Use Case #4

IoT for improving first responders situational awareness and safety [UMA Testbed]

Overview and Objectives

This use case aims to provide comprehensive situational awareness of field operations in PPDR scenarios. It involves monitoring field agents using a combination of geographical and indoor positioning, environmental sensors, and wearable biological sensors, alongside real-time text, audio, and video transmissions. The data is transmitted over 5G and processed at the CCC. This information is then displayed on the platform's front-end upon the operator’s request, along with alerts generated by AI and ML algorithms to detect man-down situations and other critical incidents (e.g., gunshots, environmental hazards, physical threats, etc.).

To gather the necessary knowledge for implementing this ambitious development, several initial tests have been defined, along with potential complementary information. Various tests were conducted, to measure KPIs relevant for the use case and the PPDR community.

The primary objective of these experiments was to gather information that demonstrates the benefits of using 5G for vertical applications in PPDR scenarios. The initial tests are designed to collect data on various aspects, including E2E delay, platform-specific message delay, UE availability, and the satisfaction level of potential CCC operators while using the application.

At UMA testbed, ONE performed both lab testing at UMA facility with their private 5G network, and orga-nized and executed several large-scale trials with the Malaga Police in real events. The goal was to measure several network-related KPIs to assess the feasibility of the 5G infrastructure for emergency scenarios using the Mobitrust platform.

Use Case Description

The Mobitrust platform is the key technology behind the Use Case 4 of 5G-EPICENTRE, whi ch is centered on IoT for improving first responders’ situational awareness and safety. Mobitrust has been subject to continuous development by a specialised OneSource team for the past eight years, and the latest enhancements led to the cloudification and split intro microservices of its internal components. The wearable devices, known as BodyKits, are able to use 5GSA, which brings vast improvements to field awareness by delivering reliable communications, low latency and enough bandwidth for real-time HD video from multiple points in the field.

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The platform has a wide range of possible end users, including police forces, fire departments, civil protection, military forces, industrial workers and emergency medical services. By leveraging multiple technologies and collecting inputs from multiple sources such as sensors (biological, environmental and positioning), cameras, among others, Mobitrust offers the following functionalities:

- Integration with 4G and 5G for public safety communications
- Data correlation and personalised notifications
- Integration with Commercial-Off-The-Shelf (COTS) devices
- Integration with Mobile Device Management
- Advanced statistics
- A secure mobile platform
- Automated actions in response to a set of defined events
- Automated alarms in case of an anomalous sensor reading

All the video, audio and sensors transmissions may be sent to mobile Command and Control Centres (CCCs) as well as to a central location CCC. From these control centres, with the enhanced situational awareness, operators are able to perform better informed decisions and improve the overall safety of field teams and the public in general.

