



Horizon 2020
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Measuring Mobile Broadband Networks with MONROE

Anna Brunstrom
Karlstad University

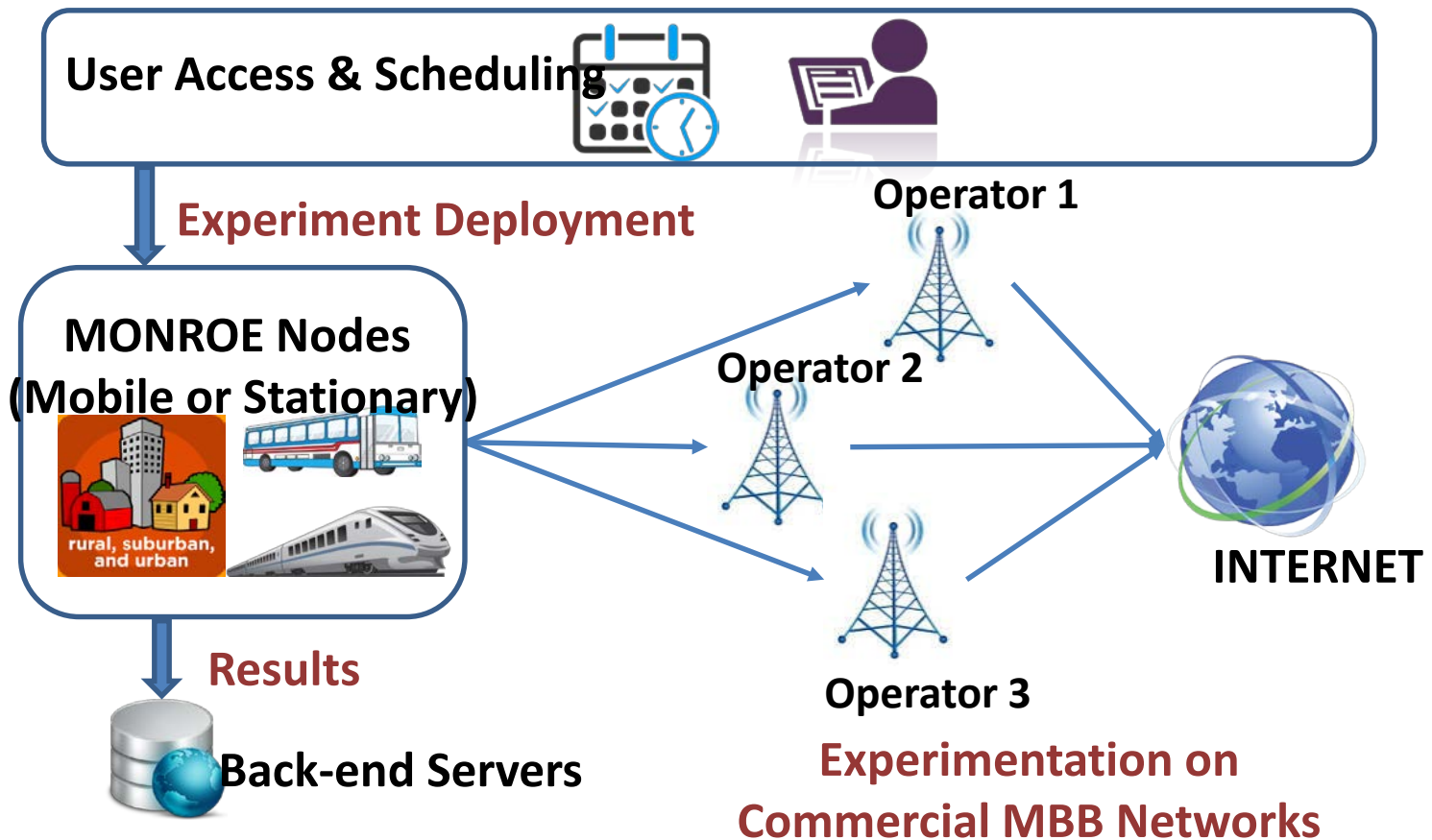
Outline

- Mobile broadband measurements
- The MONROE approach
- Use cases
 - Key MBB performance metrics: Roaming
 - Application performance: Web browsing
 - Innovative protocols and services: NEAT

