On Relay User Equipment Activation in Beyond 5G Radio Access Networks

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***Abstract*— This paper envisages a Beyond 5G (B5G) Radio Access Network (RAN) in which the relaying capabilities offered by user equipment (UE) are used as a way to improve the coverage and robustness of the network. The paper proposes and develops the functional framework for supporting the activation of the suitable relay UEs (RUEs) in coverage constrained scenarios. It is based on characterizing each potential RUE through a utility metric that measures the coverage enhancements brought to the network when the RUE is activated. To derive this metric for all the candidate RUEs, the framework considers the use of a Network Digital Twin that allows the offline analysis of different configurations in a fast and safe way. Using the proposed framework, a RUE activation algorithm is proposed and evaluated. The obtained results reflect that significant outage probability reductions can be obtained in the scenario under different traffic distributions thanks to the activation of the RUEs with the highest utility.**

***Keywords*— Beyond 5G, Radio Access Network, User Equipment, UE-to-network relaying.**

I. INTRODUCTION

Fuelled primarily by the huge demand in video traffic, which currently accounts for 69% of all mobile data traffic and is forecast to further increase in coming years [1], mobile network operators (MNOs) are forced to respond promptly with decisive capacity scaling on their Radio Access Network (RAN) deployments to face the high traffic demands. This requires large capital expenditure (CAPEX) on network improvements (e.g., deploying 5G RAN infrastructure). However, dwindling average revenues per user, market saturation and intensifying competition make the MNOs seeing their finances stretched. Therefore, MNOs need to find not only new revenue streams (e.g., capitalizing on emerging vertical markets) but also new and creative ways of managing and deploying their 5G and beyond RAN infrastructures.

At the same time, an unprecedented technological evolution in user equipment (UE) has occurred in recent years, leading to the availability of UEs with very powerful communication and computational capabilities. These UEs can be in the form of personal use devices, such as smartphones and high-end wearables, or equipment integrated in other platforms such as cars and drones.

Embracing the two abovementioned trends, our recent paper [2] presented a vision of a Beyond 5G (B5G) scenario where the UE can also be exploited to augment the RAN infrastructure as a source of distributed capacity and network intelligence. This vision foresees the UE taking a more active role in network service provisioning and actively complementing the RAN infrastructure, e.g. by relaying traffic from other UEs towards the network. This is expected to positively impact MNOs in terms of a significant reduction in the number of fixed base stations to deploy, as it was estimated in the initial results obtained in [2]. Moreover, the RAN will be empowered with more flexibility for supporting different use cases, such as enhancing the performance in front of mitigating objects' obstructions in millimetre wave (mmWave) deployments, augmenting capacity in high-density areas, providing coverage extension, or improving resilience.

The option of deploying relay stations for extending the coverage and capacity in a cellular network has been well considered in the literature for a number of years (see e.g., [3]), although with practical implementation limited to rather specific use cases (e.g., extending coverage in a tunnel). However, the interest for relays has recently revamped, for example, with the Integrated Access and Backhaul (IAB) technology that provides an alternative to fibre backhaul by extending 5G New Radio (NR) to support wireless backhaul [4][5]. Similarly, a recent study item in the Third Generation Partnership Project (3GPP) Release 18 also considers the use of vehicle-mounted relays [6], like some previous works such as [7][8]. In turn, the capability of UE-to-network relaying, in which a UE relays the traffic of another UE to/from the network in a two-hop communication has recently been included among the connectivity models of [9] in 3GPP Release 18, identifying different scenarios for the use of relay UEs (in home, smart farming, smart factories or public safety), together with requirements and key performance indicators.

While the UE-to-network relaying concept and enabling technologies have been in place for some time, their efficient realization requires the conception and development of new features in B5G systems. These span from top level service layer capabilities for MNOs and UE owners to interact with each other to settle the conditions for engaging the UEs as part of the RAN, down to the necessary management and control layer capabilities for exploiting the connectivity brought by the UEs. In this respect, a key functionality within this bunch of research challenges is the so-called "Relay UE (RUE) activation", that is, the criteria to decide where and when a UE is suitable to be activated to act as a relay, thus integrating this UE as another interoperable component of the RAN. In this respect, our recent paper [10] studied to what extent the information and knowledge about the context bring value in order to take more intelligent RUE activation decisions.

