Performance Evaluation of 5G Standalone Seamless Home Routed Roaming for Connected Mobility in Cross-border Scenarios

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***Abstract*—Cooperative, Connected and Automated Mobility (CCAM) and Future Railway Mobile Communications Systems (FRMCS) services usually require uninterrupted seamless connectivity. However, in cross-border scenarios, legacy roaming techniques lead to interruption times in the range of one to two minutes, which results unsuitable for the provisioning of demanding CAM and FRMCS services. This paper presents the implementation of state-of-the-art roaming optimization techniques in both the 5G Core and radio access network, including a novel radio optimization handover mechanism for home-routed roaming (HRR) that enables the completion of roaming procedures in 5G Standalone (SA) networks with short interruption times. In addition, a network key performance indicator (KPI) tool is presented to measure the network performance in terms of latency, throughput, and interruption time during roaming. Unlike previous works, static and dynamic performance evaluations are performed in a realistic environment over 5G SA networks deployed on the Mediterranean cross-border corridor between Spain and France. The proposed optimization mechanism yields average interruption time measurements in the range between 135ms and 155ms, enabling seamless service continuity in cross-border scenarios.**

Keywords*—5G, cross-border, mobility, seamless roaming, interruption time.

I. Introduction

Cooperative, Connected and Automated Mobility (CCAM) [1] and Future Railway Mobile Communications Systems (FRMCS) [2] services often require ultra-low latency, very high data rate, and wide spectrum availability. However, high mobility introduces challenges related to radio communication channel phenomena, frequent handovers, resource management at the network edge, etc. Cross-border scenarios pose additional hindrances as users cross international borders and transit between different Public Land Mobile Networks (PLMNs) managed by different Mobile Network Operators (MNOs). Limited cooperation and information exchange between MNOs complicates the provisioning of uninterrupted and seamless mobility services in cross-border scenarios [3].

When crossing international borders, the User Equipment (UE) undergoes roaming or inter-PLMN handover[1] procedure to move from one PLMN to another. Legacy roaming techniques such as Home-Routed Roaming (HRR) [4] lead to service interruption times up to a few minutes [5][6], which is unacceptable for demanding CAM and FRMCS use cases. Moreover, with HRR, all user data is directed to the home User Plane Function (UPF), rendering mobile edge computing (MEC) ineffective in reducing latency when the UE is connected to the visited PLMN (v-PLMN). Conversely, in Local Break-Out (LBO) roaming mechanisms [4], data traffic is not forwarded to the home UPF as shown in Fig. 1, but UEs must establish a new Protocol Data Unit (PDU) context with the v-PLMN, resulting in a UE IP address change that impacts application continuity. Although HRR is the preferred method in terms of interruption time, the application of roaming optimization techniques to HRR becomes essential to further diminish interruption duration.

Prior European research projects attempted to address cross-border roaming optimization [5] [7]. 5GCroCo [8] implemented cross-MNO handover in 5G Non-Standalone (NSA) networks by establishing the S10 interface between Mobility Management Entities (MMEs) and the roaming interfaces S8 between Packet Data Network Gateway in the h-PLMN and the serving gateway in the v-PLMN, achieving a 121 ms interruption time with HRR. In 5G-CARMEN, a release-with-redirect procedure [5] was used involving a UE transitioning from idle to connected mode. A service interruption time of 1.95 s was achieved using 5G NSA networks. However, validations were limited to private 5G NSA networks. 5G-MOBIX [9] implemented a 5G Standalone (SA) roaming solution with two 5G Cores based on LBO, with interruption times of tens of seconds, which is unsuitable for demanding mobility use cases. In contrast, 5GBlueprint [10] presented the first practical implementation of seamless 5G SA roaming using off-the-shelf UEs and gNodeBs. Such implementation combined HRR and N14-based handover, defined in the 3GPP Release 16 specifications [11], allowing PDU context to be transferred to the v-PLMN. By performing this procedure in the N14 preparation phase, the PDU session can be set up in advance. 5GBlueprint lab tests showed promising interruption times of 135 ms on average.

In this context, additional roaming optimization techniques are required to enable the completion of roaming procedures in 5G SA networks with short-enough interruption times to enable demanding, high-mobility use cases. In this regard, the 5GMED project [12] advances the state-of-the-art by proposing a HRR with optimization mechanism. Unlike

[1]In the paper, the terms "roaming" and "inter-PLMN handover" are used interchangeably.

