Use Case #2

Multi-agency and multi-deployment mission critical communications and dynamic service scaling [CCTC Testbed]

Overview and Objectives

The results of the present UC should be framed into the performance of NEM’s recently containerised MCX innovation branch. The final performance of the containerised MCX solution (after internal quality processes, and before becoming the final MCX product) shall improve this initial performance.

The UC2 experimentation objectives have followed two different lines, on the one hand to analyse the service performance (under those deliverable’s definitions), and on the other hand to study interesting 5G functionalities for the PPDR sector, such as dynamic deployment and re-instantiation possibilities offered in 5G cloud nativized environment’s, which are aligned with CTTC’s scenario objectives.

Use Case Description

MCXs provides a way for robust connection against errors, ensured predetermined quality of service and network priority over other communications. They are used from public safety and emergency (police, fire, health, etc.) to operators and industrial environments (Oil&Gas, mining, transport, etc.).

The most widespread public safety communication solutions such as TETRA or P25 are based on legacy private radio technology, with proprietary deployments. This is why both public administrations and private companies have to cover the costs of deploying these networks. In addition, there is a mix of providers and differences between networks that end up locking administrations into one provider, with the resulting cost overruns.

On the other hand, the current digital revolution demands new multimedia capabilities, high-speed data access and new functionalities. The emergency communications sector has not been excluded in this sense, and concepts such as remote video assistance, augmented reality, video emergency calls, etc. are beginning to gain relevance. However, the development of this type of services would not be possible over current TETRA or P25 networks, due to their technological limitations. Thus, the capabilities of 5G technology represent a key milestone in the evolution of the MCX sector, as it brings improved bandwidth, low latency with ultra-reliable service and massive machine-to-machine communication (eMBB, URLLC and mMTC) capabilities. In addition, 5G networks create the concept of “Network Slicing”, which opens up the possibility of splitting the 5G mobile operator’s network into something similar to a sub-network. These 5G “Slices” can be managed in a semi-independent way of each other, enabling a parallel MCX virtual sub-network, so even if the regular netw ork is saturated by traffic, the MCX service can continue working normally.

This has therefore been the research focus of the last few years for NEMERGENT, to deepen the understanding of 5G technology and create a solution that can ultimately deliver enhanced emergency communications services. Therefore, NEMERGENT has taken advantage of the need for a technological leap in the emergency communications sector, along with the opportunity that new 5G improvements offered, to develop solutions that can be deployed as a vertical service in public, private or both hybrid 5G networks.

