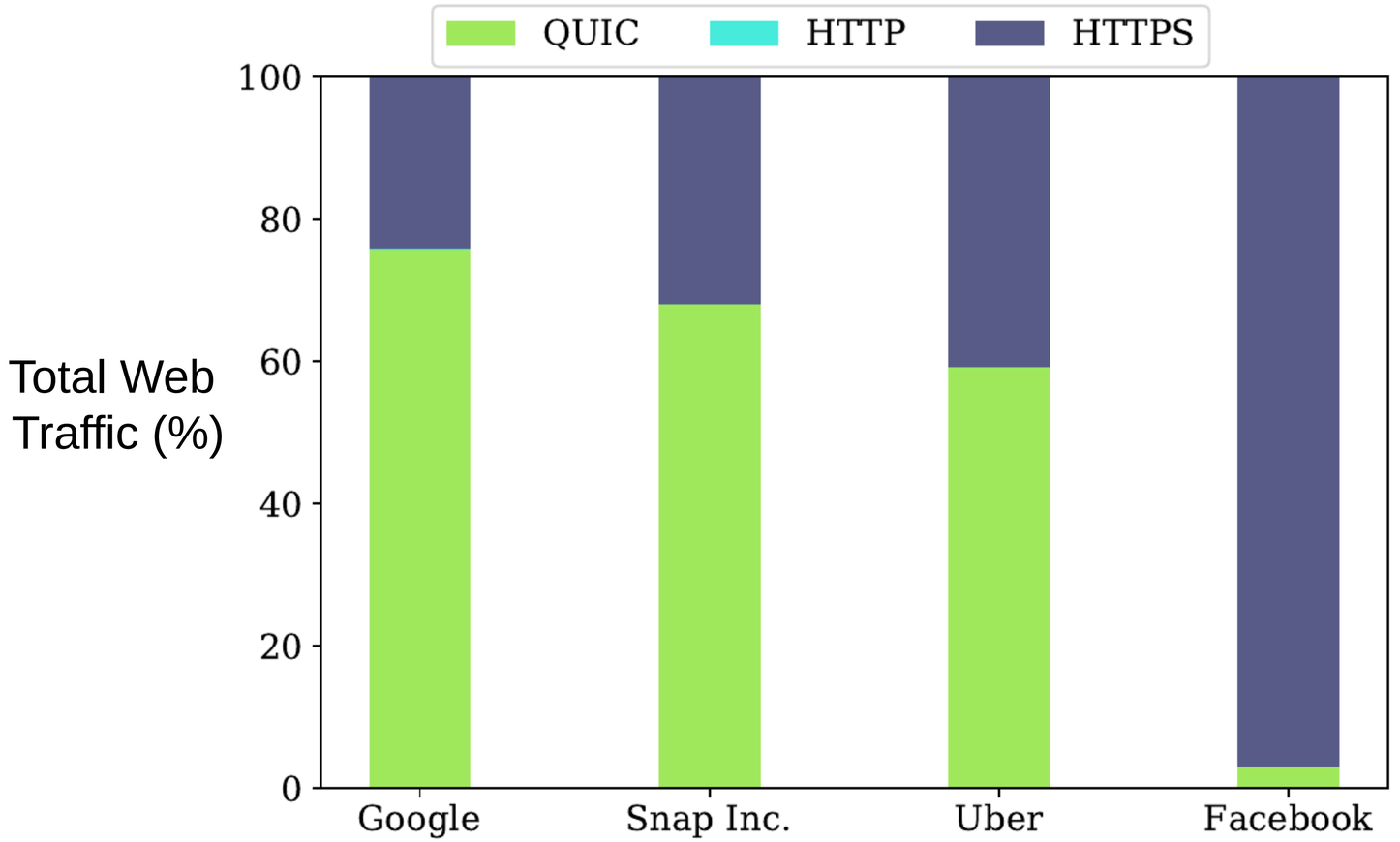

ORGANIZATIONS SERVING QUIC

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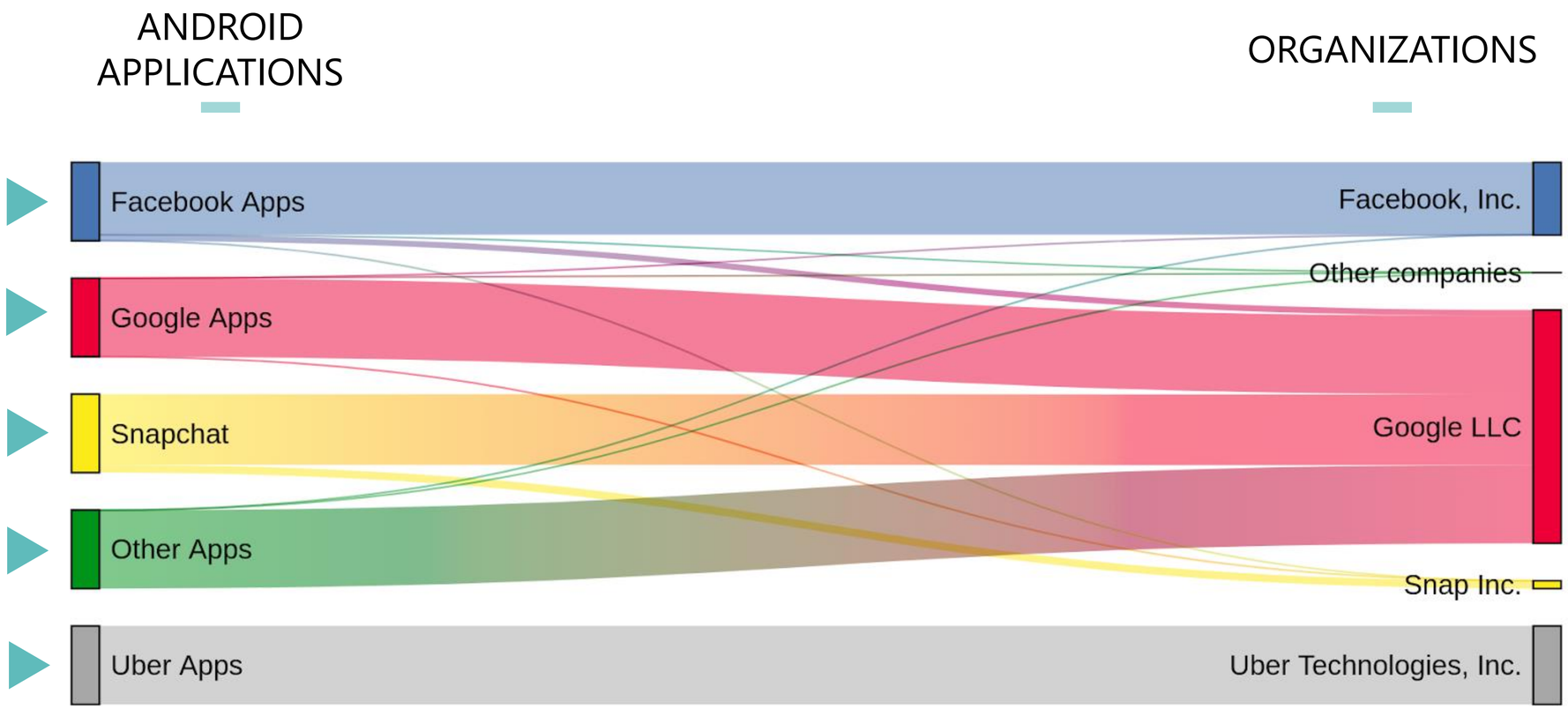
QUIC TRAFFIC

Between Android applications and organizations



- Other Apps (144): 80% of their QUIC connections were resolved to:
  - *.g.doubleclick.net
  - dns.google
  - *.google.com
  - *.googlevideo.com
  - *.google-analytics.com
- Embedded Google SDKs, e.g., Google Analytics SDK or Google Mobile Ads SDK