With all the above, this paper presents a functional architectural framework for supporting the RUE activation function. The proposed solution leverages the main knowledge elements analysed in [10] and provides a practical implementation approach. Specifically, it is based on characterising each RUE through a utility metric that measures the coverage enhancements brought to the network when the RUE is activated. Moreover, to accelerate the process of determining this utility metric, the framework considers the use of a Network Digital Twin (NDT), which consists in a virtual digital representation of the B5G network that enables the offline analysis of different configurations in a faster and safer way than if these configurations had to be tested directly on the network. Digital twins, used in different industries such as smart manufacturing, construction, etc., have recently received attention as a powerful tool for optimizing and developing B5G and 6G networks including testing and validation steps [11][12]. Making use of the developed framework, the paper also proposes and evaluates a RUE activation algorithm, which proves to efficiently reduce the outage probability in the scenario.

The rest of the paper is organised as follows. Section II presents the RUE activation problem and the challenges that it should face. Based on this, Section III presents the architectural framework for RUE activation and details the considered algorithm, which is assessed by means of simulations in a realistic urban scenario in Section IV. Conclusions and future work are summarized in Section V.

II. USE CASE DESCRIPTION

This work considers a 5G network deployed by an MNO. As main building blocks, it consists of a RAN (composed by a number of base stations (BSs) operating with 5G NR technology), a core network and a Service Management and Orchestration (SMO) layer. At the SMO, a huge amount of Performance Measurements (PMs) are collected and stored, enabling to get a picture of how the RAN is performing in terms of e.g., coverage, capacity and Quality of Service (QoS) provisioning. This picture can accommodate relatively long term perspectives (e.g., how many calls have been dropped in a BS in the last several days) as well as rather short term perspectives (e.g., what percentage of packets the scheduler has delivered too late in the last 15 minutes). In this way, these PMs allow feeding many different decision making processes that intend to optimise the RAN performance and operate at different time scales.

The RUE applicability use case considered in this paper is coverage optimisation. This is motivated by the fact that 5G coverage footprint can be poor, particularly when considering the operation in mmWave bands. Then, the concept is that the RAN can be augmented with a number of UEs that can be dynamically activated to act as RUEs. In this way, a UE can access the core network either through a direct radio link with a BS or through a RUE.

A possible approach to exploit the RUE concept would start by identifying, through PM measurements, the BSs that experience coverage problems. For these BSs, we are interested in identifying the UEs that can be of most help in improving the coverage and activate them to acts as RUEs. To this end, acquiring knowledge about the UEs in the area and their behavioural patterns will be relevant. For example, UEs that remain in a certain (fixed) location for a long period of time (e.g., at home) can potentially be good candidates to become RUEs, since they can better resemble the role of a base station. Nevertheless, to what extent a UE can be useful as RUE will also depend on the nearby UEs that can benefit from the relaying capabilities to alleviate coverage and/or capacity problems. Thus, if a UE is in a location that UEs around have good connection with the base station, then this UE will hardly be useful as RUE. Instead, if this UE happens to be in a place that can help in overcoming e.g., coverage problems from a high number of nearby UEs, then this UE can bring substantial benefits when becoming a RUE. Therefore, the key aspect to realise the augmented RAN concept is to be able to identify those UEs that happen to be in "strategic" locations for sufficiently long periods of time. The problem becomes somehow more complicated when considering that the traffic will change in time and space, so that the need for RUEs will also vary in time and space. Moreover, the availability of the various candidate UEs to become RUEs will also vary in time, since for example a UE can be short of battery and therefore not available as RUE or the UE can move from one location to another (e.g., the UE is at home and then the user leaves the area and moves to the office).

