Experiment #11

Medical diagnosis for emergency scenarios [Altice Labs]

Overview and Objectives

Medigraf [1] is a medical teleconsultation platform that enables collaboration of healthcare professionals and common diagnosis. It provides remote healthcare services, offering a collaborative web environment to conduct medical appointments via video conferencing and real-time clinical data sharing. Medigraf enables the collaborative/simultaneous viewing of means of diagnosis by multiple healthcare professionals. Medigraf is an **Altice Labs** product. Therefore, from a strictly business point of view, it cannot be considered a 5G-EPICENTRE 3rd-party application. However, because it can also be exploited as a PPDR tool (it has been demonstrated as such in the past, but never used in real scenarios so far), and because its characteristics are quite unique compared to all other 5G-EPICENTRE first- and third-party experiments, it was considered a valuable addition to the list of third-party applications.

Medigraf has been extensively used as a teleconsultation tool between Portuguese hospitals and medical centres, as well as between Portuguese hospitals and hospitals in other countries, especially in Africa, used by doctors for pre-programmed sessions. Typically, the available network resources are plentiful. Therefore, degradation of network performance is rarely experienced as a significant problem by Medigraf users.

However, as stated above, Medigraf might as well provide an effective solution in a wide range of emergency or unplanned scenarios, in which timely diagnosis and quick medical intervention represent a crucial factor to avoid or mitigate serious consequences (*e.g.*, makeshift emergency hospitals in major disaster events). For this kind of scenarios, wireless mobile technologies are the only connectivity option in most cases. Inadequate performance and unreliability may be major obstacles against the use of legacy (pre-5G) mobile network services. Also, quick on-demand deployment could represent a key requirement in such emergency scenarios. For this type of scenarios, 5G, as can be demonstrated via the 5G-EPICENTRE platform in particular, can provide several concrete benefits:

- Improved and stable throughput, which may be especially important to transmit medical images for which loss of quality cannot be tolerated.
- Reduced latency, which is especially important for collaborative/simultaneous viewing of medical video by multiple healthcare professionals, for common diagnosis.
- Improved reliability and dependability.
- Swift and scalable deployment, which may represent a crucial asset in unplanned and emergency situations.

5G-EPICENTRE provided an opportunity to test this kind of scenario, evaluate the value of 5G for Medigraf, and understand the challenges posed by the integration in the 5G-EPICENTRE platform.

This project has received funding from the European Union's Horizon 2020 Innovation Action programme under Grant Agreement No 101016521.

The Medigraf application runs on a Windows Server 2019 VM. In this experiment, the Medigraf server was deployed at the network edge of the 5G testbed, in order to optimize performance. The basic experiment network setup is represented in Figure 1.