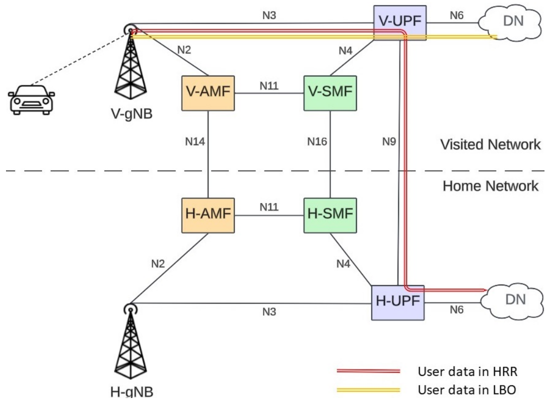


Fig. 1: User plane data flow when either Home-Routed Roaming (in orange) or Local Break-Out roaming (in red) is used.

in [10], optimization based on equivalent PLMN (ePLMN) and N14 interface between AMFs are evaluated in a real cross-border scenario over two 5G SA networks of eleven gNodeBs, covering 65 km of the Mediterranean corridor across the border between Figueres (Spain) and Perpignan (France). In addition, 5GMED proposes a radio handover optimization method based on the use of the N2 interface, which is also evaluated in the aforementioned real environment. Moreover, this paper provides static and dynamic measurements of real 5G SA networks in a highway, which may be used in future research to calibrate simulations of vehicle-to-network (V2N) communication technologies based on 5G.

The remainder of this paper is organised as follows. Section II introduces the cross-border 5G network implementation of 5GMED, including the 5G SA network architecture and seamless roaming optimization techniques. Section III presents a performance evaluation in both static and dynamic measurements. Static measurements aim to evaluate the peak performance of the networks, specifically focusing on latency and throughput. On the other hand, dynamic measurements aim to analyze the evolution of network metrics along the corridor and quantify interruption times during inter-PLMN handovers. Section IV summarizes the main challenges and lessons learned during implementation and performance evaluation. Finally, Section V concludes the paper.

II. Implementation of Cross-border 5G Standalone Networks and Seamless Roaming

This section provides an overview of the 5G SA networks that have been deployed in the Mediterranean cross-border corridor within the 5GMED project. The architecture of the 5G SA networks and the location of the gNodeBs in both the Spanish and French segments of the corridor are presented in Section II-A. The optimization techniques that have been implemented to minimize interruption time during roaming are presented in Section II-B.

A. 5G Standalone Network Architecture

The architecture of the two private 5G SA networks that have been deployed by 5GMED within the Mediterranean cross-border corridor, spanning from Figueres (Spain) to Perpignan (France), is depicted in Fig. 2. This illustration showcases the network functions (NFs) situated in the 5G Core of each 5G SA network, the internal interfaces connecting these network functions, the interfaces between the 5G Cores and their respective 5G RAN (i.e., N2, N3), and the interfaces that facilitate cross-border roaming (i.e., N8, N14, N16), which are described in detail in Section II-B. Both 5G Cores incorporate essential network functions, including: Access and Mobility Management Function (AMF), Session Management Function (SMF), Unified Data Management (UDM), Authentication Server Function (AUSF), centralized User Plane Function (UPF), and distributed UPF. The two 5G Core instances have been supplied by Druid. They are hosted on two separate servers in Castellolí (Spain), located 155 kilometers southwest of Figueres. The challenging cross-border orography adds complexity to establishing the transport network that provides connectivity between the gNodeBs along the corridor and the 5G Cores in Castellolí. The transport network integrates various technologies, including multiple microwave point-to-point connections and fiber optic links.

The 5G RAN comprises twelve gNodeBs, with six Ericsson gNodeBs deployed in Spain and the remaining six gNodeBs from Nokia situated in France. All of the Ericsson gNodeBs and five Nokia gNodeBs have been installed, and the installation of another Nokia gNodeB is currently in progress. The Ericsson gNodeBs operate within a 90 MHz spectrum bandwidth, while the Nokia gNodeBs utilize a 70 MHz bandwidth. The Time Division Duplex (TDD) pattern is configured as DDDSU (4:1) and the special slot is set to 10:2:2.

Fig. 3a provides an overview of gNodeB locations in France, where red tower symbols indicate gNodeBs utilizing spectrum from the French operator Free Mobile operating in band N78, and green tower symbols, labeled as BTS04 and BTS05, represent gNodeBs within Linea Figueres-Perpignan (LFP) infrastructure. Fig. 3b provides an overview of gNodeB locations in Spain, where red tower symbols represent gNodeBs provided by Vodafone operating in band N78, while green tower symbols represent gNodeBs on LFP infrastructure operating in band N77. In addition, a Distributed Antenna System (DAS) operating in band N78 has been installed within an 8 kilometer railway cross-border tunnel. This DAS comprises 23 access points connected via fiber to a Master Unit by CommScope, which is connected to a Remote Radio Unit and Baseband Unit provided by Nokia.

To mitigate interoperability issues between Nokia and Ericsson gNodeBs, cross-border roaming was configured specifically between two Ericsson gNodeBs at the border: Le Perthus-SP gNodeB and La Jonquera gNodeB. Consequently, among the six Ericsson gNodeBs, five are connected to the Spanish 5G Core, and the additional Ericsson gNodeB (Le Perthus-SP), along with all the Nokia gNodeBs, are linked to the French 5G Core.

