ACQUA: A user friendly platform for network monitoring and QoE forecasting

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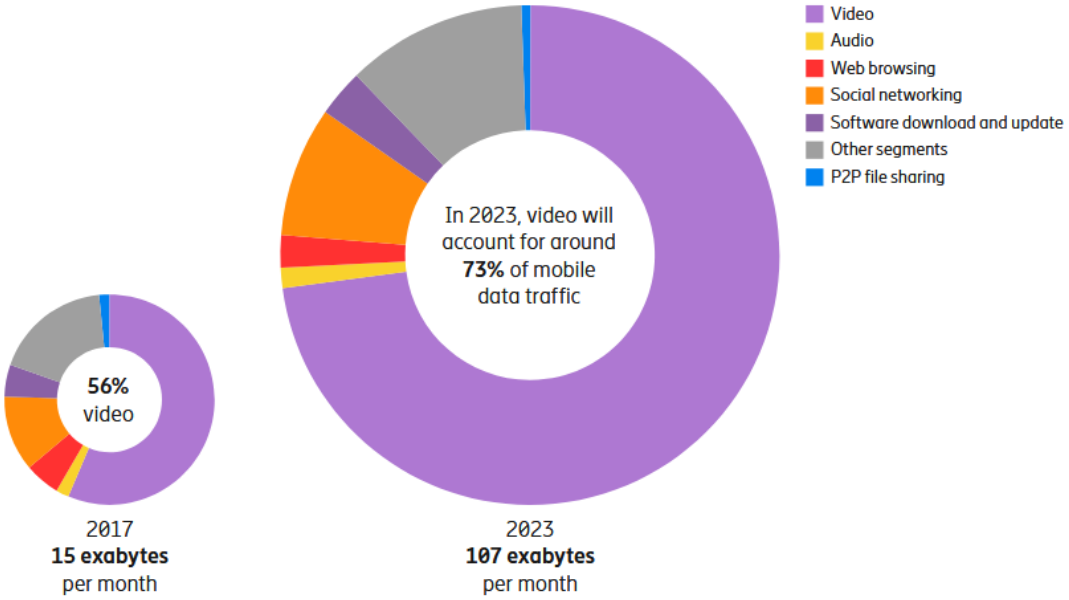
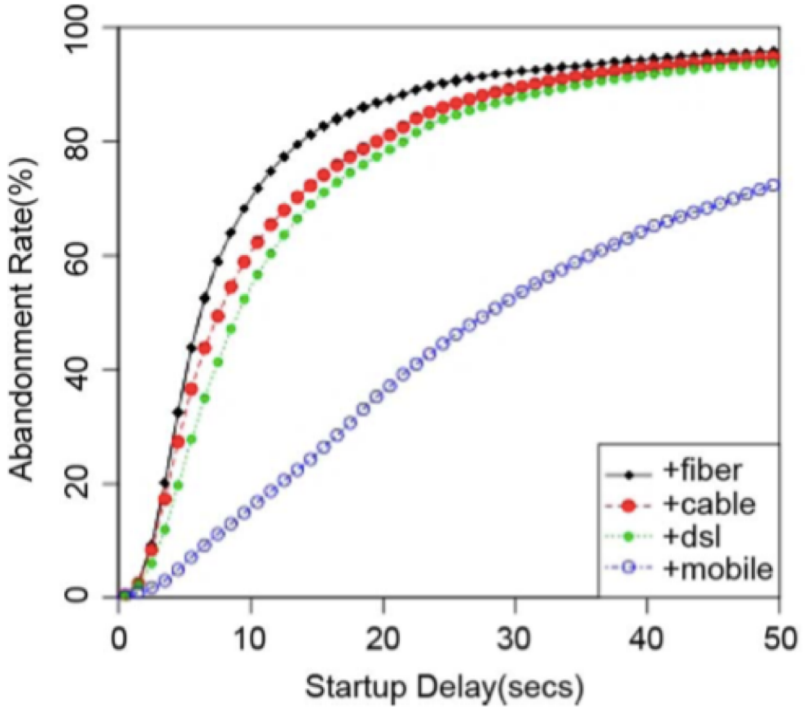
Internet usage today



Source: *https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-june-2018.pdf



Source: Video stream quality impacts viewer behavior: inferring causality using quasiexperimental designs. IEEE/ACM Transactions on Networking, 2013

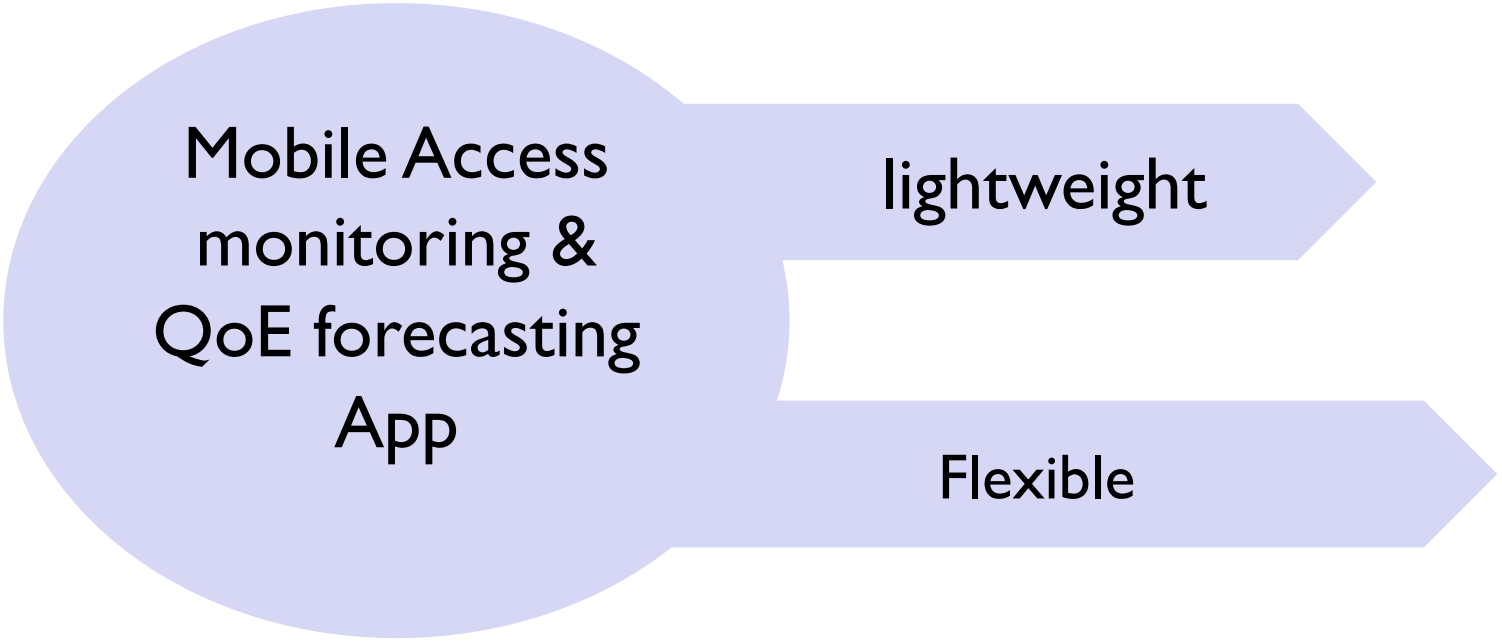
Quality of Experience (QoE) in the Internet