State of the Art in Mobile Measurements

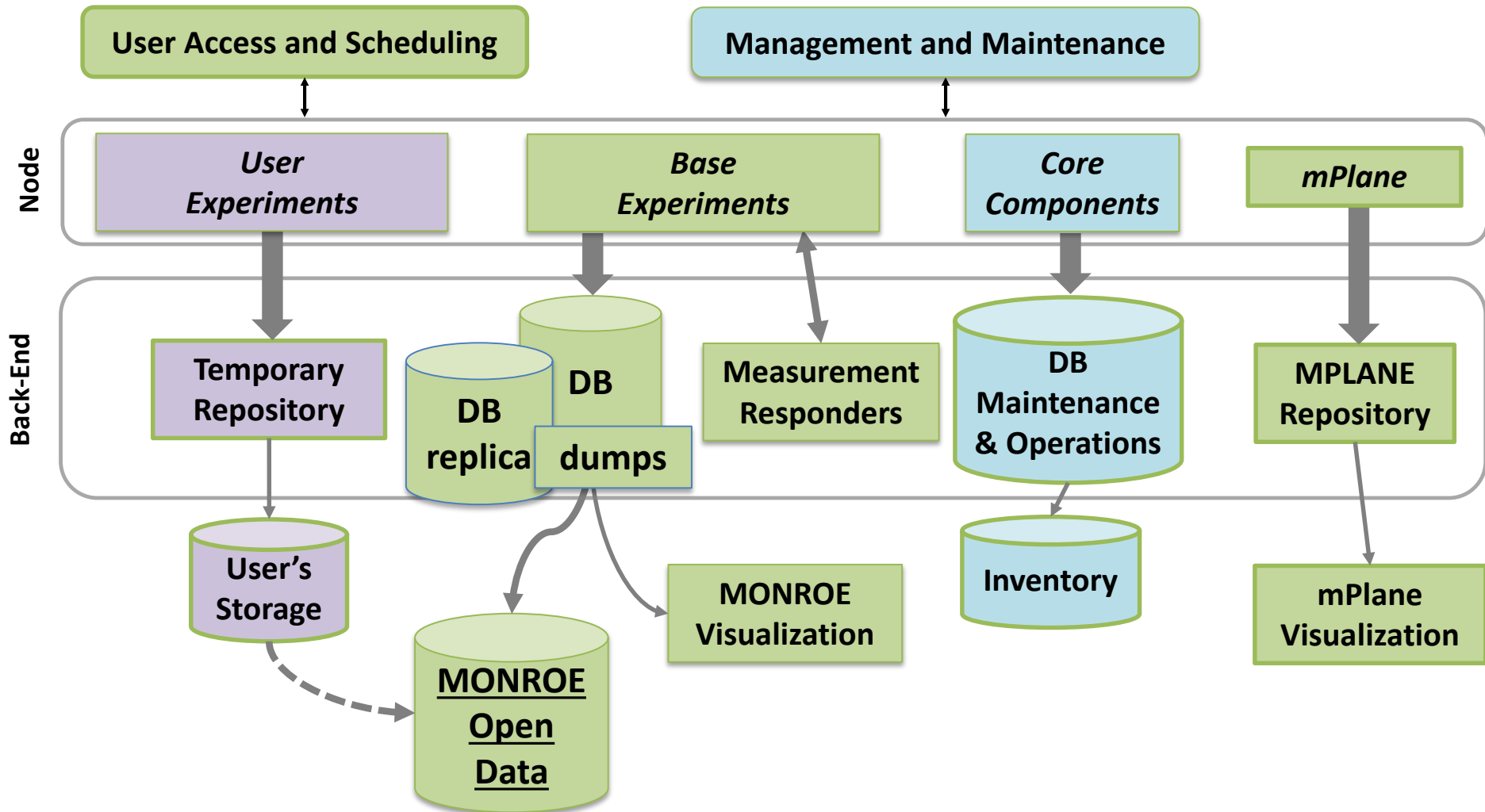
- Crowdsourced Measurements (e.g. Speedtest, Opensignal)
 -  Large Scale, end-to-end
 -  Noisy, user bias, short-term
- Drive-by tests by agencies or operators
 -  End-to-end
 -  Expensive, not scalable, short-term
- In network measurements (e.g., operator logs)
 -  Large scale, long-term
 -  Not end-to-end
- UE and Server System Operators (e.g. google)
 -  Large scale
 -  Not transparent and not controlled