B. 5G Roaming Optimization Techniques

To reduce the long interruption time induced by roaming, the 5GMED project has implemented the following roaming optimization techniques that were presented in [12].

- *Reduction of Network Attachment time with Equivalent PLMN Configuration*: This involves incorporating the PLMN-ID of the French 5G SA network into the ePLMN list of the Spanish 5G SA network, and reciprocally including the Spanish PLMN-ID in the ePLMN list of the French 5G SA network. The ePLMN list is broadcast to the UE within the PLMN, enabling the UE to attempt

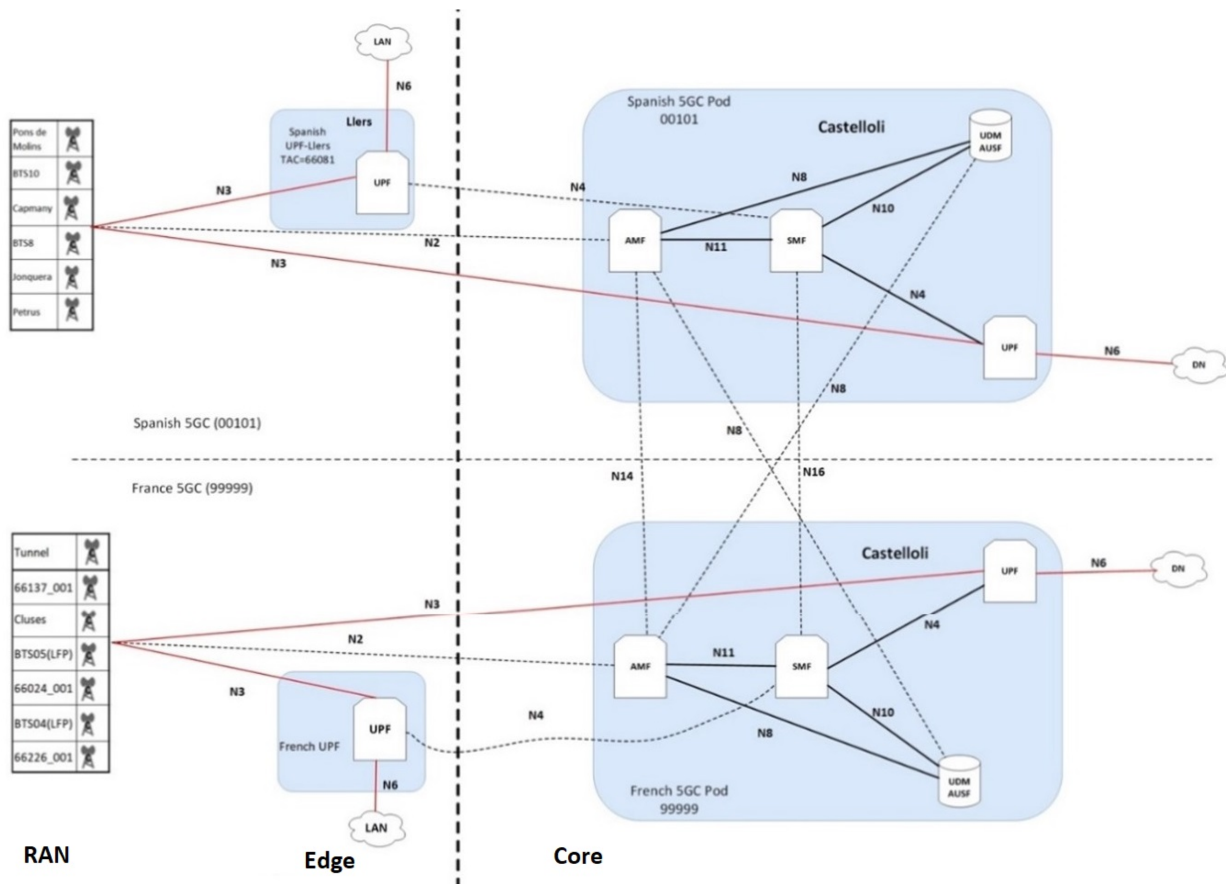


Fig. 2: Architecture of 5G SA networks deployed by 5GMED in the Mediterranean cross-border corridor.

connection to one of the PLMNs in the ePLMN list when it loses signal from its h-PLMN. This technique aims to expedite the network search process, as the UE avoids trying to attach and authenticate to each network detected in the radio interface.