- QoE = Set of factors impacting user perception of applications performance (ITU-T Rec. P.10/G.100)
  - Some are subjective, but others are objective as network and terminal performance

Ex. QoE on a scale 1 to 5
MOS (Mean Opinion Score)

- Our ultimate goal: Understand the impact of the network on the QoE
  - Measurement and modeling
  - Causality analysis
  - Troubleshooting
  - Enhancement, e.g., caching and transport

ACQUA: Motivation & Challenges



State of the art

	Mobile	*Light*	*QoE*
Speedtest	✓	✗	✗
MobiPerf	✓	✗	✗
Sensorly	✓	✗	✗
RTR-NetTest	✓	✗	~
Meteor	✓	✗	✓
iPerf	✗	~	✗
ACQUA	✓	✓	✓

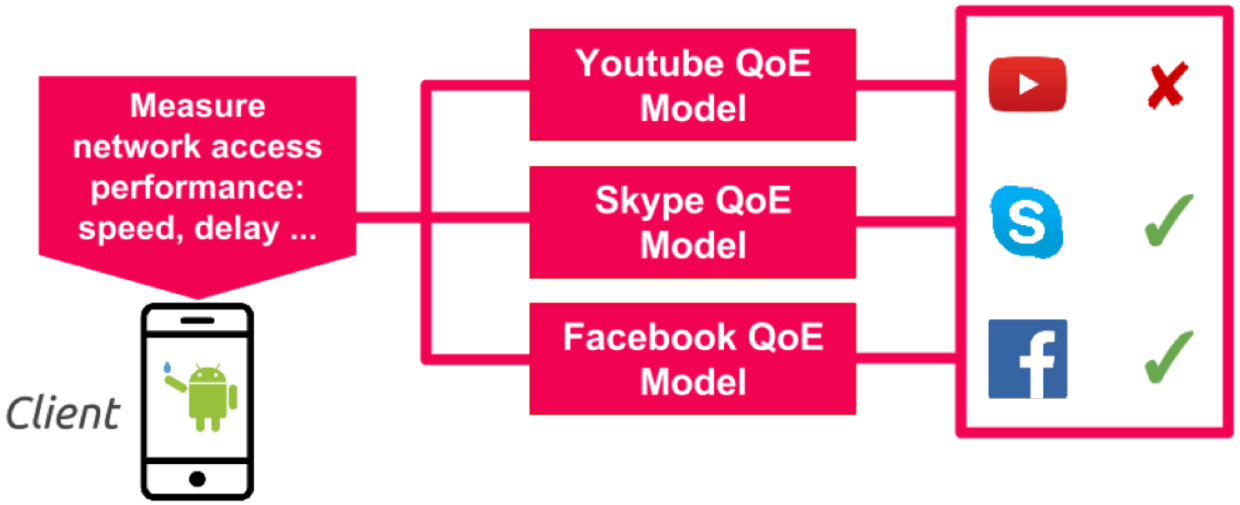
Existing tools are either:

- ❑ Greedy in terms of data consumption
- ❑ Scarce in terms of the feedback on the user's QoE