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

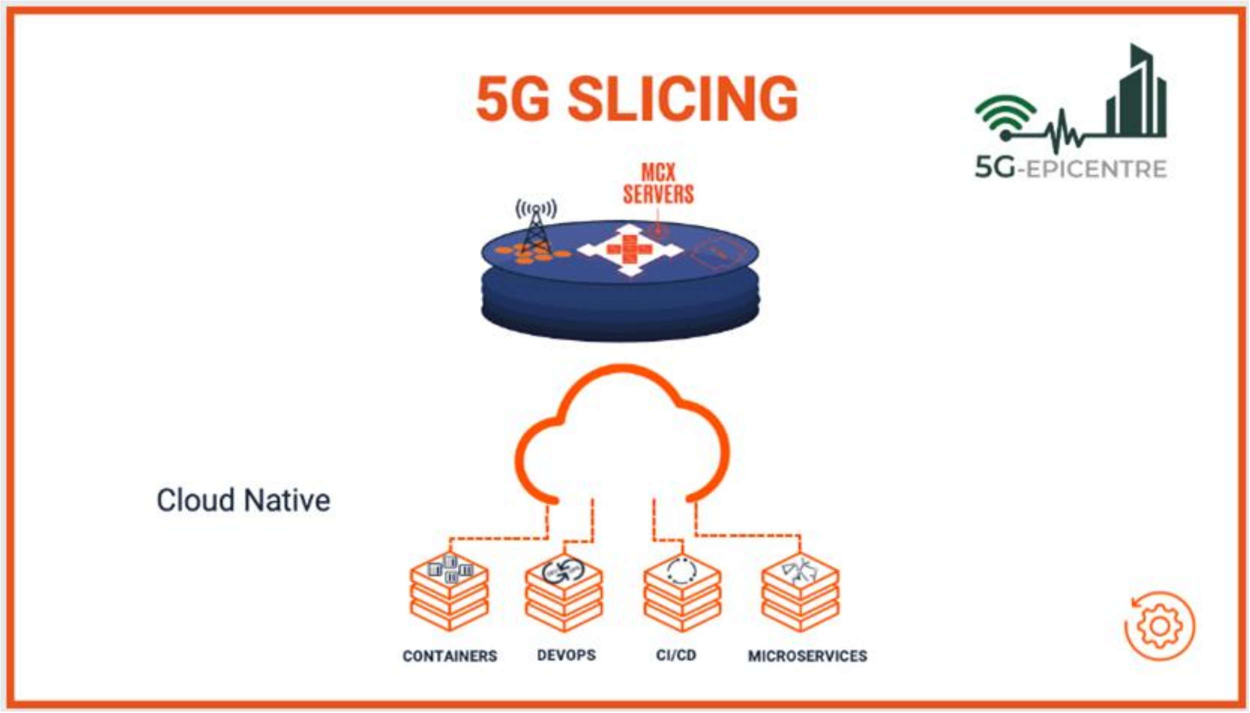

Figure 2: UC2 Architecture

In this framework, a platform such as the one proposed in the 5G-EPICENTRE project acquires significant relevance. NEMERGENT intends to use the infrastructure and services created in the project to continue offering technological advances in its MCX solutions, and to experiment with new functionalities. The Use Case (UC) aims to address the need for coordination between Public Protection and Disaster Relief (PPDR) agencies by implementing a dynamic solution based on location or network conditions. It also seeks to explore Quality of Service (QoS) management and slicing for MCX communications. To this end, a fully microservices-based MCX solution has been developed, fitting with the cloud-native nature of the 5G-EPICENTRE platform, as described in Figure 2. This technology, used in both the MCX solution and the 5G-EPICENTRE platform, will increase the deployment agility, enhancing the experimental needs raised in this UC.

Experiment Setup/Methodology/Deployment

The whole experimentation process has also been described in this deliverable, based on measurement samples calculated iteratively for obtaining the overall values. The results shown in Table 1 are classified as Upgradable (U), Acceptable (A) and Optimal (O) ranges.

In order to prepare for the experimentation, a Kubernetes-based environment managed by CTTC hosted the deployed MCX services. Additionally, for the extended experimentation, a multi-cluster environment has been envisioned. Also, a minimum of two PTT UE devices were used, where MCX clients were installed to perform E2E MCX interactions. The measures were collected by one of these clients during the different iterations, and then uploaded to the MCX server-side services. Then, these measurements were MQTT-queued, as service-associated results, and added to the 5G-EPICENTRE platform's analysis processes.

Table 1 provides the performance experimentation and the obtained KPIs. As a result, all KPIs managed to reach optimal values, thus improving the forecasted performance.

Table 1 : UC2 KPIs

KPIs	Results expected	Experimentation results
UC 2.1	Network RTT	21.13ms - Optimal
UC 2.2	MCPTT Access Time	35,02 ms - Optimal
UC 2.3	MCPTT E2E Access Time	237,2 ms - Optimal
UC 2.4	Service Availability	99,92 % - Optimal
UC 2.5	Re-instantiation time	54,79 s - Optimal
UC 2.6	Merged talk groups creation time	0,82 s - Optimal

NEM's MCX solution is entirely based on Kubernetes. The service can be deployed using Helm, a package manager for Kubernetes. It helps to deploy applications reading the templates, deploying the services accordingly. If the cluster environment does not support Helm, it can be used from an external machine pointing out to the cluster. The basic deployment requisites have already been mentioned and additionally, last section of the present factsheet provides an insight into the additional deployments needed for inter-cluster and inter MCX communication.

Experiment Execution and Results

Table 1 summarises the resultant outcome of the performance experimentation. Functional experimentation is further analysed in the last section of the present factsheet. The following sequence of statistical data has been calculated under the conditions of the experiment, as a common procedure for both scenarios. The statistical results are shown in Figure 1 - Figure 5, framing them with a reference measure based exclusively on 5G performance, such as CTTC's RTT calculation.