- *Configuration of Idle Mode Roaming with AMF Relocation and RAN Assistance*: This is enabled by the deployment of the N14 interface between the visited and home AMFs as shown in Fig. 4. In the control plane, this allows the AMF in the v-PLMN to get the UE context from the source AMF, thus reducing the registration time. In the data plane, this reduces the user plane re-establishment time, since the new network is informed of used UPF and UE IP address when HRR is activated. Furthermore, the controlling RAN is configured to inform the UE (as a part of the release message) about the available target frequency bands when crossing the border. This will enable a cell re-selection mechanism that will speed up the process of idle mode roaming.
- *Configuration of Inter-PLMN Handover*: This is enabled by configuring the 5G cells from the two PLMNs at the border as neighboring cells, which transforms the roaming into N2 based handover from radio point of view. The UE will report the measured signal power of the v-PLMN neighbor cell to its network and when the handover conditions are met, the source network will initiate the handover procedure. This handover configuration is done on top of the two previous configurations.

(a) gNodeBs in French segment. (b) gNodeBs in Spanish segment.

Fig. 3: Location of gNodeBs deployed by 5GMED in the Mediterranean cross-border corridor.

With these optimization techniques, the interruption time is expected to be as low as two hundred milliseconds [6].

III. Performance Evaluation

This section outlines the results of the performance evaluation tests conducted on the 5G SA networks deployed in the Spanish and French segments of the Mediterranean cross-border corridor.

First, the test set-up and procedures used for the measurement, storage and visualization of network KPIs are de-

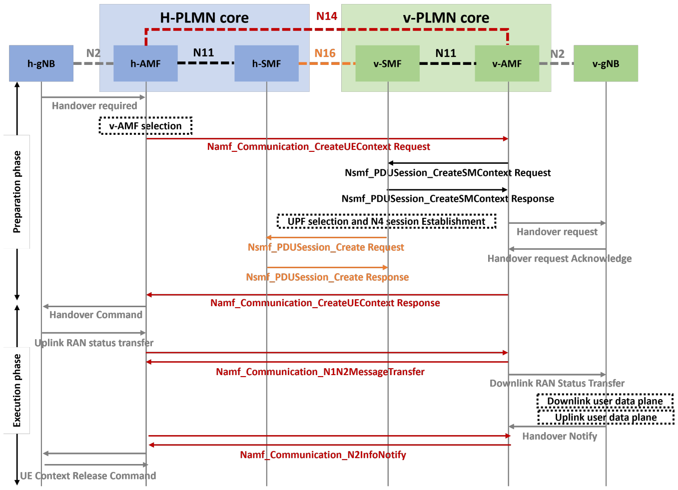
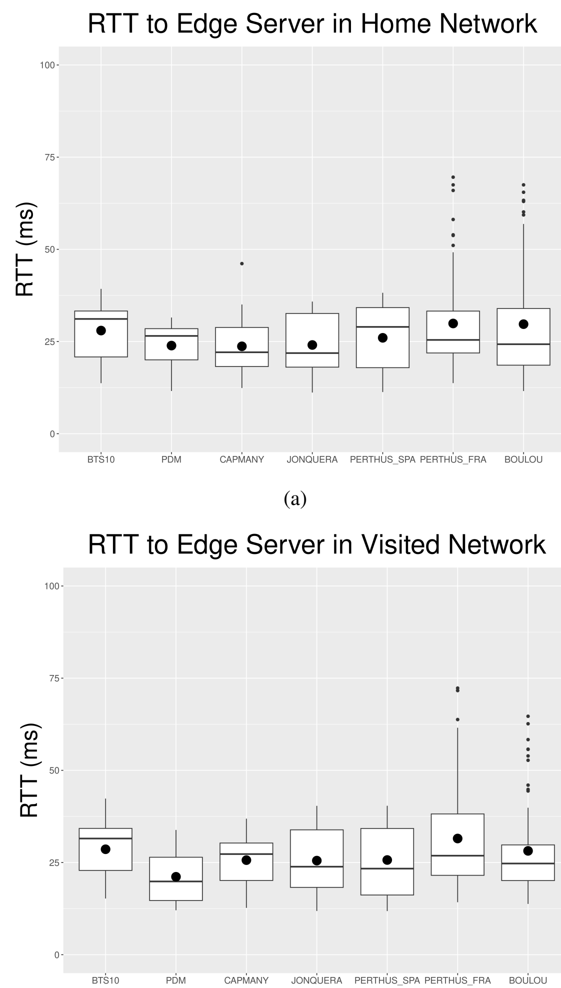


Fig. 4: Home-Routed Roaming procedure when using N14 interface.



(a)

(b)

Fig. 5: Static measurements of Round-Trip Time at seven gNodeBs with UE connected to: (a) home network (h-PLMN); (b) visited network (v-PLMN).

scribed in Section III-A. Section III-B presents the results of latency and throughput measured with a UE remaining stationary in locations very close to the gNodeBs. Finally, Section III-C presents the results of dynamic measurements of latency, throughput, and interruption time, collected with a UE on board a vehicle traversing the corridor and crossing the border between Spain and France on multiple times. In these experiments, the UE executes an inter-PLMN handover when it moves away from the coverage area of the Spanish 5G SA network and enters into the coverage area of the French 5G SA network, and vice versa.