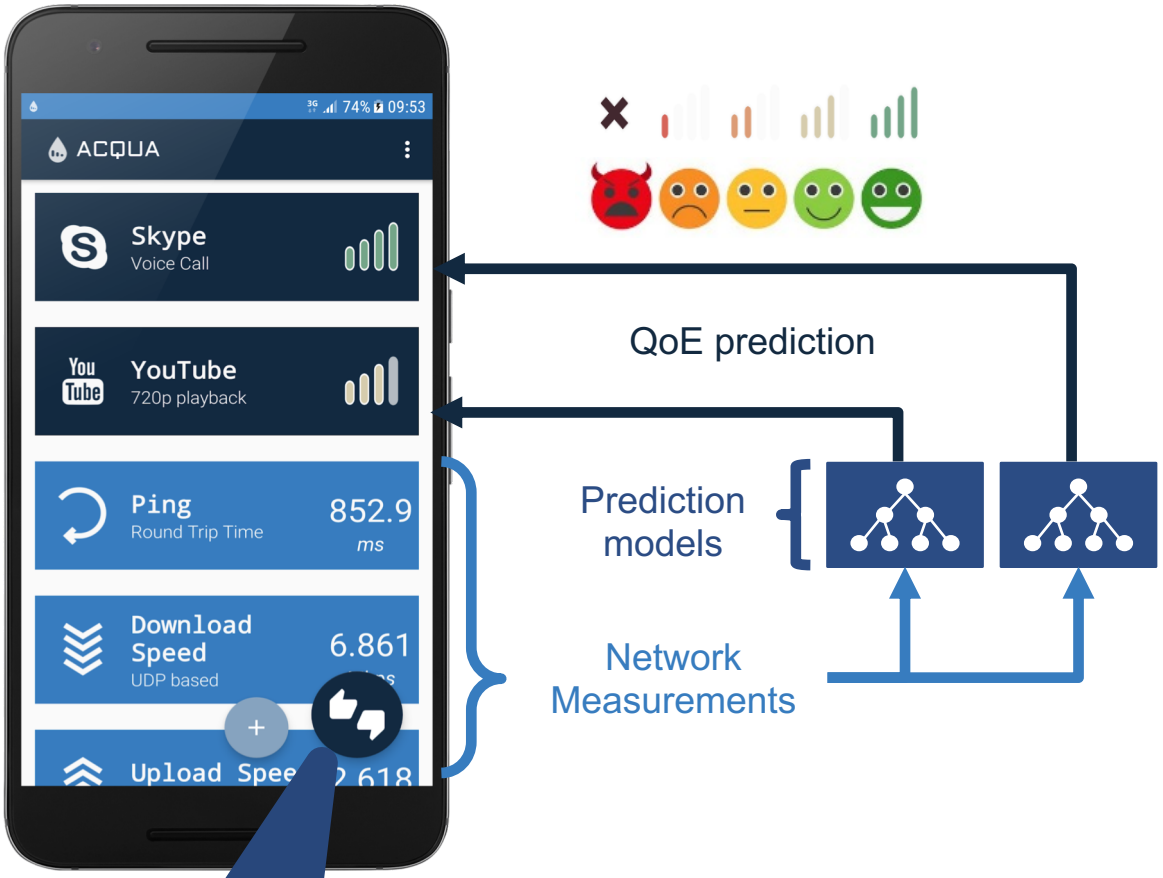
Our approach

- Network monitoring
  - ✓ Lightweight measurement in terms of data consumption
    - ICMP pings (RTT, jitter and loss rate)
    - Bursts of UDP packets (Estimated throughput)

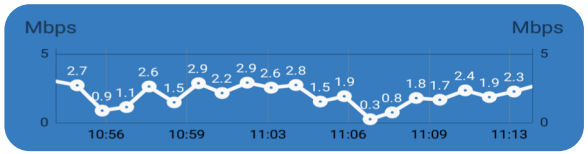
- QoE forecasting
  - ✓ Flexibility: Model-based cross-application QoE forecasting



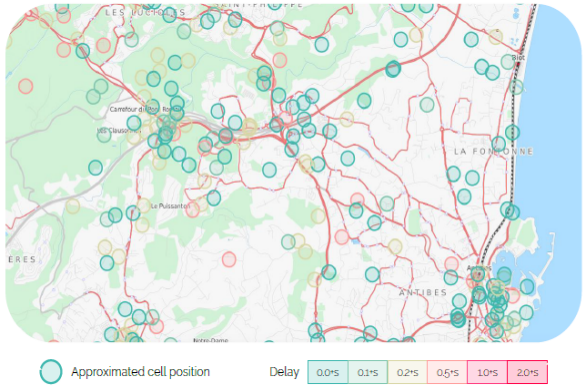
ACQUA: GUI & Features



What else?