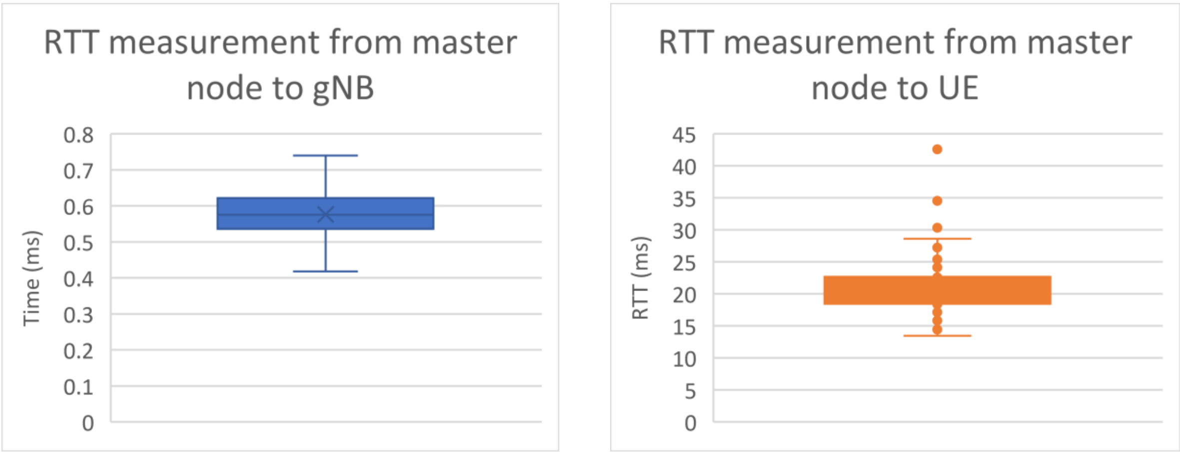

Figure 1: RTT measurement from master node to gNB/UE

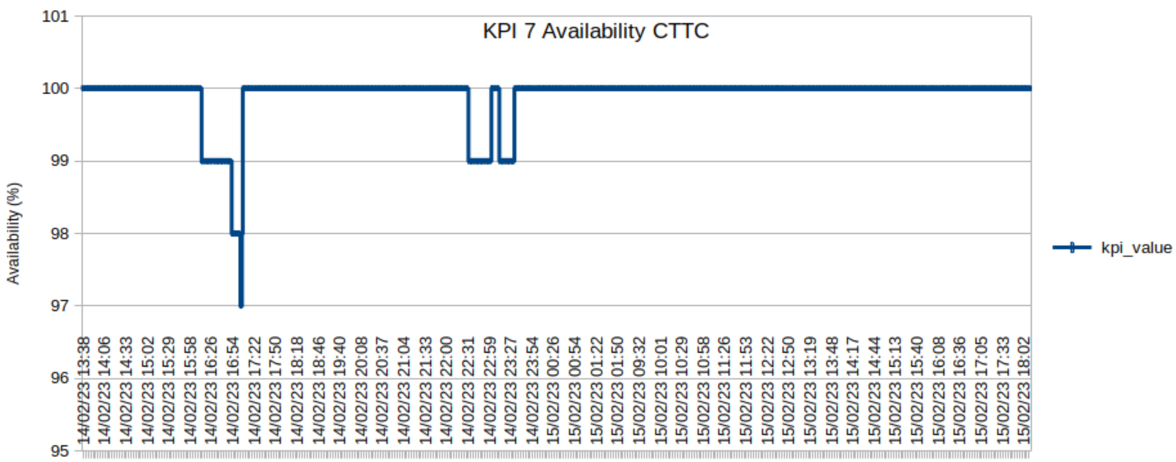

Figure 2: UC 2.4 Service Availability at CTTC

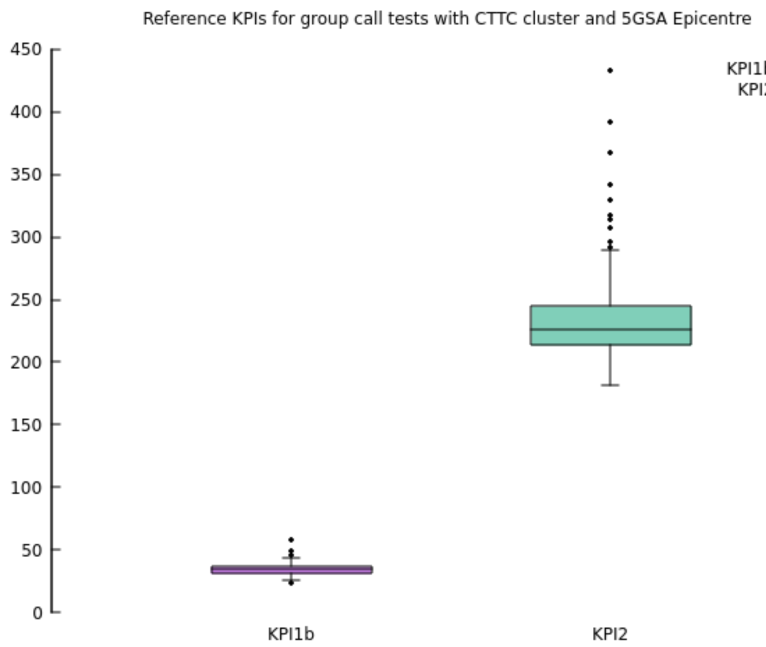

Figure 3: UC 2.2 Access time (KPI1b) and UC 2.3 E2E Access time (KPI2) at CTTC

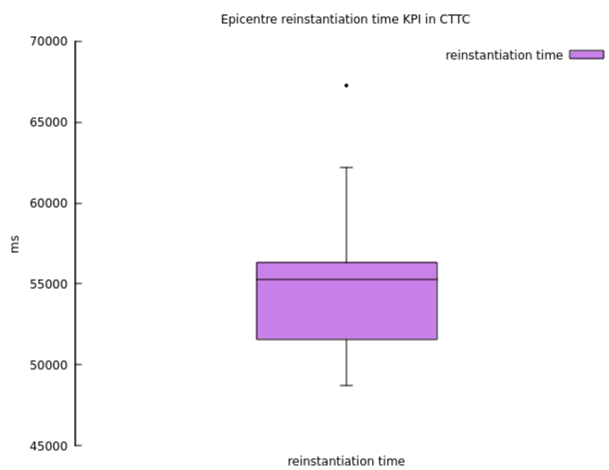

Figure 4: UC 2.5 Re-instantiation time (CTTC)

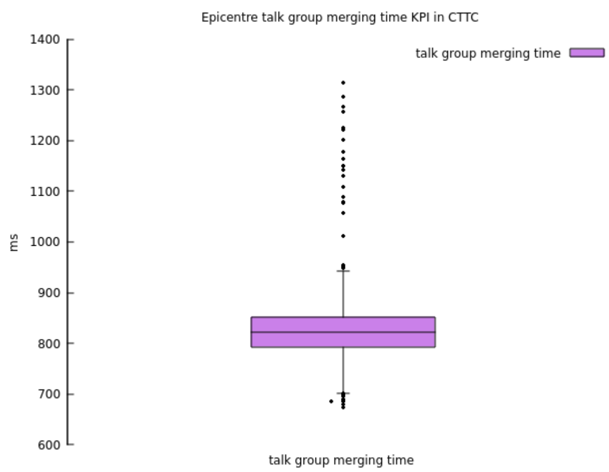

Figure 5: UC 2.6 Merged talk groups creation time (CTTC)

Overall evaluation

All UC2 KPIs have reached the optimal values defined in the project, having undergone optimisation processes by both the vertical and the underlying network managers. More KPIs than expected have reached optimal values, which is a major milestone for an innovation branch like the one tested.

The proposed UC has also been intensively analysed from a functional point of view, exploring both low latency and re-instantiation time, needed to guarantee MCX communication conditions in PPDR environments. Both of these concepts have a direct impact on how reliable 5G networks might be perceived by PPDR agencies', and these demonstrations encourage the adoption of 5G solutions among PPDR developers. Thanks to the conclusions obtained in SC4, an interesting experimental scenario is offered, in which to prepare PPDR Network Applications for possible contingencies in emergency situations. The emergencies faced by this sector, such as floods, earthquakes, fires, hinders to guarantee correct operation of the network in the affected areas. For this reason, studying the mobility of 5G components, as well as PPDR Network Applications such as NEM's MCX solution, is particularly interesting. Such functionalities would provide resilience in PPDR communication in emergency situations.

All these initiatives have had a corresponding demonstration, to show live how the MCX service works in the context under analysis. Therefore, the UC2 experimentation process can be considered satisfactory, since from a performance, conceptual analysis of advanced 5G functionalities and demonstration point of view, the experimentation has been a success.

Conclusions

Almost all UC2 KPIs have reached the optimal values defined in the project having undergone optimisation processes by both the vertical and the underlying network managers. More KPIs than expected have reached optimal values, which is a major milestone for an innovation branch like the one tested. Furthermore, those KPIs that have obtained acceptable values, such as re-instantiation time, have not been the focus of this scenario, so probably they are susceptible to improvement. These have been further elaborated in the context of SC4.

The proposed UC has also been intensively analysed from a functional point of view, exploring both slicing and QoS Management for service-network interaction, needed to guarantee MCX communication conditions in PPDR environments. Both of these concepts have a direct impact on how reliable 5G networks might be perceived by PPDR agencies, and these demonstrations encourage the adoption of 5G solutions among PPDR developers.