A. Network KPI Collection Tool

A network KPI collection tool has been developed to measure, store, and visualize in real-time the following network metrics: *(i)* the latency induced by the 5G SA networks; *(ii)* uplink and downlink throughput; and *(iii)* the interruption time introduced by the inter-PLMN handover. The network KPI collection tool is composed of hardware and software elements. The hardware, integrated on board a test vehicle, consists of a laptop and a 5G modem (Quectel RM500Q-EVK) functioning as UE, two external antennas (Taoglas MA350), a GPS receiver, and a power inverter. On the software side, the tool incorporates various Python scripts for measurement acquisition, a Prometheus database for storage, and Grafana dashboards for visualization. The methods used to measure network KPIs are described below.

- *Latency*: The latency induced by the 5G SA networks (including 5G RAN, transport network, and 5G Core latency) is obtained from round-trip time (RTT) measurements between the UE and a MEC-hosted application server directly connected to the UPF of the home 5G network. RTT is measured by sending periodic "ping" commands at intervals of 100 ms from the UE to the IP address of the application server.
- *Throughput*: Uplink and downlink throughput are measured using IPerf3 with UDP traffic. An IPerf3 server is located on the MEC-hosted application server, while an IPerf3 client runs on the laptop of the KPI collection tool, generating new throughput measurements every second.
- *Interruption Time*: The interruption time is measured by sending "ping" commands from the UE to the application server at intervals of 15-20 ms, which is the maximum sampling rate that can be achieved with the UE. The interruption time is defined as the time elapsed since the UE sends a "ping" command without response until the UE gets a response from the application server.
- *Radio Parameters*: The network KPI collection tool uses the libqmi[2] library to gather radio parameters from the 5G modem by means of the Qualcomm MSM Interface (QMI) protocol. The radio parameters include signal strength, Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), Signal-to-Interference-plus-Noise Ratio (SINR), Physical Cell-ID (PCI), and PLMN-ID.

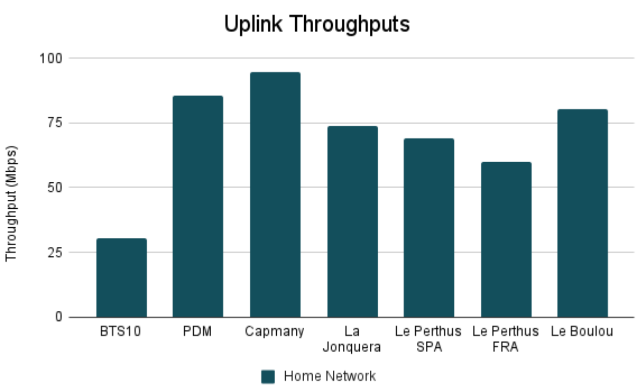
The PCI and PLMN-ID values are monitored throughout the interruption time measurements to discern whether the interruption is attributable to a coverage gap within a 5G cell, a radio handover, or an inter-PLMN handover.

[2]https://github.com/linux-mobile-broadband/libqmi

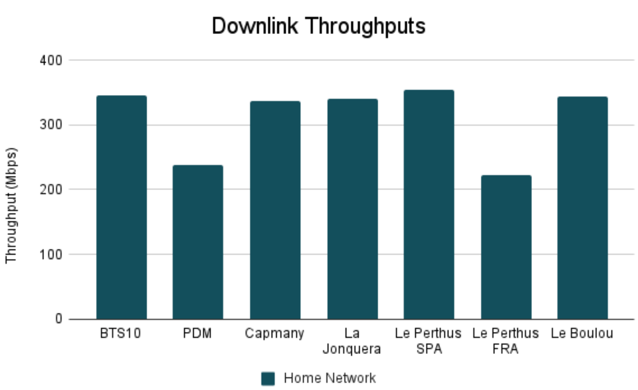
B. Results of Static Measurements

The aim of static measurements is to determine the peak performance of both 5G SA networks with the UE stationed at sites in close proximity and within the line-of-sight of the gNodeBs. These measurements were conducted with the UE positioned in four Spanish 5G cells (BTS10, Pont de Molins, Capmany, and La Jonquera), and three French 5G cells (Le Perthus-SP, Le Perthus-FR and Le Bolou).