Access quality over time

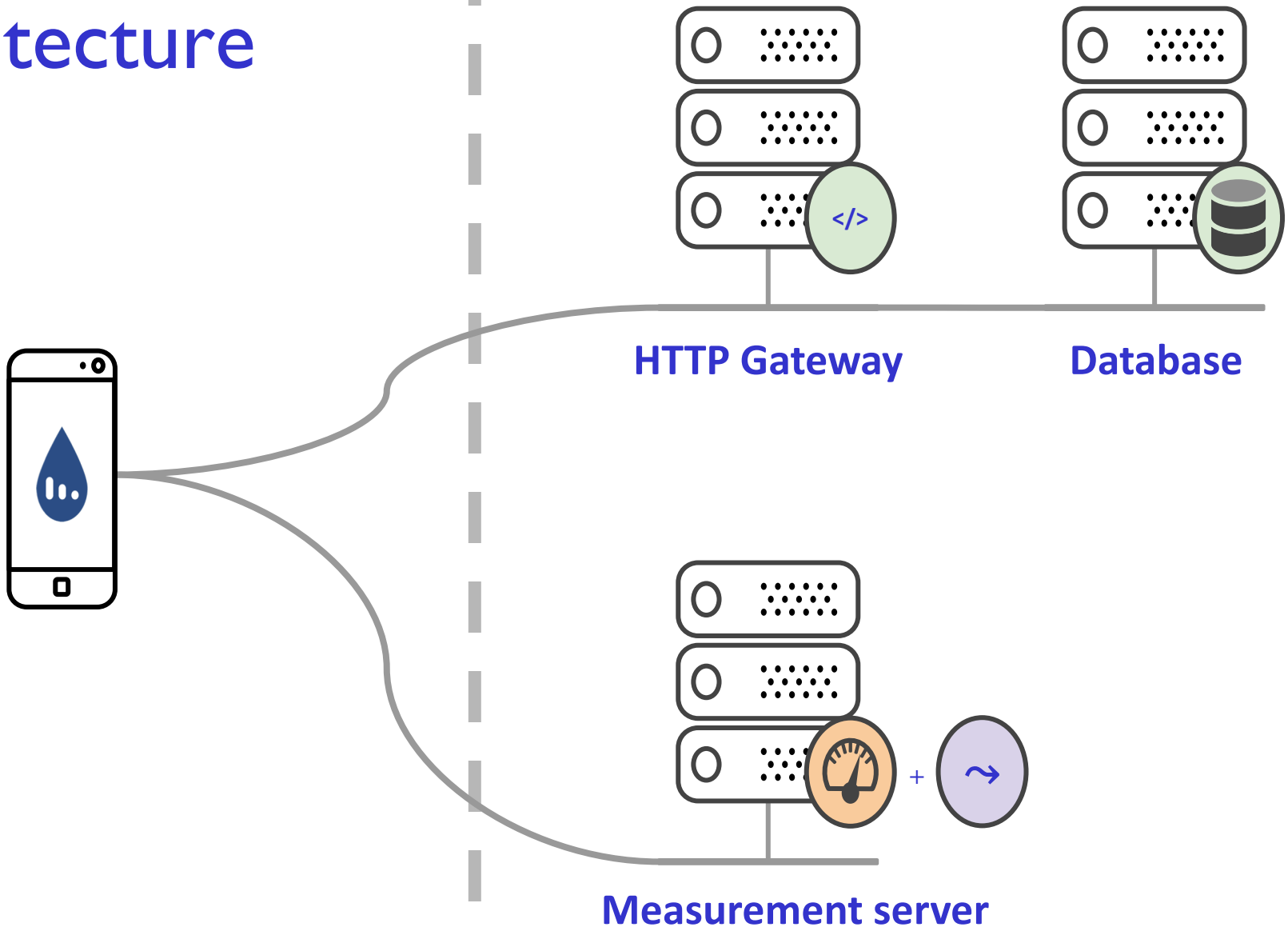


Network performances around you

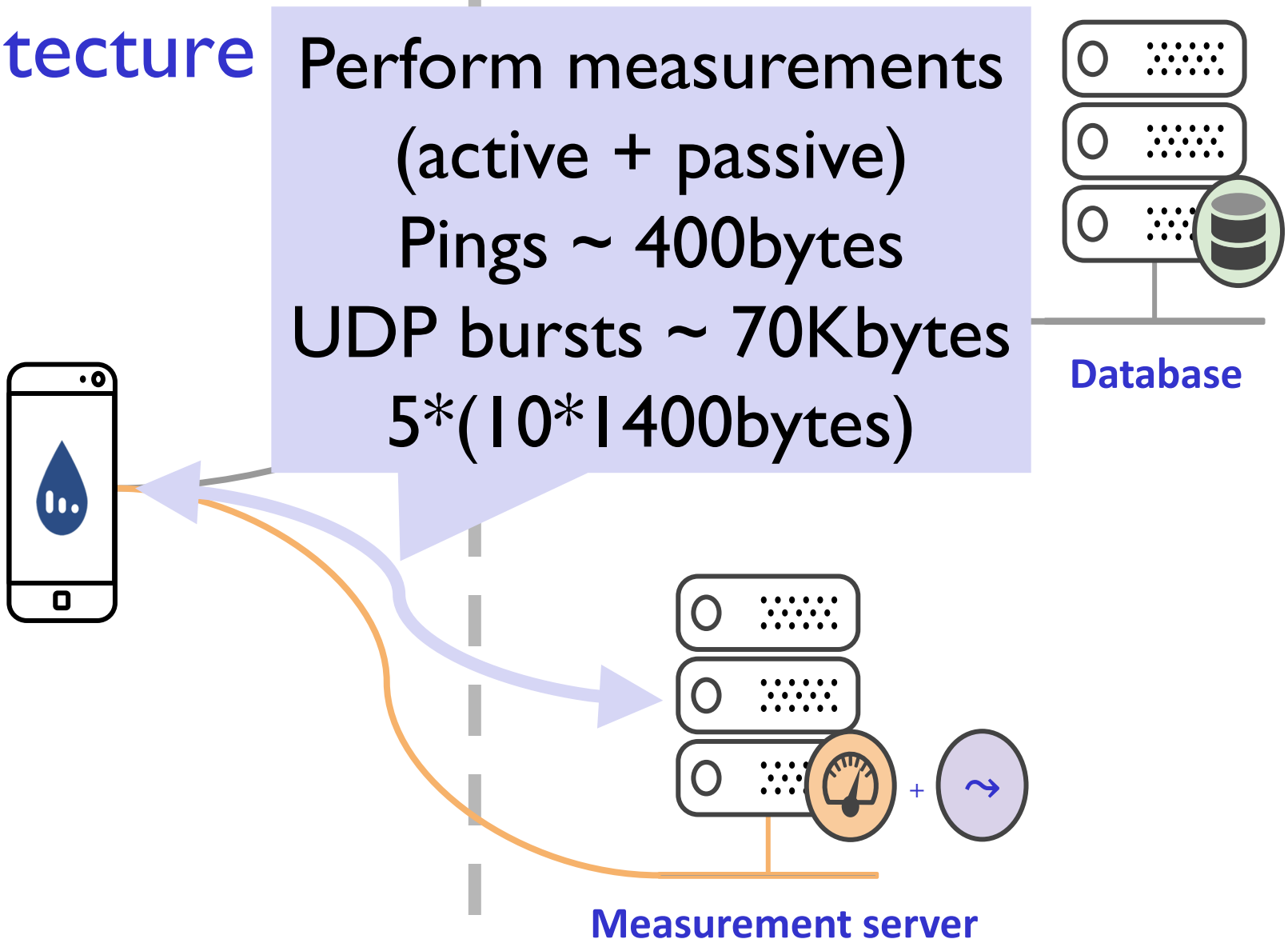
GET IT ON Google Play

More details: project.inria.fr/acqua/

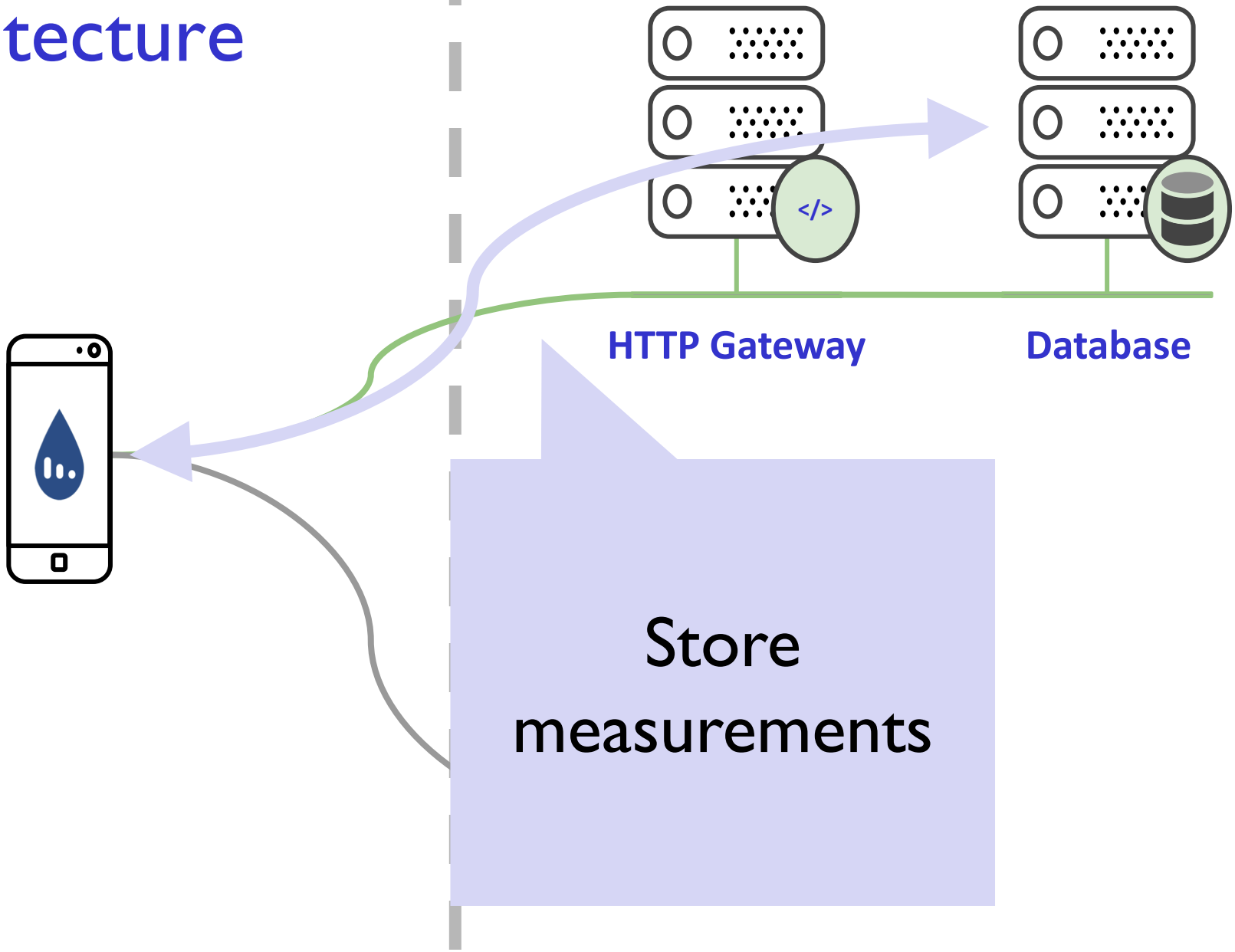
Architecture



Architecture



Architecture