These various situations are depicted in the example illustrated in Fig. 1. At timeframe A several UEs face coverage problems with the serving base station (e.g., due to an obstacle causing blockage in the mmWave band). Imagine the UEs are a group of friends having a beer in a bar. Imagine also that UE#1 and UE#2 are terminals of people who are staying at their home, in apartments close to the bar, and that can provide relaying capabilities to overcome this situation. Imagine UE#1 offers better propagation conditions for relaying than UE#2. Therefore, in this case, UE#1 should be selected to become RUE. In turn, at timeframe B, the bar is still open and clients continue having blockage problem. However, at this time UE#1 is not available. Therefore, in this case, UE#2 should be selected as RUE. Finally, at timeframe C, both UE#1 and UE#2 are available for relaying. However, at this time the bar is closed and there are no customers. Therefore, in this case, there would not be the need to activate any RUE.

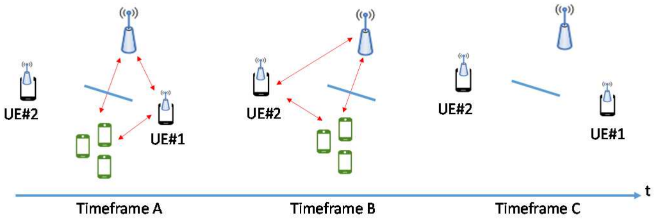

Fig. 1. Examples to illustrate the RUE activation problem

III. RUE ACTIVATION SOLUTION

A. Architectural framework

Based on the discussions of Section II, Fig. 2 depicts the functional architectural model that is proposed for addressing the RUE activation problem in a base station of interest. It is assumed that the RUE activation for a base station would be triggered by the observation of certain performance degradation (e.g., high call dropping, low throughput) through radio network monitoring tools. In such case, the operator intends to exploit UEs as RUEs to improve the performance. To this end, the SMO layer includes the RUE activation function that decides which UEs should be activated to act as relays. Once a UE is activated as a RUE, it becomes visible to the other UEs in the cell, who will see the RUE as a node with the capability of providing

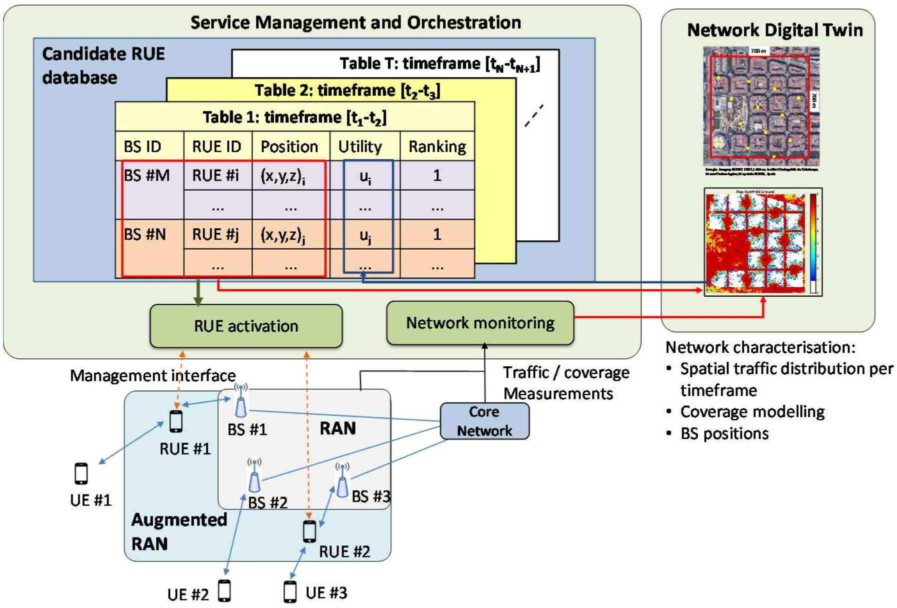

Fig. 2. Functional architectural model of the RUE activation solution

access to the network. Then, UEs will be able to either connect directly to a BS or take advantage of an activated RUE. Specifically, the assumed connectivity criterion is that a UE will connect to the node (either the BS or an activated RUE) providing the highest Signal to Interference and Noise Ratio (SINR).