All these initiatives have had a corresponding demonstration, to show live how the MCX service works in the context under analysis. Therefore, the UC2 experimentation process can be considered satisfactory, since from a performance, conceptual analysis of advanced 5G functionalities and demonstration point of view, the experimentation has been a success.

Advanced SC4 scenario experimentation

This initial experimentation has been taken further, exploiting the advantages offered by this Instantiation & Latency scenario. A hybrid Network Application such as NEM's MCX solution requires components interacting with the network itself (*e.g.*, the N5 interface between the AF of the NEM MCX solution and the 5G PCF described in SC3). One of the differences between 5G networks and their predecessors is that their logical elements, which provide the network intelligence, are fully virtualised. Hence, they offer technological advantages, because they can be deployed at will, whether for rescaling, contingency actions, or performance optimisation. SC4 presents an ideal scenario for verticals to prepare for such contingencies, exploring the addressing issues that can arise when applying such network resilience functionalities (particularly interesting for the PPDR sector).

An experimental context has been created in which, based on the 5G scenario above, up to 3 Kubernetes clusters have been enabled, in which different instances of both 5G elements (such as the UPF) and vertical services (such as NEM's MCX), can be deployed, exploring the unique advantages of 5G technology that such interactions can offer. Figure 6 shows this experimentation context, where different UPF instances were deployed in each cluster, alongside different MCX Network Applications instances.

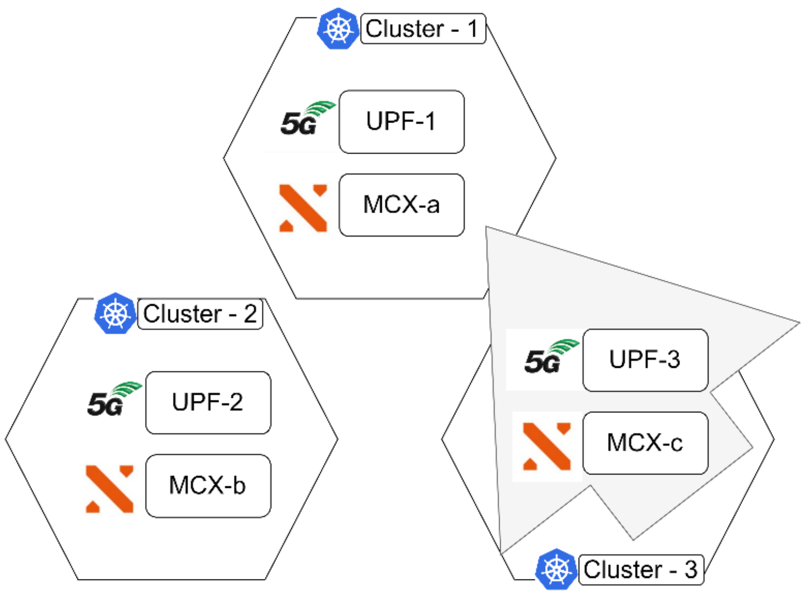

Figure 6: SC4 advanced instantiation context

The scenario is complicated by the need to redeploy the content of one of the clusters to another location. Such needs may occur, when either a cluster is malfunctioning, the need for scaling appears, or reactively to 5G KPI performance. In this case, CTTC has explored the deployment of services through Karmada controlling network latency, a malfunction has been emulated in one of the clusters.

In parallel, the MCX service has been deployed in different instances, emulating a situation where different PPDR agencies (each with their own MCX communication services) must coordinate and collaborate (possible PPDR-related scenario in real emergencies). For this purpose, a campaign has been created, through the MCX-1 interface to interconnect different MCX services and coordinate communication groups of different PPDR agencies. In addition to this, development and integration effort has been made for the MCX inter-cluster communication to work. This means that the MCX-1 interface would work seamlessly, even if the different MCX services are in different Kubernetes clusters, thus abstracting the Kubernetes needed addressing at a service level.

This scenario has allowed to explore the addressing change between internal components that an MCX service undergoes when re-instantiating from one Kubernetes cluster to another. MCX services reinterpret the new location of the migrated service, maintaining the initial campaign configuration in a PPDR user-agnostic manner. This re-instantiation process has been optimised to the point where, in 2 minutes and 13 seconds, a coordinated communication between agencies is possible again. In addition, the vertical service would also be prepared to deal with the 5G UPF mobility and re-instantiation, thus enabling a minimal impact on the MCX service offered to the PPDR users, when addressing these network resiliency processes.