MONROE, a distributed platform to measure and assess mobile broadband networks

DEMO: MONROE, a distributed platform to measure and assess mobile broadband networks

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***Abstract*—This demo presents the MONROE distributed platform and how it can be used to implement measurement and assessment experiments with operational mobile broadband networks (MBBs). MONROE provides registered experimenters with open access to hundreds of nodes, distributed over several European countries and equipped with multiple MBB connections, and a backend system that collects the measurement results. Experiments are scheduled through a user-friendly web client, with no need to directly access the nodes. The platform further embeds tools for real-time traffic flow analysis and a powerful visualization tool.**

I. Introduction

Mobile broadband (MBB) networks and operators provide a variety of services using technologies like 3G, 4G and 4G+ to several billions of devices. At the same time, mobile data traffic grows exponentially, with a 69 % increase in 2014 and a tenfold expected increase by 2019 [1].

With such a diffusion, and considering the variety of technologies and network deployment strategies, monitoring and assessing the performance and reliability of MBB networks is essential to guarantee the existence of appropriate infrastructures for a continued economic development. However, mobile applications that run speed tests [2] or drive-by tests [3] are not enough, because they are inherently not scalable and/or the measurements are not repeatable. Moreover, existing methods neglect the importance of accurate metadata information, e.g., location info, type of equipment, subscription type, which is fundamental to correctly contextualize the measurements.

In contrast, in the frame of the MONROE project[1] we have developed a unique distributed platform to conduct independent, repeatable, multi-homed, large-scale measurement and experimental campaigns for collecting data from operational MBB networks. The availability of this vast amount of data will advance our understanding of the fundamental characteristics of MBB networks and their relationship with the performance parameters of popular applications. This is crucial not only to improve user experience for services that are running on the current 3G/4G infrastructure, but also to provide feedback on the design of upcoming 5G technologies.

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[1]https://www.monroe-project.eu/

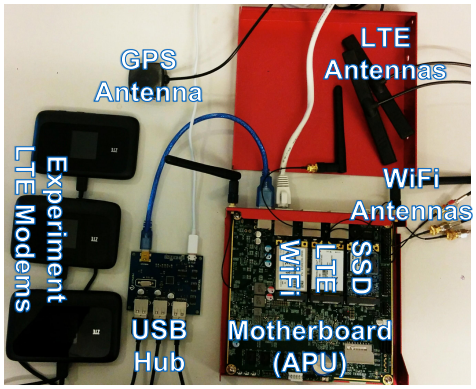

Fig. 1: A MONROE measurement node dissected.

In our interactive demo, we show how to design and deploy user-defined measurements in real time using nodes spread over Europe, and how to collect and analyze the results of the experiments with a user-friendly visualization tool.

II. The MONROE platform

MONROE is a multi-homed MBB platform that offers 3 cellular connections for experimentation. Fig. 1 illustrates the hardware blocks of a MONROE node, which include a mini motherboard APU1D4,[2] a WiFi 802.11ac/b/g/n module, LTE modems (3 of which are connected via USB), a GPS unit, storage, and antennas. We have designed and built several hundreds of nodes and a software framework that is responsible for the orchestration of experiments and for the collection, analysis, visualization and sharing of measurements. Nodes are either statically placed or mobile, i.e., deployed on trains, trucks and busses. MONROE nodes act as normal MBB static or mobile users, with their off-the-shelf or custom applications.

The MONROE framework is illustrated in Fig. 2 and comprises six main components: i) *User access and scheduling system:* Measurements are handled by a scheduling system through a user-friendly web interface. User access and provisioning of resources follow Fed4FIRE[3] federation specifications. ii) *Management and maintenance system,* which tracks

[2]http://www.pcengines.ch/apu1d4.htm
[3]http://www.fed4fire.eu/

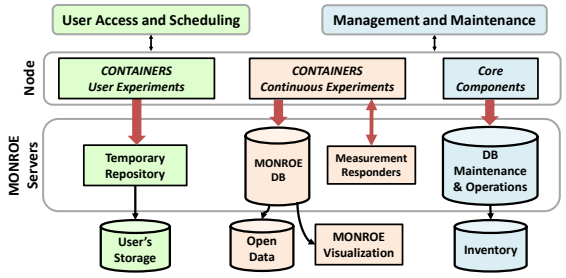

Fig. 2: Building blocks of the MONROE platform.