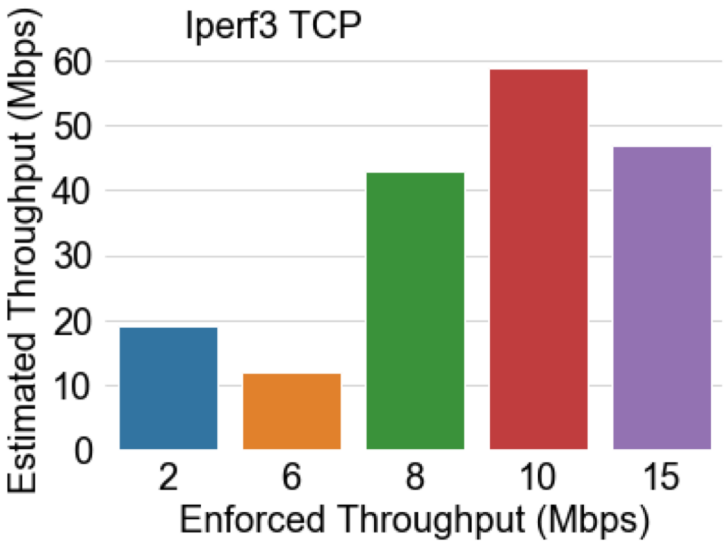


Metrics collected by ACQUA

Active	Passive
RTT	User ID
Download loss rate	Signal strength
Upload loss rate	Mobile operator
Download jitter	Radio access technology
Upload jitter	WIFI SSID
UDP Download throughput	Network cell (CID, LAC)
UDP Upload throughput	Roaming status