MONROE: A unique infrastructure for end-to-end mobile measurements





Platform: Closer Look



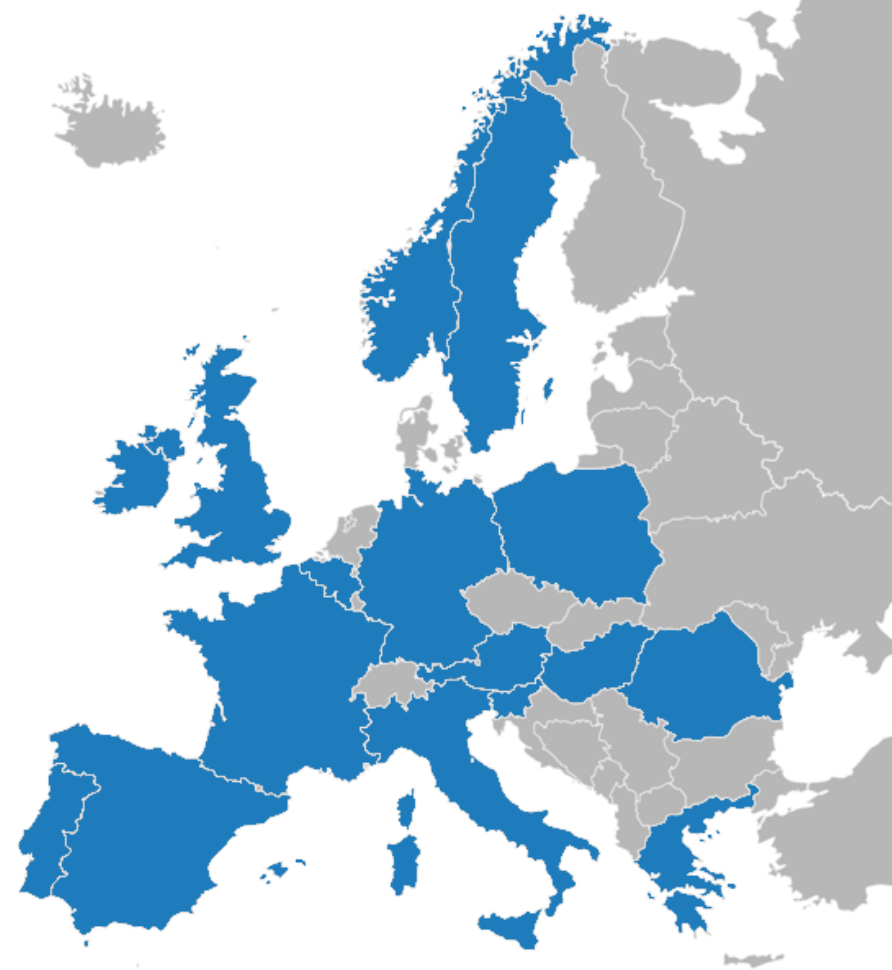
MONROE Footprint

16 different countries
46 different operators
180+ nodes

150 Main Platform
30+ Open Calls

More than 670,000 experiments
in one year

**OPEN to the
community since
November 2017!**



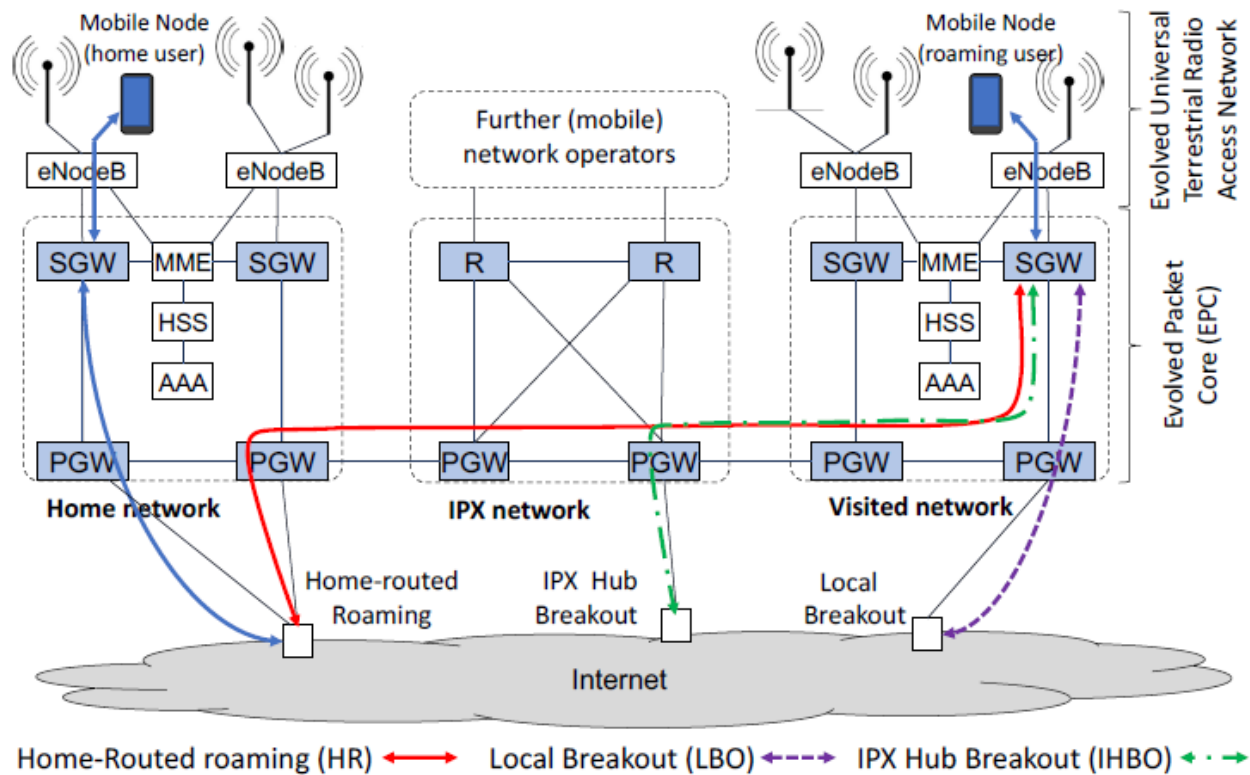
<https://www.monroe-project.eu/>

info@monroe-project.eu

<https://github.com/MONROE-PROJECT>