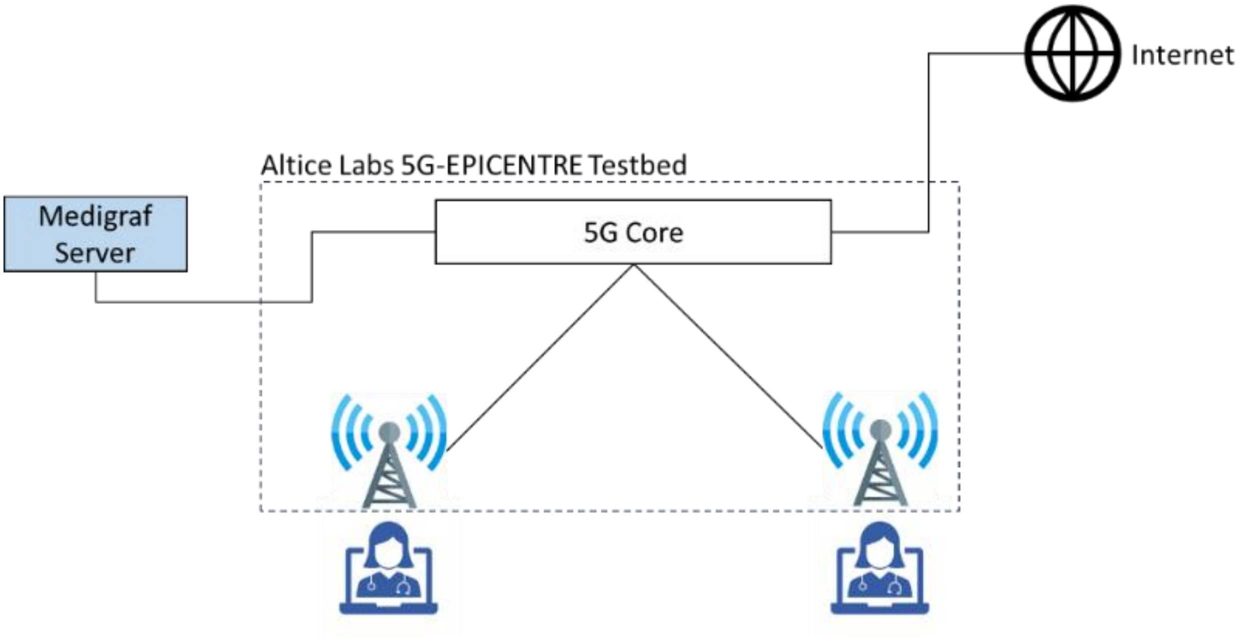

Figure 1: Medigraf experiment network setup

Testbed Readiness

The Medigraf deployment on the 5G-EPICENTRE platform, described in the next section, presented several challenges to be faced. The first was that this solution runs in VMs only, whereas the 5G-EPICENTRE platform is optimized to handle containers deployed via Helm. The other challenge was the complexity of the installation process, and the lack of automation.

To overcome the installation challenge, a new VM was created in Proxmox, and the solution was manually installed, following the tutorials available, with support of the product development team.

Regarding the deployment challenge, a Helm chart and a respective container were created, with a script inside for interacting with the Proxmox API to start the VM, when the container starts, and another script to stop the VM, when the container ends. With these two solutions, it was possible to proceed to the next phase of the experiment, and deploy the application.

Experiment Deployment

Medigraf was deployed on the 5G-EPICENTRE Altice Labs 5G infrastructure. The Medigraf product was previously installed in a VM, as described earlier, and the instruction to Proxmox API to start or stop came from a container deployed through a Helm chart.

The creation of a new experiment and the deployment of the Helm chart on Altice Labs infrastructure strictly followed the 5G-EPICENTRE defined procedures, supported by the 5G-EPICENTRE Portal. After choosing the scenario for Altice Labs testbed, Figure 2 demonstrates usage of the Portal in the deployment of the Medigraf application.