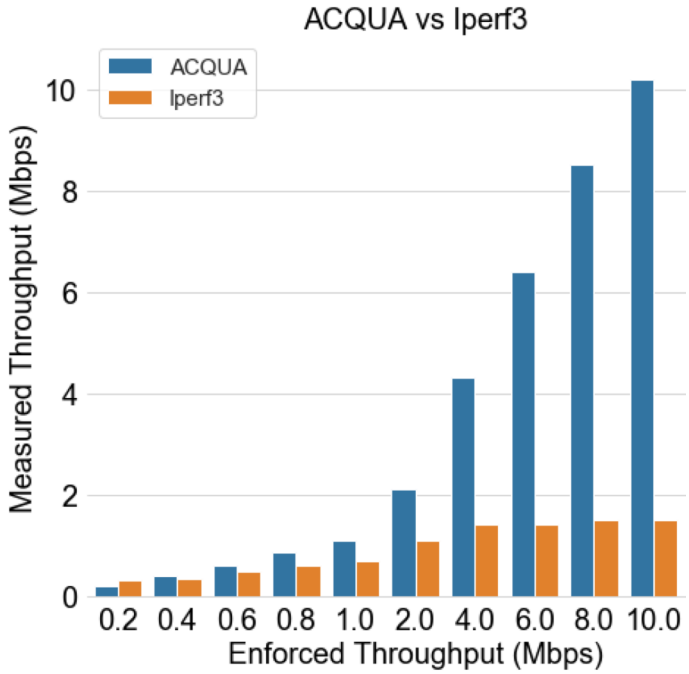
All in no more than 75KB

ACQUA vs iPerf at equal data consumption

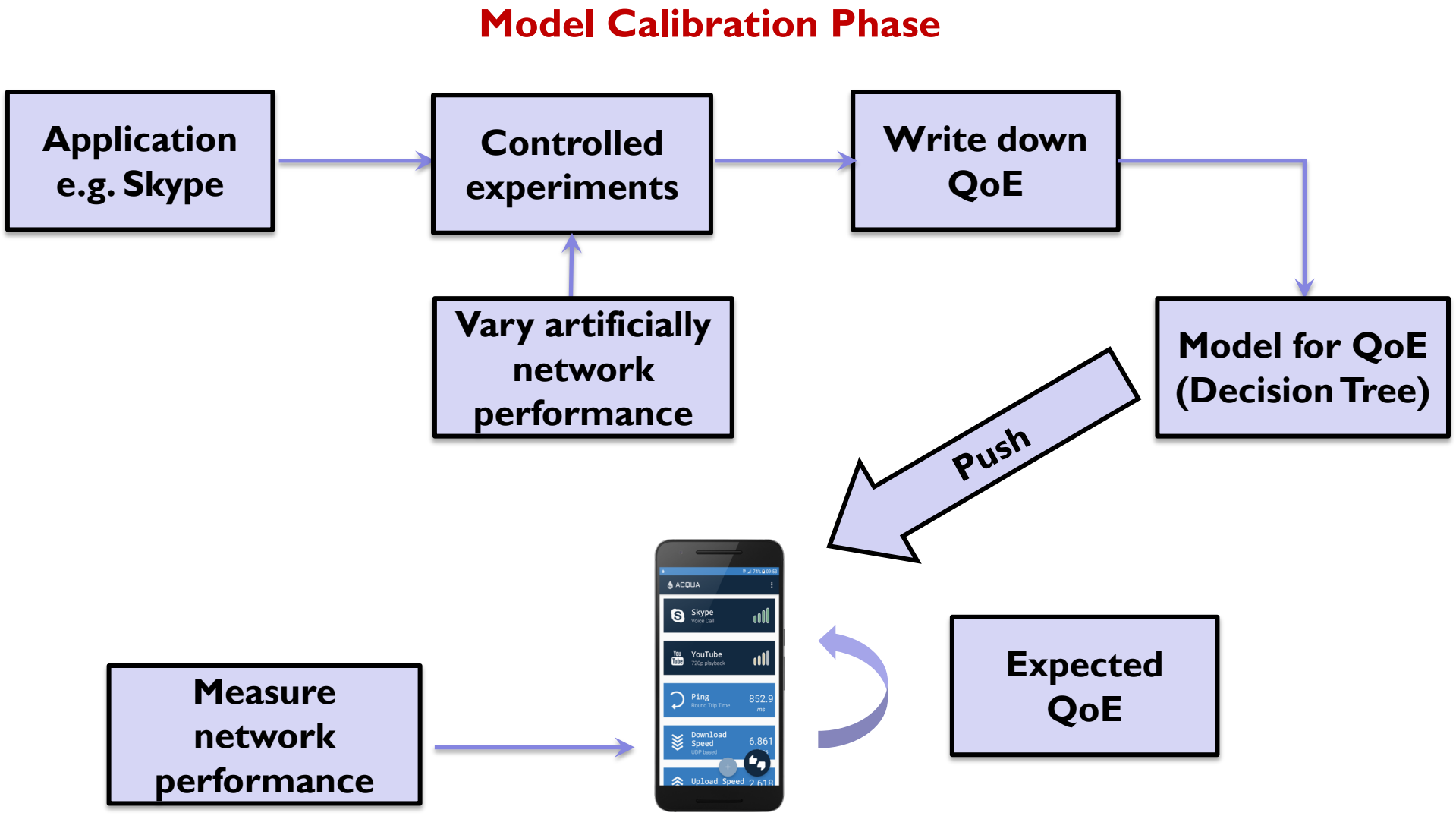


Noisy estimates by iPerf3 caused by TCP dynamics in case of short transfers.

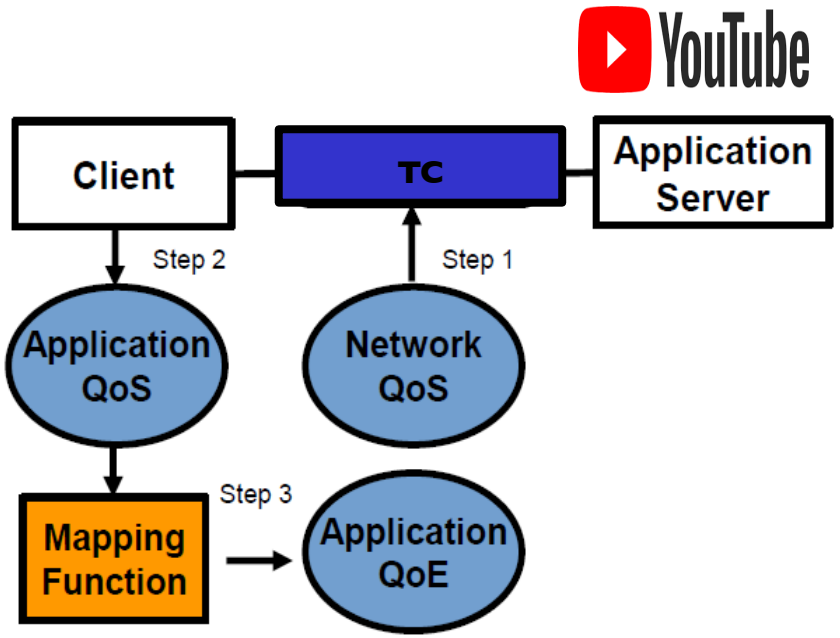
Bandwidth underestimation by iPerf3 caused by the initialization delay.



ACQUA models life cycle



Experimenting with YouTube



- Three measurable path metrics
  - -Bandwidth/throughput, delay/RTT and loss rate in the download direction
  - -Throughput = 0 – 10 Mbps
  - -RTT = 0 – 5000 ms
  - -Loss Rate = 0 – 25 %
- Three application-level QoS
  - -Initial join time,
  - -number of stalling events,
  - -total duration of the stalling events

QoE definition for YouTube Video

Multiclass Classification:

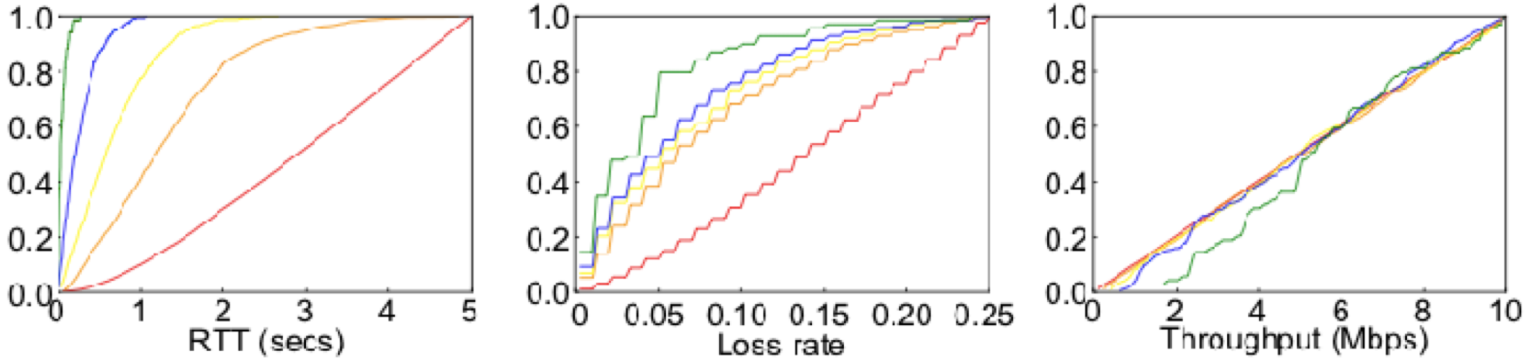
$$QoE_{exp} = \alpha e^{-\beta t} + 1 \quad (\alpha = 4, \beta = 0.0347)$$