Fig. 5 illustrates the box plots representing 100 samples of RTT measurements for each gNodeB between the UE and the MEC-hosted application server. Fig. 5a and Fig. 5b depict the RTT measurements when the UE is connected to its h-PLMN and v-PLMN, respectively. In Spanish 5G cells, the UE is connected to h-PLMN when equipped with a Spanish SIM card, while it is connected to v-PLMN when using a French SIM card. Conversely, in French 5G cells, the UE connects to the h-PLMN with a French SIM card and to the v-PLMN when utilizing a Spanish SIM card. As can be observed in Fig. 5, the average RTT values fall within the range of 25 ms to 30 ms across all gNodeBs. To be more accurate, 75% of the RTT values are below 30 ms, and if we exclude outliers, the RTT values are between 15 and 60 ms. Furthermore, despite the use of HRR, the average RTT when the UE is connected to the v-PLMN is not significantly higher than the average RTT observed when connected to the h-PLMN. This similarity is attributed to the close proximity of servers hosting both Spanish and French 5G Cores in Castellolí, resulting in negligible differences in average RTT. Finally, there is an observable trend of slightly increasing maximum RTT values corresponding to greater distances between the gNodeBs and the 5G Cores. For example, Fig. 5a shows that the average value of the RTT is greater at the gNodeBs of Le Perthus and Le Bolou in France than in the gNodeBs of La Jonquera and Capmany in Spain.



(a)



(b)

Fig. 6: Static measurements of average throughput at seven gNodeBs with UE connected to home network (h-PLMN): (a) uplink throughput; (b) downlink throughput.

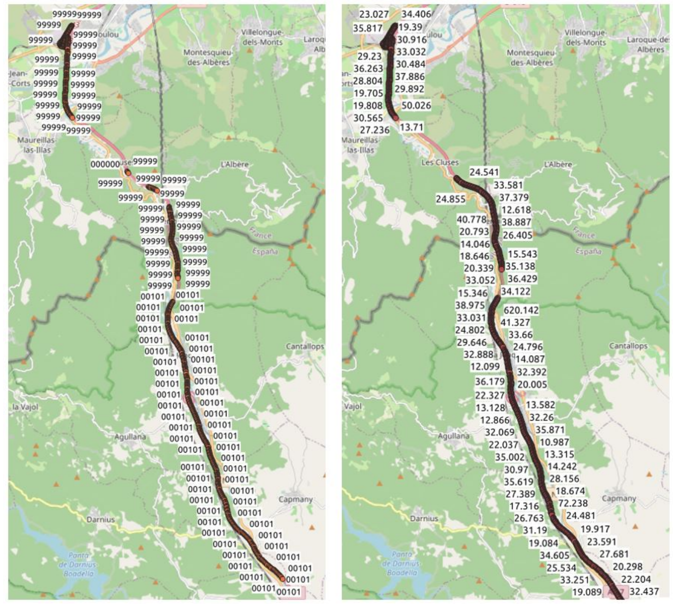


Fig. 7: Heat-maps of PLMN-ID (left) and Round-Trip Time measurements (right) along the E-15 highway in the Mediterranean cross-border corridor.

Fig. 6 depicts the average values calculated from 100 samples of throughput measurements using UDP traffic, with the UE connected to the h-PLMN. The corresponding average values of uplink and downlink throughput at seven gNodeBs are illustrated in Fig. 6a and Fig. 6b, respectively. The lowest average uplink throughput is approximately 30 Mbps in BTS10, while ranging between 60 and 90 Mbps in the other gNodeBs. The average downlink throughput varies from 225 to 350 Mbps across different gNodeBs. The measurements were validated using a 5G NR throughput calculator[3], using TDD mode, one aggregated carrier, four MIMO layers, a 90 MHz bandwidth, and the TDD pattern DDDSU. The peak theoretical values calculated were 333 Mbps for downlink throughput and 118 Mbps for uplink throughput, which is close to what we obtained (see Fig. 6a and Fig. 6b).

C. Results of Dynamic Measurements

The aim of dynamic measurements is threefold: *(i)* assess the evolution of network KPIs with respect to the geographical position of the UE, *(ii)* identify 5G coverage gaps along the cross-border corridor, and *(iii)* measure interruption times during inter-PLMN handover. These measurements were conducted with the UE in motion across the corridor, traversing the border, and doing roaming between the Spanish and French 5G SA networks.

[3]https://5g-tools.com/5g-nr-throughput-calculator/

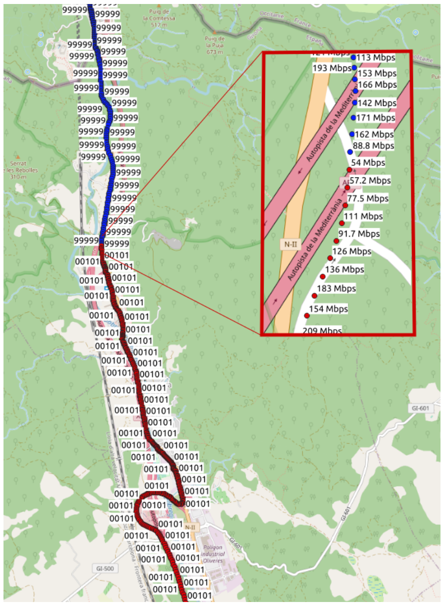


Fig. 8: Heat-map of downlink throughput measurements during inter-PLMN handover test on the N-II road in Spain.