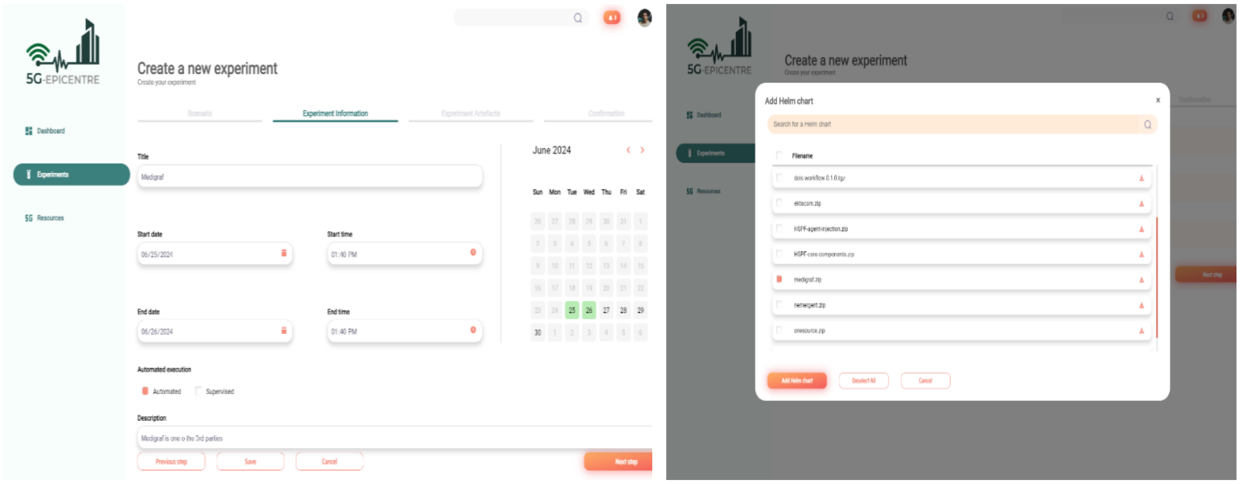

Figure 2: 5G-EPICENTRE experiment creation wizard environment for Medigraf

Upon startup, Medigraf provides a web interface, accessible through any device with an internet browser in port 443, as shown in Figure 3.

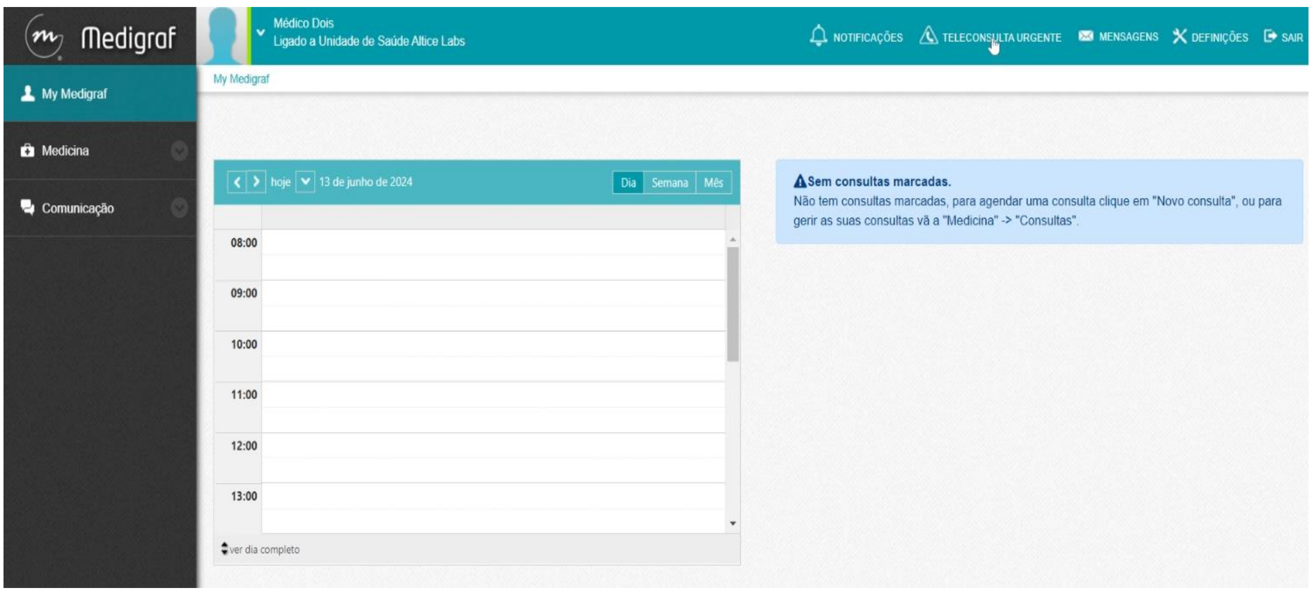

Figure 3: Medigraf graphical user interface.

Experiment Execution and Results

For this experiment, two laptops were connected to the 5G-EPICENTRE testbed with 5G dongle ASKEY NDQ 1300 [2]. To start an emergency teleconsultation, pressing the existing button in the graphical UI is enough. When this button is pressed, the user is requested to enter some information and select one of the available doctors. When the doctor accepts the call, the web interface changes, shows both cameras and medical information regarding this specific session (Figure 4).