The RUE activation function is supported by the *candidate RUE database*, which contains the list of UEs that stay within the BS for a sufficiently long period of time. For example, a UE staying at office during the morning could become a candidate RUE for the BS located nearby. Similarly, as the same UE goes home in the evening, it could become candidate RUE for the cell nearby the household. How the list is built is out of the scope of the paper, on the presumption that the identification of "home UEs" associated to BSs would not be difficult to achieve (e.g. by observing that a UE is always served by the same BS at certain times, hours, etc.).

The candidate RUE database is organized in tables associated to different timeframes to account for the fact that the locations of the candidate RUEs can change along the day. For example, a given candidate RUE may only be in the list during the morning while the UE owner is at office, while another candidate may only be available at night while the owner is at home. Then, the table of a timeframe includes the set of candidate RUEs per BS that use to be available during that timeframe. Information about location of the candidate RUE within the BS is also retained in the database. This can be collected, e.g. by analysing geo-localised Radio Resource Control (RRC) measurement reports provided by the UEs [13].

To identify the candidate RUEs that are more relevant for improving the coverage, each candidate RUE in the database has a *utility metric* that indicates how suitable the candidate is for acting as relay. In this way the candidate RUEs can be ranked following this utility metric and the resulting ranking will be used by the RUE activation function to determine the RUEs to activate at each time. The decision to activate a RUE will be communicated to the corresponding UEs using a management interface.

The *utility* of a given UE to act as RUE depends on its local conditions (e.g. how good are its propagation conditions with the BS) and also on its surrounding environment (e.g., if there are other UEs in proximity who have bad propagation conditions with the BS and can benefit from this UE acting as relay). One way to assess the utility level could be by trialling the UE as RUE in the live network and retaining some historical/statistical metrics of the performance achieved. However, this could lead to very long trial times and also to trialling situations where the RUE is not providing a good solution. Therefore, in order to accelerate the RUE database creation process while at the same time keeping a realistic assessment of the RUE behaviour, the architectural model considers the use of a Network Digital Twin (NDT) to determine the utility metric of the candidate RUEs. The NDT includes a realistic digitalized model of the actual network and the relevant functionalities. It is fed from network measurements of the spatial traffic distribution, coverage maps, etc. to accurately model the network conditions. Then, the NDT can be used to execute offline simulations of different situations in which the candidate RUEs are activated or deactivated according to the database and then observing their impact on the rest of users. Being an offline simulation, it is possible to simulate long network observation periods of several days, months, etc. in times of minutes or hours.

It is worth noting that the NDT would provide the "initialisation" of the database, with initial ranking and utility levels for each candidate RUE. Once the algorithm would be executed on the live network, the utilities could be updated based on actual performances achieved and the ranking could be modified accordingly.

B. NDT model

The NDT includes a digital model of the network and captures in a realistic way the spatial traffic distributions of each timeframe. The model is used for simulating the network behaviour under different dynamic conditions with different activated RUEs and UEs moving through the scenario and generating traffic. During the simulations, the NDT will assess the SINR in the different links to determine the serving BS/RUE of each UE, its spectral efficiency and its outage condition.

The most relevant aspects included in the NDT model for the use case considered in this paper are: (1) BS deployment and relevant parameters of each BS, such as operating frequency, transmit power, antenna gain and channel bandwidth. (2) Candidate RUEs, modelled with equivalent parameters as the BSs. (3) UEs, modelled with parameters such as the antenna gain or noise figure. (4) Traffic generation models for different UE types in accordance with the spatial traffic distribution in each timeframe. Realistic spatial traffic distributions could be generated e.g. from geo-localised measurements reports generated by the UEs while they are connected to the network. (5) Mobility models for different UE types. (6) Propagation loss maps for characterizing the BS-UE and the RUE-UE links, which can be obtained from propagation models and/or from real network measurements. It is worth mentioning that for the considered use case the dynamism of the network is modelled at a time scale in the order of seconds and, for this reason, the effect of dynamic processes operating at ms time scale such as fast fading or scheduling is considered in average terms.

C. Utility metric definition and computation

The utility metric considered in this paper intends to characterize how good a candidate RUE is for reducing the outage of the different UEs. To this end, the NDT as described in the previous section is used to conduct different off-line dynamic simulations for each time frame that consider the proper spatial distribution of the UEs, their traffic generation and mobility processes, and the availability or not of various candidate RUEs (depending e.g., on battery level).