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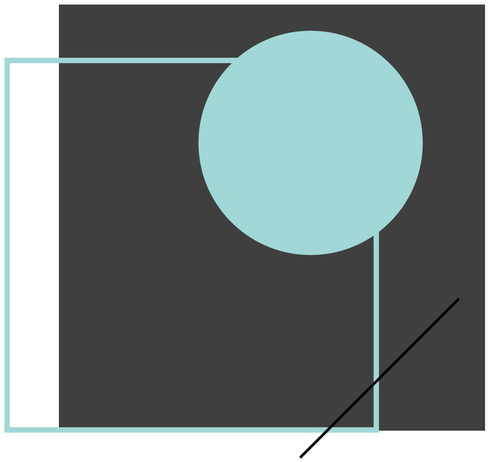

4. CONCLUSIONS

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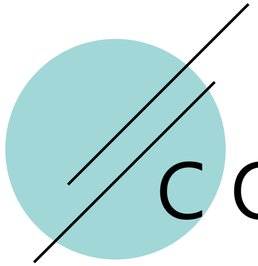

CONCLUSIONS

PROFILE THE ADOPTION OF QUIC

CROWDSOURCED MOBILE TRAFFIC DATA

MORE ANDROID APPS USING QUIC

MORE COMPANIES ADOPTING QUIC

FUTURE WORK: TEMPORAL ANALYSIS TO TRACK THE EVOLUTION OF QUIC

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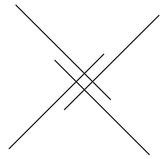

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