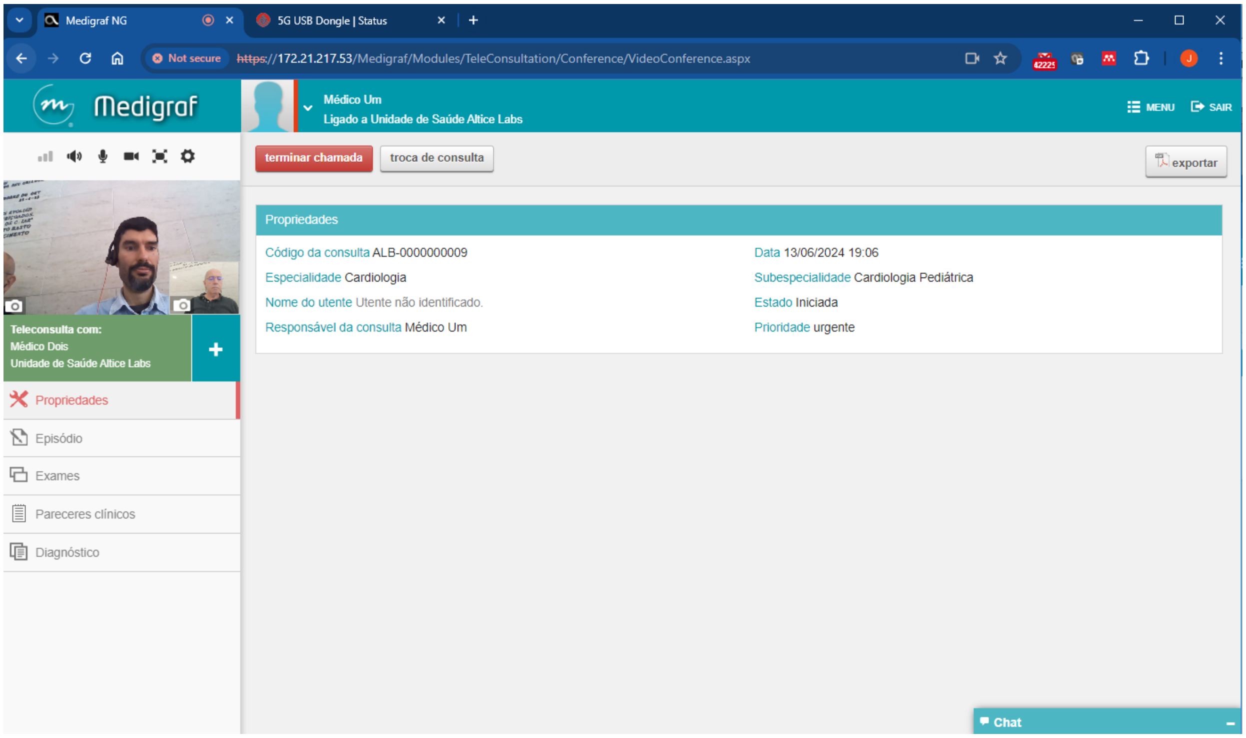

Figure 4: Medigraf teleconsultation user interface

In a typical Medigraf session, real-time clinical data is shared between doctors or practitioners (Figure 5).