During the off-line simulations, the spectral efficiency conditions of the UEs are assessed. Assuming a UE requiring connectivity in the downlink direction, the NDT computes the spectral efficiency S_D when this UE is directly connected to the BS with the highest SINR by using the Shannon formula as:

$$S_D = \min\left(S_{\max}, \log_2\left(1+SINR_{BS-UE}\right)\right) \qquad (1)$$

where $SINR_{BS\text{-}UE}$ is the SINR in the link between the BS and the UE and S_{max} is the spectral efficiency corresponding to the maximum Modulation and Coding Scheme (MCS) of 5G NR from [14]. If the obtained spectral efficiency is lower than a certain threshold S_{min} that establishes the minimum requirement for a proper service provisioning, the UE will be assumed to be in outage and it will require the support of a RUE to gain access to the network.

In turn, when the UE is connected to one of the activated RUEs in a BS, the achievable spectral efficiency S_R will be limited by the segment BS to RUE or RUE to UE with the worst spectral efficiency, so it becomes:

$$S_R = \min\left(S_{\max}, \log_2\left(1+\min\left(SINR_{BS-RUE}, SINR_{RUE-UE}\right)\right)\right) \qquad (2)$$

where $SINR_{BS\text{-}RUE}$ and $SINR_{RUE\text{-}UE}$ denote, respectively, the SINR in the BS-RUE and RUE-UE links. If a UE has $S_D < S_{min}$ and $S_R \geq S_{min}$ this means that its serving RUE is contributing to solve an outage situation. Consequently, the utility for this RUE should be increased. Specifically, the instantaneous utility of the *i*-th RUE at time *t*, denoted as $u_i(t)$, is defined as the number of UEs served by this RUE at time *t* that fulfil the conditions $S_D < S_{min}$ and $S_R \geq S_{min}$.. Then, the utility metric U_i of this RUE is given by the time average of $u_i(t)$ during all the simulation time T_i that it has been activated across all simulations, that is:

$$U_i = \frac{1}{T_i}\int_0^{T_i} u_i\left(t\right)dt \qquad (3)$$

The time T_i should be long enough to ensure the statistical significance of the utility metric. As a practical rule of thumb, T_i should account for at least 100 activations for each candidate RUE.

Although the utility metric considered in this paper is oriented to the capability of the RUE for solving outage situations, it is worth mentioning that the utility metric concept is general and other definitions could be considered as well, such as the improvement in spectral efficiency of the served UEs.

D. RUE activation algorithm

The RUE activation function for a certain BS #M runs the pseudo-code indicated in Algorithm 1 taking as input the information of the candidate RUE database corresponding to the timeframe when it is executed. First, it will check which of the listed candidate RUEs are actually available at the execution time (line 1). This is to consider that the list of candidate RUEs in the database reflects the usual behaviour, but it may be possible that a candidate is not available at some specific time (e.g. because the UE owner is not at office on that day, because the UE has very low battery, etc.). Based on this, the available RUEs will be sorted in decreasing order of their utility metric (line 2). Then, the algorithm will activate the *N* candidate RUEs with the highest utility, where *N* is a parameter of the algorithm. The setting of *N* can be based on offline simulations conducted with the NDT for different values of this parameter.