Example Experiment: Roaming

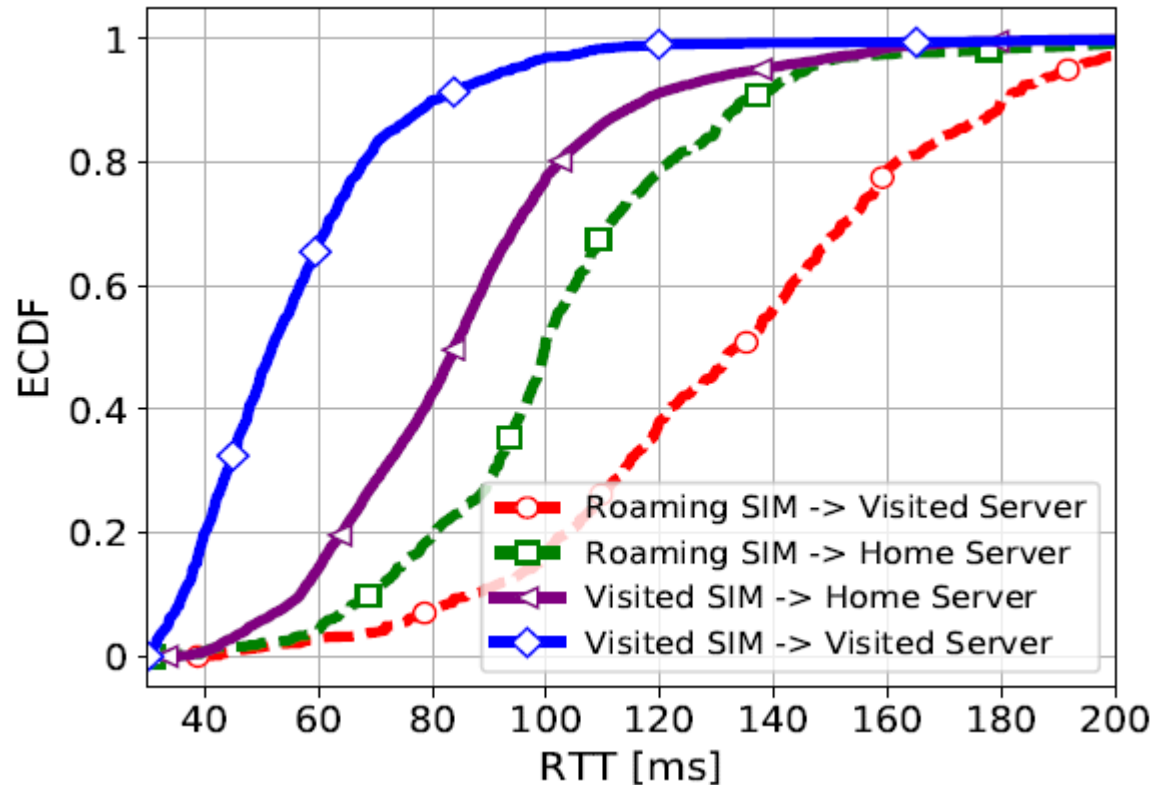
Roaming is a complex procedure



Roaming – Impact on Performance

- 16 MNOs
- 6 countries

- Traceroute: path discovery
- Dig: DNS lookup
- Curl: data transfer



Roaming – Key Findings

- Delay Implication:
 - Extra delay from visited country back to home country
 - Operators tend to use HR (home-routed roaming) to simplify accounting
- Traffic implication:
 - No additional traffic differentiation on 16 MNOs