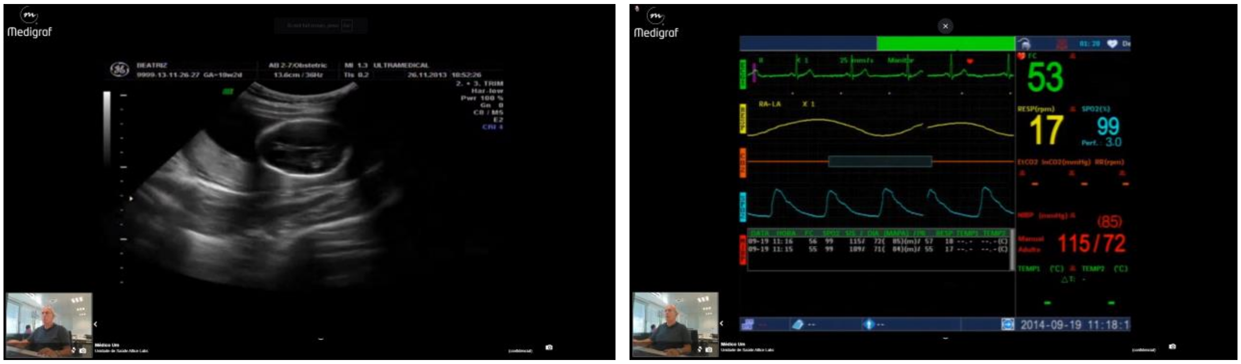

Figure 5: Medigraf real-time clinical data sharing

For Medigraf, latency and throughput are key parameters, especially in scenarios based on medical imaging (e.g., collaborative/simultaneous viewing of medical video by multiple remote healthcare professionals, for common diagnosis). Although extremely low latency is not so critical as in other types of medical applications (e.g., remote surgery), the importance of latency is still quite significant.

Traditionally, time to deploy does not represent an important KPI, as the application is supposed to run in a planned and controlled environment. However, using Medigraf in a highly dynamic and unplanned PPDR setup may require a new approach, in which swift, on-demand deployment of new instances is needed, to address specific challenges.

Taking advantage of the Medigraf virtualized environment, deployment and resource scalability, enabled by the 5G-EPICENTRE platform, can represent a key benefit to use the application in a PPDR context. The time to deploy (time between the moment the command has been received from the platform and the application is up and running) was measured and the results are provided in Figure 6 (10 measurements). A deployment time in the interval 20-23 seconds can be considered quite an interesting result for most PPDR scenarios.

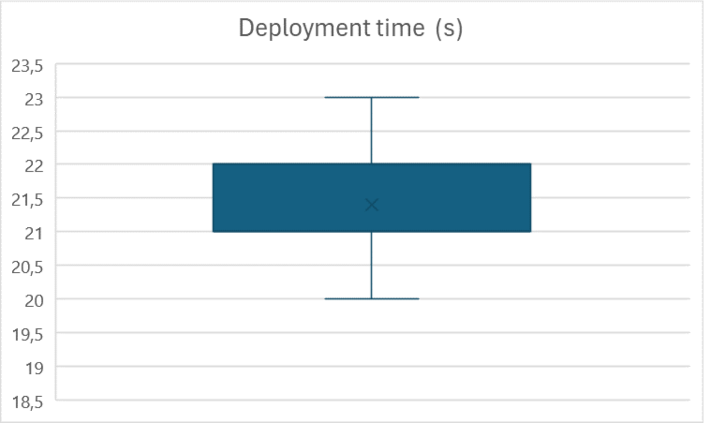

Figure 6: Medigraf deployment time

Overall evaluation

The integration in the 5G-EPICENTRE platform was an opportunity to evaluate the potential utilization of Medigraf in application scenarios different from the traditional medical teleconsultation setup, especially medical diagnosis in emergency or unplanned scenarios. Additionally, the value of 5G technologies to enable reliable and trustworthy communication in such scenarios was also evaluated.

In relation to the first point, Medigraf provided positive indications of being prepared to widen its scope to new application scenarios through the deployment on the 5G-EPICENTRE platform. The fact that Medigraf is hosted in a VM made the deployment process more complex, but did not prevent the key objectives from being accomplished. The time and effort required to deploy a new instance can be considered acceptable, and in line with PPDR requirements.

In relation to 5G performance, the experiment provided good quality results. However, because it is still 5G-agnostic, the exploitation of 5G features (*e.g.*, 5G network APIs, 5G network slicing) is still limited. In this regard, it becomes clear that there is considerable room for improvement until Medigraf is prepared to fully exploit the potential of 5G.

References

[1] Altice Labs, "Teleconsultation & Telediagnosis System – Medigraf," [Online]. Available: https://www.alticelabs.com/products/ehealth-telemedicine/. [Accessed June 2024].

[2] ASKEY, "5G NR USB DONGLE," [Online]. Available: https://www.askey.com.tw/products-detail/ndq1300/. [Accessed June 2024].