Where t is the total buffering time and α and β are computed according to best and worst case scenarios:

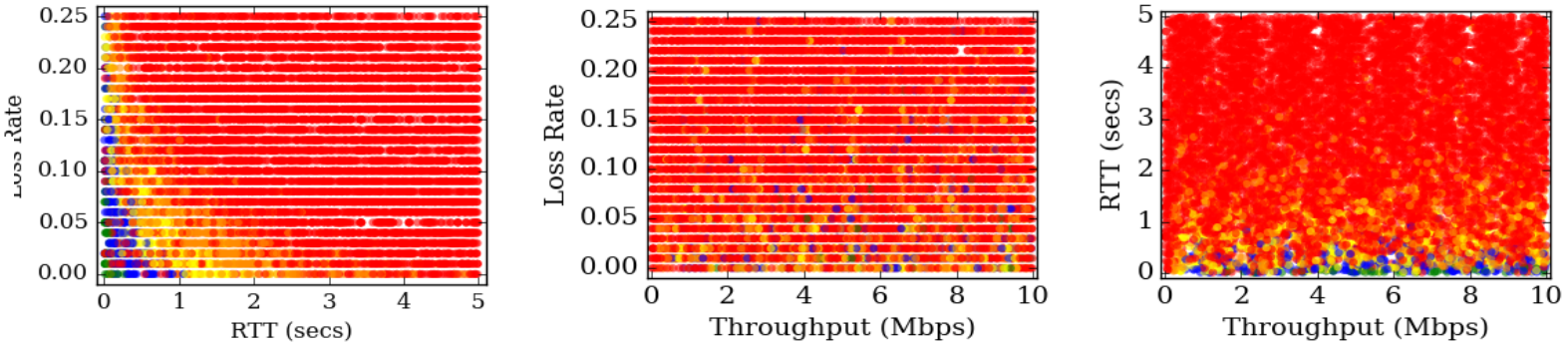
- Best case: QoE is maximum of 5 for zero buffering time
- Worst case: QoE is equal to 1.5 for buffering of 50% of the total duration of the video

Controlled experimentation results (YouTube)