- Content implication:
 - Geo- restricted content: same rule is applied at home and visited countries.

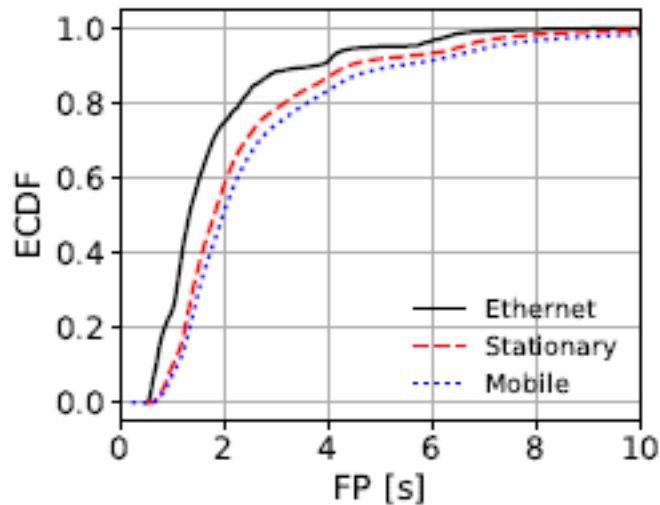
Example Experiment: Web browsing

- Motivation:
 - Find out the major factors affecting web performance and quantify their impact
 - Run large-scale, repeatable and reproducible experiments with intertwining technologies, protocols, and setups.
 - Compare 3G/4G MBB performance of browser and different protocols
 - Open-data for further analysis