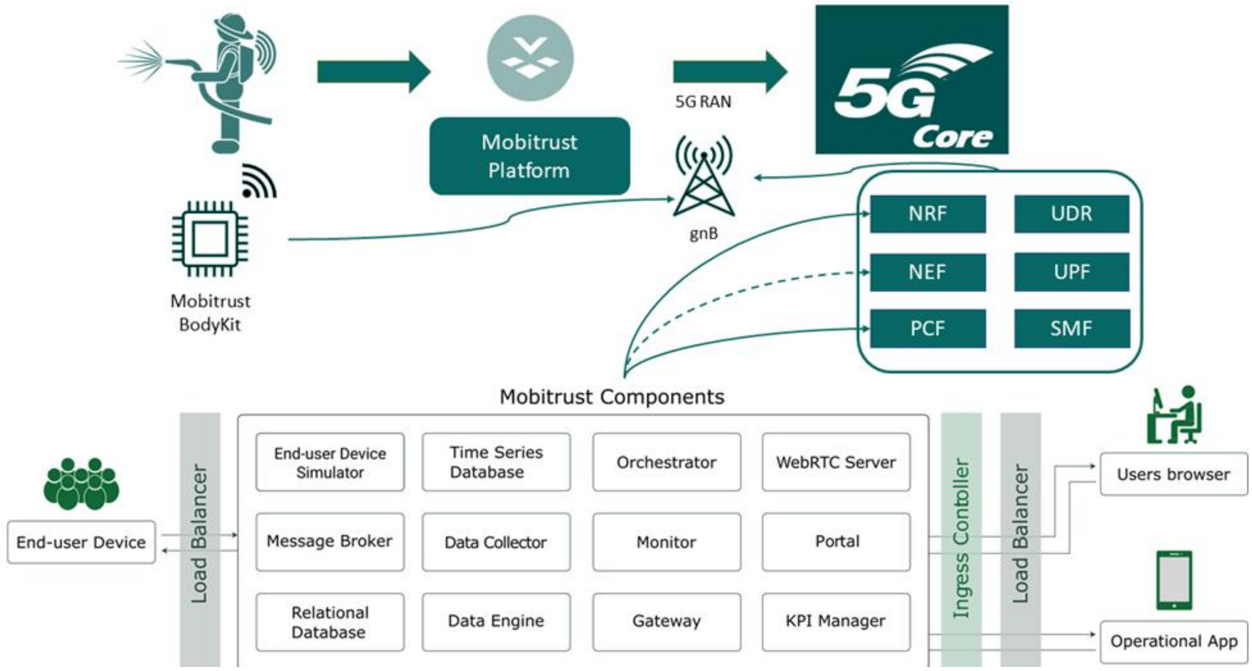

Figure 1: Mobitrust network services

Thought to be used anywhere at any time, the Mobitrust platform is now leveraging the microservice architecture, which allows the split of its internal components into multiple geographical locations. Hence, certain components can be instantiated near the scenarios where operations are taking place. Such proximity will allow a decrease in latency for communications and also the reliability of the whole system by being tolerant to failures in backhaul connectivity, which are known to occur in certain catastrophe scenarios.

Experiment Setup/Methodology/Deployment

The Mobitrust platform was deployed at UMA location and integrated with all testbed features. The devices, drones, AR/VR devices, and all other components were integrated with the testbed and 5G network. The setup followed the project's planning.

The Mobitrust platform was deployed into the Kubernetes infrastructure using all the features available (throughout the project duration), starting with the manual deployment, then helm, 5G-EPICENTRE platform and finally tested with Karmada. This UC also integrated the Holistic Security and Privacy Framework (HSPF, see D2.8).

Experiment Execution and Results

A survey on the results was presented to stakeholders during various project interactions and focused on evaluating their experience with the Mobitrust CCC, taking into account satisfaction, usability, and benefits. A feature emphasized by the stakeholders was the seamless access to real-time information for decision-makers and emergency responders. The integration of smartwatches within the CCC was also a notable feature. However, the lack of direct communication with field operations was considered a downside, which is to be expected since it is a feature being targeted in other use cases besides UC4. Overall, we obtained a user experience rating of 95%, exceeding the target result. This user experience rating is consistent across both test beds, as ALB and UMA utilized the Mobitrust CCC in all scenarios.

In the next two tables we present the technical experimentations results. Contextualizing the parameters in the tables, the DVA values correspond to the Direct View to the Antenna results and the NVA values mean No Direct View to the Antenna. The values identified as WLK and CAR represent measurements taken while the UE was carried by a pedestrian and a vehicle, respectively.

Table 1: UC4 KPIs – UMA experimentations results

KPIs	Results expected	UMA indoor results	UMA outdoor results	UMA wlk/car results	UMA slicing results
UC 4.1	Network RTT ≥ 50ms	DVA: 28.27ms	DVA: 20.98ms	WLK: 19.79ms	CS: 29.50ms
		NVA: 37.81ms	NVA: 19.95ms	CAR: 34.47ms	NCS: 24.87ms
UC 4.2	Message Delay ≥ 60ms	DVA: 30.98ms	DVA: 24.69ms	WLK: 21.47ms	CS: 28.25ms
		NVA: 41.76ms	NVA:22.38ms	CAR: 45.54ms	NCS: 24.20ms
UC 4.3	IK Availability ≥ 99%	99.50%	99.50%	99.56%	99.52%
UC 4.4	User experience ≥ 85%	95%			

Table 2: UC4 Network Metrics – UMA experimentations results

KPIs	Results expected	UMA indoor results	UMA outdoor results	UMA wlk/car results	UMA slicing results
UC 4.5	Network RSSI ≥ -85dBm	DVA: -39.72dBm	DVA: -37.88dBm	WLK: -55.38dBm	CS: -45.65dBm
		NVA: -56.48dBm	NVA: -60.20dBm	CAR: -64.44dBm	NCS: -55.52dBm
UC 4.6	Network RSRP ≥ -70dBm	DVA: -50.10dBm	DVA: -47.90dBm	WLK: -66.65dBm	CS: -56.0dBm
		NVA: -67.03dBm	NVA: -70.70dBm	CAR: -80.46dBm	NCS: -65.85dBm
UC 4.7	Network RSRQ ≥ -15dB	DVA: -10.0dB	DVA: -10.0dB	WLK: -10.70dB	CS: -10.0dB
		NVA: -10.0dB	NVA: -10.0dB	CAR: -14.32dB	NCS: -10.0dB