Fig. 7 depicts heat maps illustrating PLMN-ID and RTT measurements obtained during a single driving test at a speed of 90 km/h on the E-15 highway, covering the route from the gNodeB of Le Boulou (France) to the gNodeB of Pont de Molins (Spain). The PLMN-ID for the French 5G SA network is 99999, and for the Spanish 5G network, it is 00101. As it can be observed, the coverage of the French 5G SA network extends from Le Boulou (in the north) to Le Perthus-SP (at the border) and penetrates into the Spanish territory. There exists a 5G coverage gap of 2 km in the French network, and efforts are underway to address this gap by installing a new Nokia gNodeB in France. Additionally, another brief coverage gap is observed within the 5G cell of La Jonquera (Spain), particularly near the roaming area between the 5G cells of Le Perthus-SP and La Jonquera. This gap is influenced by the intricate topography and vegetation in the vicinity. We are addressing this issue by augmenting the power level of the gNodeB of La Jonquera. The RTT heat map depicted in Fig. 7 indicates that initially, the UE establishes a connection to the French network (v-PLMN) with data traffic. Subsequently, it seamlessly performs an inter-PLMN handover, leading to its connection to the Spanish network (h-PLMN) with ongoing data traffic.

Inter-PLMN handover tests were conducted in a 0.5 km segment of the N-II road in Spain (shown in Fig. 8), located 3 km from the village of Le Perthus (France), running parallel to the E-15 highway. This particular location exhibits a robust overlap between the coverage areas of the Spanish and French 5G SA networks, facilitating rapid movements of the UE between their respective coverage areas. Fig. 8 illustrates a heat map displaying downlink throughput measurements acquired during a driving test at a speed of 60 km/h on the N-II road segment where the inter-PLMN handover takes place. The UE was equipped with Spanish SIM card. Red dots correspond to the Spanish 5G coverage area (h-PLMN), while blue dots correspond to the French 5G coverage area (v-PLMN). The downlink throughput exhibits variations between 150 and 200 Mbps at different positions of the UE, gradually decreasing to 50 Mbps in locations near the inter-PLMN handover.

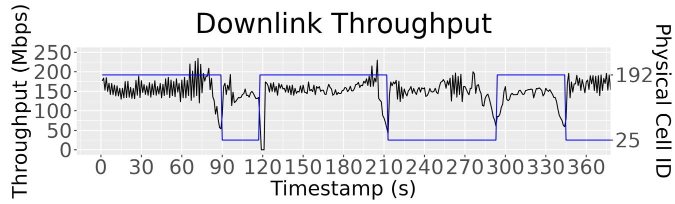


Fig. 9: Downlink throughput during five consecutive inter-PLMN handovers on the N-II road between PCI 192 (Spain) and PCI 25 (France).

Fig. 9 presents a time-series plot illustrating downlink throughput during five consecutive inter-PLMN handovers on the N-II road, transitioning between PCI 192 (La Jonquera gNodeB in the Spanish network) and PCI 25 (Le Perthus-SP gNodeB in the French network). In general, the downlink throughput exhibits fluctuations between 150 and 200 Mbps as the UE moves within each network. Significantly, there is a notable drop to less than 50 Mbps observed during the inter-PLMN handover, particularly when the PCI changes from 192 to 25 and vice versa.

Fig. 10 depicts the box plots representing 30 samples of interruption time measurements during inter-PLMN handover. The box plot on the left represents inter-PLMN handover from h-PLMN to v-PLMN, while the one on the right corresponds to v-PLMN to h-PLMN handover. In both scenarios, the median interruption time is approximately 140 ms. The average interruption time is 135 ms for h-PLMN to v-PLMN handover and 155 ms for v-PLMN to h-PLMN handover. The latter is higher than the former due to the higher latency in the Le Perthus France gNodeB than in the Le Perthus Spain gNodeB as it was shown in Fig. 5. The interquartile range for h-PLMN to v-PLMN handover spans approximately 110 ms to 165 ms, representing the central 50% of the data. For v-PLMN to h-PLMN handover, the interquartile range extends from 135 ms to 165 ms. The results of inter-PLMN handover implemented in 5GMED demonstrate performance comparable to a standard inter-cell handover within the same PLMN, with interruption times falling within the range of 100-120 ms.