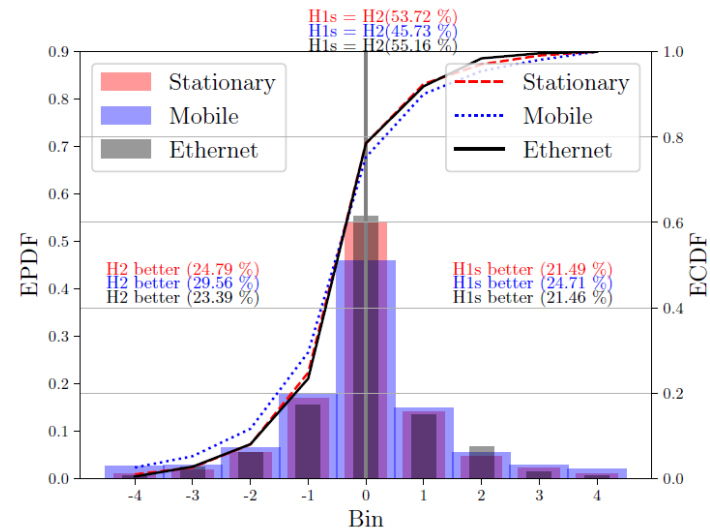
Web browsing – Key Findings

- 11 MNOs
- 4 countries
- 100+ locations
- 2,000,000+ page visits

- 3G and 4G
- HTTP/2 and QUIC
- Firefox and Chrome
- QoE metrics: FP, PLT, SI



Distribution of FP for Chrome



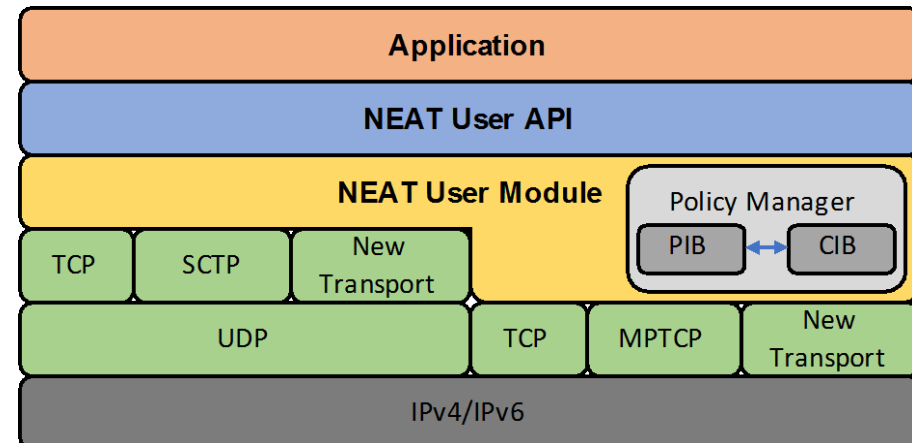
Distribution of SI for Chrome

“Web” – Key Findings

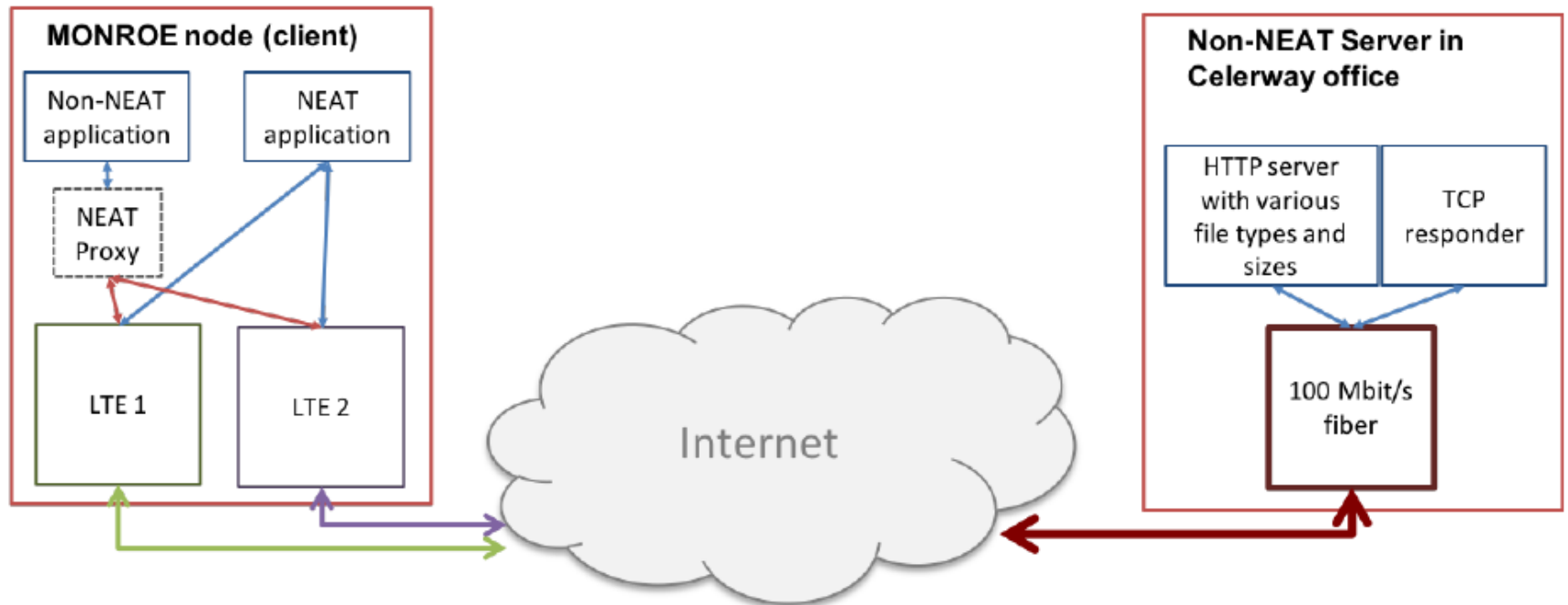
- Network impact:
 - Significant penalties for MBB users
 - Mobile nodes suffer further penalties due to changing channel conditions and handovers
- Protocol impact:
 - Marginal benefit of using HTTP/2
 - QUIC does not improve performance
- Machine Learning:
 - Used to identify the most influential factors
 - Highlighted features: RAT, mobility, browser, webpage composition, etc.

Example Experiment: NEAT

- NEAT enables the use of transport services rather than protocols
 - i.e., an implementation of IETF TAPS
 - example services may include e.g., reliable transfer, multi-path communication
- NEAT maps application requirements to services
 - if asked for e.g. "low latency" NEAT will try to create such a service
 - the mapping is transparent to applications
- NEAT tries to improve performance and fight ossification by
 - providing a more expressive API;
 - using local and remote info to make well-informed decisions;
 - using Happy Eyeballs to ignore the existence of middle-boxes