Overall evaluation

ONE performed collection of the baseline KPI values for the UMA testbed. This consisted in two different scenarios, the first where the UE used for the collection was positioned in a place with direct vision to the antennas; and the second changing the UE location in order to not have direct line of sight to the antennas.
Alongside these KPI measurements, it was found relevant to also include some network metrics collected by the UE. These consist in RSRP, RSRQ and RSSI network values.
The collection process consisted of performing fifteen iterations, registering the KPIs during two minutes for each iteration. This process was repeated for both scenarios.
For all the three main KPIs, the value averages achieved the targeted goal for both scenarios. For the first and second scenarios, the network RTT (UC4.1) attained around 28ms and 38ms respectively. As for the Message Delay (UC4.2), it achieved around 31ms and 42ms for an (Integration Kit) IK availability (UC4.3) with an average value over 99%.
For the three specified network metrics, the average values exceeded the expected results in both scenarios. In the first and second scenarios, the average RSSI values were -40 dBm and -56 dBm, respectively. As for RSRP, the average values obtained were approximately -50 dBm and -67 dBm, while for RSRQ, average values of -10 dB were achieved in both scenarios.
Besides the baseline tests, ONE also conducted the collection of KPI values for the UMA testbed in three different scenarios. The first scenario involved placing the UE outside, in two locations one with direct line of sight to the antennas, and another without. Additionally, walking and driving scenarios were simulated, with the UE traversing the coverage area. Finally, the last scenario included connecting the UE to a congested network slice, while simultaneously having another UE on a non-congested slice.
Regarding the tests with the UE placed outside, we observed an overall improvement in the three main KPIs compared to the baseline results. The Network RTT and Message Delay achieved 21ms and 24ms, respectively, with a direct line of sight, while the same metrics achieved 20ms and 22ms without line of sight. However, in comparison with the network-specific metrics, the results were mostly the same.
In the walking scenario, the results closely align with the previous test where the UE had a direct line of sight. However, in the driving scenario, although the results still fall within the expected range, the average values are higher compared to the walking scenario.
In the last scenario, the UE connected to the congested slice exhibited a performance 20% worse compared to the UE in the non-congested slice, specifically concerning the Network RTT and Message Delay KPIs. However, the other metrics showed a similar performance when compared to the baseline values. This was expected, as the slice congestion should not impact the signal strength. In relation to UC4.4, User Experience achieved an above-target value of 95%.
Comparing the results across various scenarios, it is evident that the performance of the UMA testbed remained consistently robust. In the first and second scenarios, where the UE's positioning varied with and without a direct line of sight to the antennas, the network RTT showed commendable performance, and similarly, the Message Delay demonstrated efficient responsiveness. The walking and driving scenarios maintained a consistent level of reliability, with the walking scenario aligning closely with the direct line of sight scenario. However, while the driving scenario was still within the expected range, it exhibited slightly higher average values. Additionally, the network-specific metrics remained stable throughout all the scenarios. Even in the scenario involving a congested network slice, the UMA testbed managed to deliver values aligned with the expected results.

Conclusions

The collected KPIs with the project's Experiment evaluation strategy and experimentation plan". Additionally, network metrics recorded by the UE, i.e., Reference Signal Received Power (RSRP) and Quality (RSRQ), and Received Signal Strength Indicator (RSSI) values, were included. The collection process involved fifteen (15) iterations, with the registration of KPIs over two minutes for each iteration.

For all three primary KPIs, the average values met the goals for the scenario under examination. The network Round Trip Time (RTT, UC4.1) achieved approximately 34ms, while the Message Delay (UC4.2) reached around 37ms. In the case of the Integration Kit (IK) availability (UC4.3), an average value of over 99% availability was attained.

Regarding the collected network KPIs, both RSSI and RSRQ achieved the expected results, with average values of -72dBm and -10Db, respectively. However, RSRP fell short of expectations, reaching an average value of approximately -83 dBm.