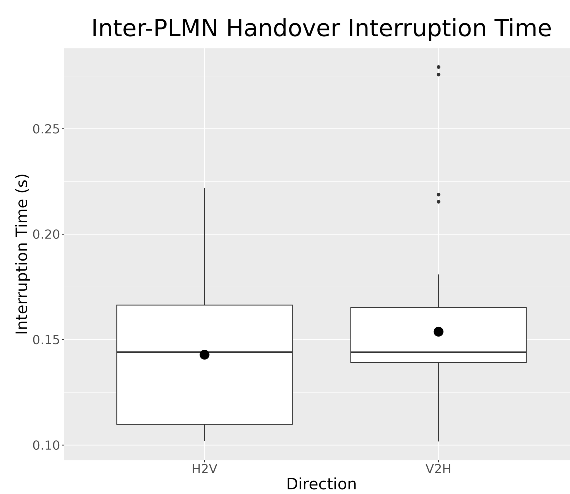


Fig. 10: Box-plots of interruption time during inter-PLMN handover from h-PLMN to v-PLMN (left), and from v-PLMN to h-PLMN (right).

IV. Challenges and Lessons Learned

This section outlines the main challenges faced throughout the implementation of the 5GMED network infrastructure.

The topography of the Mediterranean cross-border corridor is highly intricate, characterized by mountains and abundant vegetation. The challenging terrain complicated the deployment of the transport network, requiring multi-hop microwave links and numerous fiber interconnections. Multiple drive testing campaigns have been conducted (with ongoing efforts) to refine the configuration of the 5G RAN and optimize its performance.

The majority of 5G Core manufacturers do not offer support for the N14 interface. Consequently, the 5GMED project had to synchronize its timeline with the roadmap of the 5G Core manufacturer (Druid) and conduct additional tests involving various 5G Core releases and their associated roaming techniques. The implementation of the N14 interface and inter-PLMN handover introduces increased complexity and requires careful consideration and modification of parameters to ensure proper functionality. For instance, as the tracking area changes, a tracking area update is sent by the UE. In this scenario, the PLMN-ID of the visited PLMN must be included in the message, not the PLMN-ID of the home PLMN, which is the norm in intra-PLMN handovers. Therefore, changes were made to the configuration of the network to take into account this issue. Furthermore, when configuring an inter-PLMN handover, it is key that the AMF populates the ePLMN list with the PLMN-ID of the target network in the *MobilityRestrictionList IE*, an object sent to the gNodeB as part of the *InitialContextSetupRequest NGAP* message. If the ePLMN of the target network is not in the *MobilityRestrictionList*, then the gNB may not send the *Handover Required* command.

When trying to perform inter-PLMN handover between Ericsson and Nokia gNodeBs, the UE was not successful in sending the measurement report to the source gNodeB to initiate the handover procedure. This may be due to interoperability problems between vendors, or to the use of different frequencies and TDD patterns. Therefore, as described in Section II, the current deployment of roaming is done between two Ericsson gNodeBs, but the ultimate goal of the project is to implement roaming between Ericsson and Nokia gNodeBs.

V. Conclusions and Future Work

This paper provided an overview of the 5G Standalone (SA) network infrastructure deployed by the 5GMED project across the Mediterranean cross-border corridor between Spain and France. Measurements of 5G network metrics on two real cross-border 5G SA networks were performed in a highway environment, which can be used in future research to calibrate simulations of 5G vehicle-to-network communications. Performance evaluation results yielded an average round-trip time of between 25-30 ms and downlink throughput between 150-200 Mbps as the UE moves within each network. Moreover, several Home-Routed Roaming (HRR) optimization techniques were implemented in both 5G RAN and 5G Core to reduce service interruption time when crossing the border, including a novel radio optimization handover mechanism. Evaluations performed in the cross-border corridor demonstrated the ability of the 5GMED approach to provide seamless service continuity on 5G SA networks across international borders. Inter-PLMN handover measurements demonstrated a reduction of several orders of magnitude of the average interruption time with respect to legacy HRR, ensuring nearly imperceptible service interruption times. The average measured interruption time during inter-PLMN handover was 135 ms for h-PLMN to v-PLMN handover, and 155 ms for v-PLMN to h-PLMN handover, which shows the effectiveness of the roaming optimization techniques implemented, in contrast with typical interruption times in the order of seconds to minutes in legacy HRR.

In future work, 5GMED will explore the use of Local Break-Out (LBO) roaming for the deployment of time-sensitive connected mobility services, such as tele-operated driving, which are hindered by the high latencies introduced by HRR. The use of LBO becomes essential when a service application runs on the edge connected to the closest UPF to the User Equipment (UE). In this regard, 5GMED has implemented LBO and will evaluate its performance in the presence of distributed UPFs and MECs. Moreover, the performance of LBO and HRR will be evaluated and compared in terms of latency and interruption time. In addition to LBO evaluation, ongoing and future work will focus on eliminating identified 5G coverage gaps in the corridor and establishing both HRR and LBO roaming between Ericsson and Nokia gNodeBs.

Acknowledgment

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