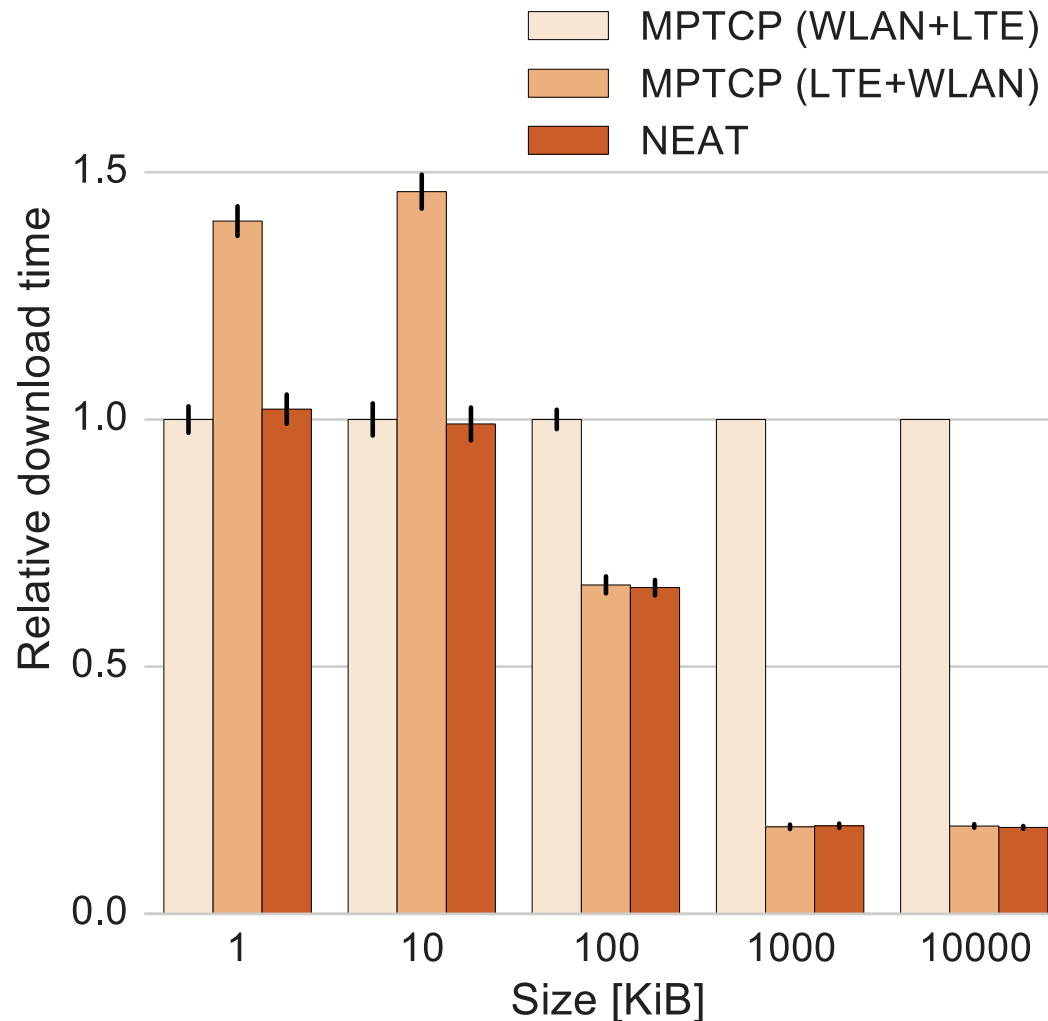


Integration with MONROE



NEAT: Selection of interface

- The choice of “initial” interface is very important
- In this experiment, WLAN quality was very poor
 - measured in library during exam week
- NEAT used link quality metrics to configure protocol



Concluding Remarks

- MONROE provides a unique infrastructure for end-to-end mobile measurements
- Enables range of different use case
- Moving the platform into 5G domain

Questions?



Hardware Implementation

Bill of Materials

Design Aspect	Component
Node Platform	APU2C4
Node Configuration	3xMC7455 + WiFi
Node Hardware	2xAPU + 3xMC7455 + WiFi
Operating System	Debian 9 Stretch
Modem Type	Sierra MC7455 CAT6 miniPCIe modem



Software Ecosystem