QoE_{exp}

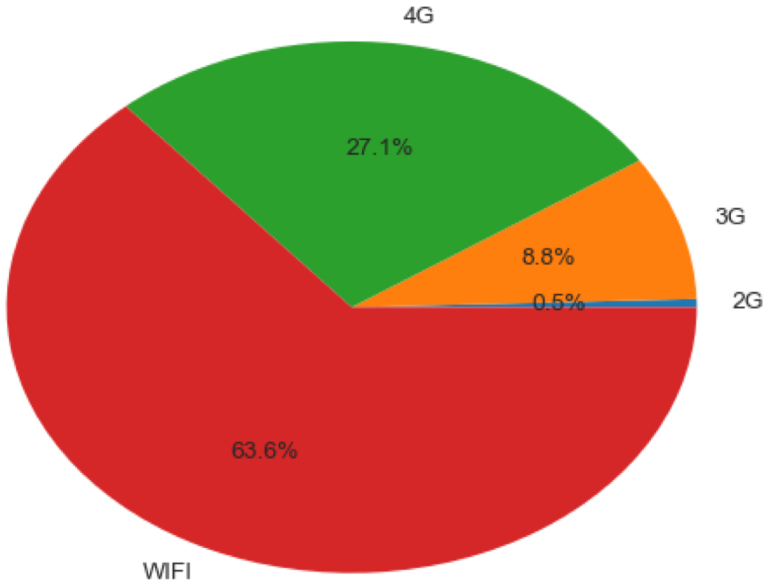


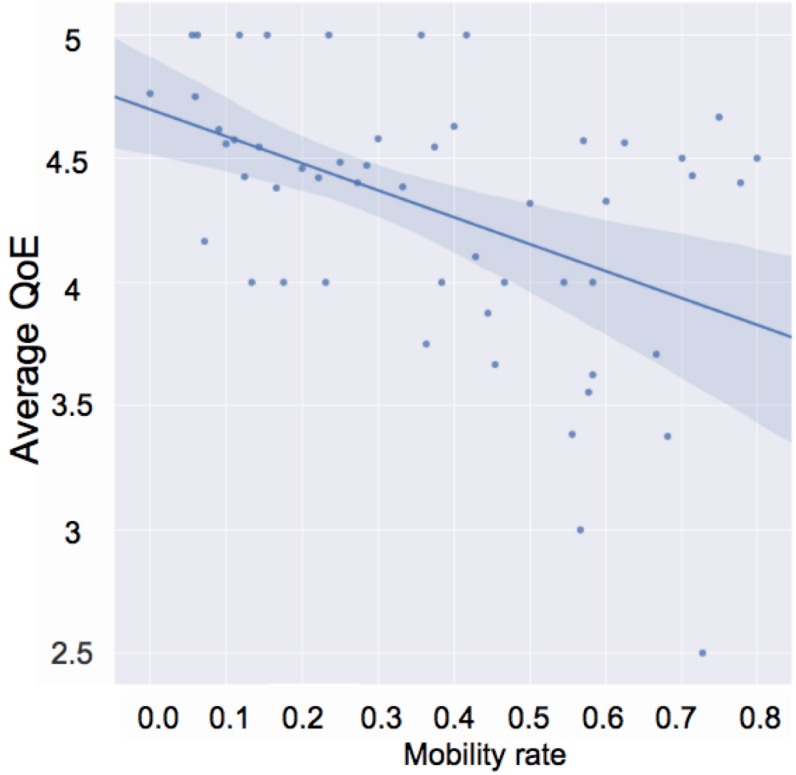
QoE_{exp}



First look on ACQUA dataset

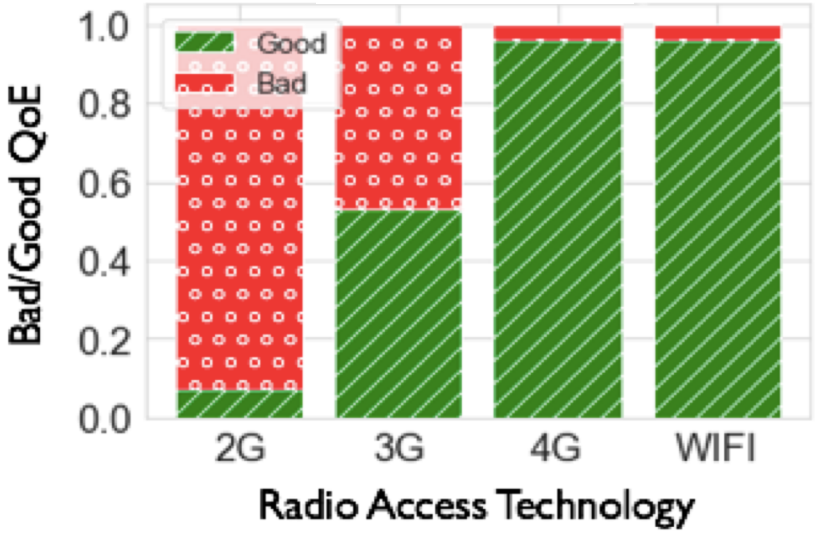
More than 1 million records

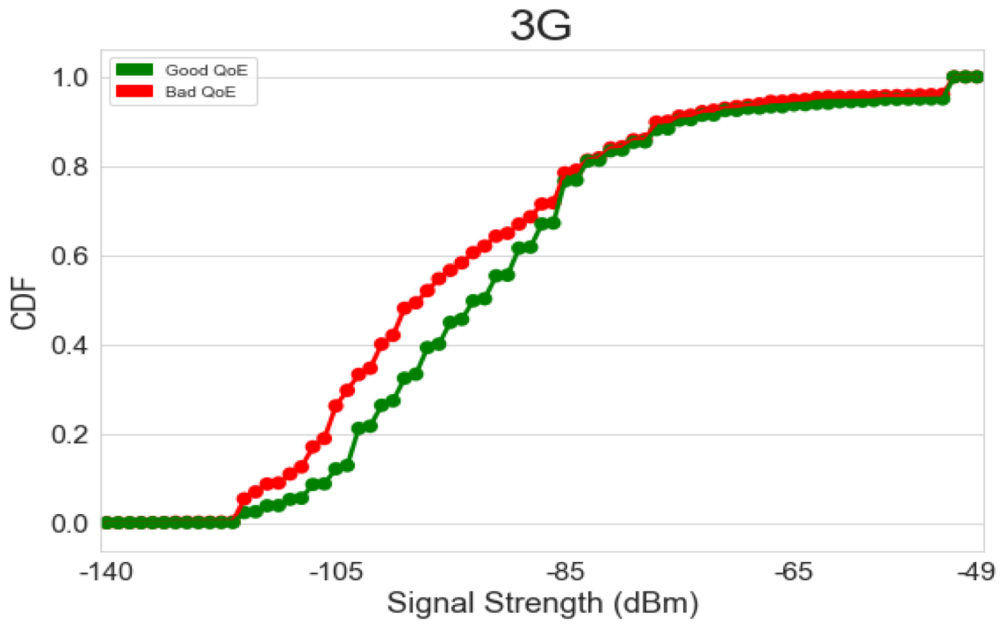


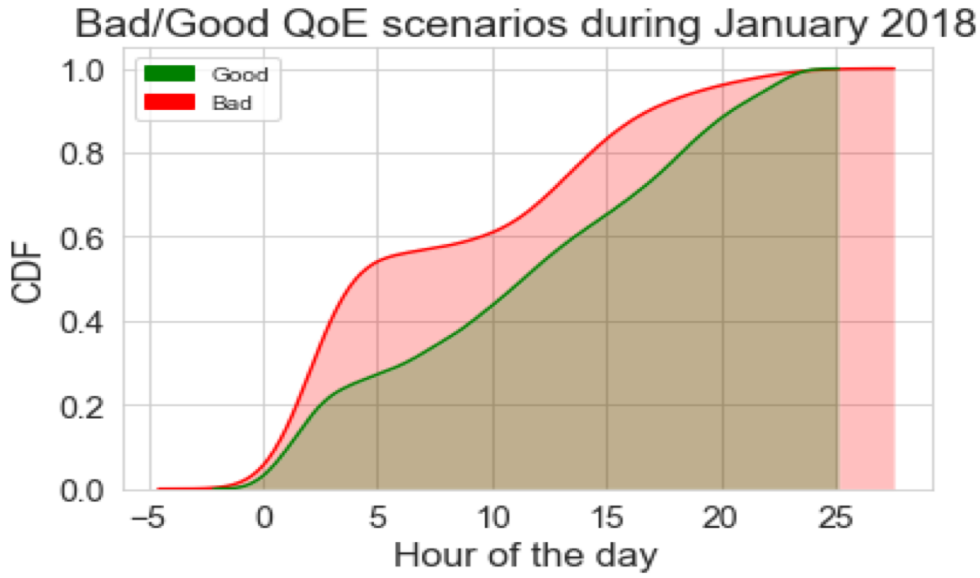


One month dataset regularly updated made available at
http://www- sop.inria.fr/diana/acqua/datasets/Android/

Bad QoE troubleshooting (YouTube 720p)







Conclusion & Future Work

- Cover other trending applications
- Enhance the QoE troubleshooting part with further analysis
- Address current limitations in terms of:
  - Coping with high bit rates (currently hard limited to 20 Mbps)
  - Battery consumption
  - Risk of blocking / filtering by middleboxes (addition of TCP as backup plane)

Thank you