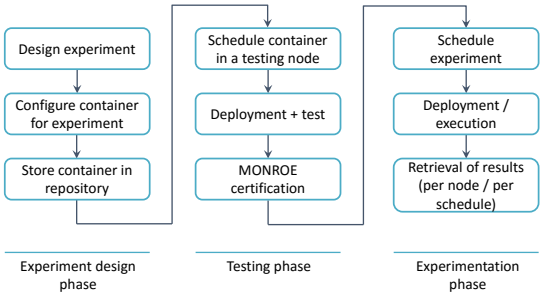

Fig. 3: Experiment creation and deployment phases.

node status, operational state and location. iii) *Node SW modules,* including MONROE core components (watchdog, routing, network monitor, etc.) and a set of Linux Docker containers[4] in which both basic MONROE and user experiments are executed in isolation. iv) *Remote repositories and databases:* Data and metadata are sent to remote repositories after each experiment, and then imported into an Apache Cassandra non-relational database. v) *"Measurement responders,"* used for active tests. vi) *Visualization:* It provides a near real-time graphical representation of the nodes status and the results of the base MONROE experiments (e.g., RTT, signal strength, HTTP download speed) via a public web page.

Notably, the MONROE framework does not only allow monitoring and analyzing the behavior of network connections in real-time, but also jointly storing measurements and metadata in the form of open data for offline analysis.

III. Experiment Deployment and Results Analysis

In this demo, we will show how to design, test and deploy experiments using the MONROE platform to measure and analyze the behavior of MBB networks (Fig. 3). First, experimenters have to define the measurements they want to obtain and decide how to implement them. Experiments run inside Docker containers, so they can consist of virtually any piece of software. During the testing phase, a MONROE administrator checks that the behavior of the container adheres to a set of minimum safety and stability rules; approved images are cryptographically signed and moved to our repository. Finally, the experimenter uses a web-based interface to schedule the experiment, selecting the number and types of nodes and suitable time-slots.

Experiments can collect active and passive traffic measurements from multiple MBB networks. For active measurements the platform provides both standard/well-known tools (e.g., ping, paris-traceroute) and project-crafted ones. For passive measurements, it embeds tools such as `Tstat` [4] to analyze the traffic generated. Moreover, each node passively generates a metadata stream with modem and connectivity status, and the measurements of several embedded HW sensors (GPS, CPU usage, temperature, etc.). Experimenters can either subscribe their experiments to the stream in real-time or consult the database afterwards. Considering that experimenters can deploy any additional measurement tools, the set of possible measurements is flexible and open.

[4]http://www.docker.com

Data and metadata stored in the database can be visualized using MONROE's web-based visualization tool, which produces interactive graphs such as time-based performance measurements, connection type/quality tracking and GPS location. For instance, Fig. 4 shows the RTT graph for the MBB networks a node connects to. Demo attendees will be given the opportunity to browse the network of deployed MONROE nodes and pick specific nodes and connections for real-time visualization of connectivity and coverage statistics.

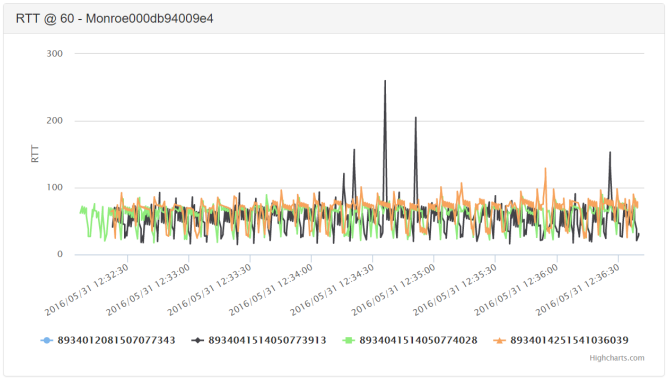

Fig. 4: Interactive RTT chart (MONROE visualization tool).

IV. Conclusions

This demo shows how to use MONROE as a distributed platform for the measurement and assessment of MBB networks. First, we show how to deploy active measurements on MONROE nodes. Then, we focus on analyzing and visualizing measurement results using the MONROE visualization tool. This part is interactive, allowing attendees to select and visualize connection and coverage statistics of MBB networks in various European countries in near real-time. In conclusion, MONROE offers all the components needed to conduct controllable and repeatable experiments on MBB networks, and to perform powerful data analyses.

References

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DEMO REQUIREMENTS

To run the demo, we need to connect to remote servers and to the MONROE nodes deployed over different countries. In practice, we simply need a small desk for a laptop and to display a sample node and its components, a chair, two power sockets and two Ethernet connections (or a reliable WiFi). We also need space for a poster and a projector with a screen (unless we can project on the wall).