Algorithm 1 - RUE activation algorithm

```
1  list_RUEs= list of candidate RUEs in BS #M that are
   available at the algorithm execution time
2  sort list_RUEs in decreasing order of their utility metric
3  activate the top N RUEs in the sorted list_RUEs
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IV. PERFORMANCE EVALUATION

A. Scenario description

The evaluation of the proposed solution has been conducted considering an urban scenario of 700 x 700 m in Barcelona city. The scenario, shown in Fig. 3, encompasses an area with different streets, avenues and a park, and with different seven floor buildings with 3.5 m floor height. The NDT is a system level simulator that models the relevant aspects of this scenario and has been used both for determining the utility of the different RUEs and also to assess the performance of the solution. The model includes a 5G NR deployment with a total of 13 outdoor microcell BSs placed at the yellow dots of Fig. 3. BS height is 10 m, frequency is 26 GHz and the total transmitted power is 25 dBm over a total bandwidth of 100 MHz. Beamforming with ideal beam steering is assumed with an antenna gain of 26 dB for the microcells and 10 dB for the UEs. UE height is 1.5 m. Only the downlink direction is considered, and the noise figure of the UE receiver is 9 dB. The propagation follows the UMi model of [15] with outdoor-to-outdoor and outdoor-to-indoor losses and 2D-spatially correlated shadowing. It is assumed that interference among cells is negligible due to the large amount of spectrum available in the 26 GHz band, which facilitates deployments with low frequency reuse, and to the interference coordination that can be achieved when transmitting with narrow antenna beams. According to [14], S_{max}=7.4063 b/s/Hz. Moreover, a UE is considered in outage if the spectral efficiency is lower than S_{min}=1 b/s/Hz.

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Fig. 3. Considered scenario

Activated RUEs transmit at 3.5 GHz with the same power and bandwidth than the microcells and with antenna gain 3 dB. The UE-to-UE propagation model of [16] is used, but including the outdoor-to-indoor propagation losses of the UMi model and an additional loss of 21 dB per floor when UEs are located in different floors of the same building. Perfect interference coordination among RUEs is assumed.

The traffic generation model assumes a total density of 8000 UEs/km^2 where a UE generates data sessions following a Poisson distribution with rate 1 session/h/UE and exponential duration with average 300s. UEs can be pedestrian, stationary and vehicular with different distributions depending on the timeframe. Pedestrian UEs move at 3 km/h along the sidewalks of the streets with 20% probability of changing direction at an intersection or following a random walk model around the park areas in which the UE maintains the same direction for an exponentially distributed time with average 10 s and makes random direction changes in a range (+45º, -45º) with respect to the current direction. Stationary UEs remain static throughout a simulation and can be placed either outdoors at a sidewalk or a park or indoors at any of the floors of a building. Vehicular UEs move along the streets at 30 km/h with 25% probability of changing the street at an intersection. Vehicular UEs can only be served by a fixed BS.

Two timeframes are considered with the traffic distributions shown in Table I. Timeframe 1 intends to represent a situation e.g. in the morning with many people around the streets. In turn, Timeframe 2 captures the evening or the night with a majority of indoor traffic.

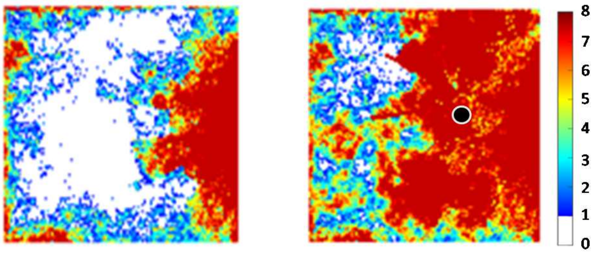
Table I. Traffic distribution in each timeframe

	Timeframe 1	Timeframe 2
Pedestrian	45%	15%
Stationary outdoor	15%	10%
Stationary indoor	30%	65%
Vehicular	10%	10%

The candidate RUE database includes a different set of RUEs for each timeframe, capturing the different traffic distribution. In each timeframe a total of 4300 candidate RUEs are considered, distributed among the different BSs. All the candidate RUEs fulfil that the spectral efficiency in the BS-RUE link is higher than S_{min}=1 b/s/Hz. The utility metric has been computed for each timeframe after a total of 800 simulations of duration 10000s.

B. Results

In order to gain some qualitative insights on the operation of the proposed approach, Fig. 4a illustrates the map of spectral efficiency obtained in the building located at the left of BS9 (see Fig. 3) when no RUE is activated and Fig. 4b shows the case when activating the top ranked RUE of BS9 in Timeframe 1 (whose position is depicted as a black dot in Fig. 4b). It can be clearly observed that the activation of the RUE leads to an important increase in the achieved spectral efficiency and to a reduction of the outage areas (depicted in white). The qualitative improvement of Fig. 4 is quantified in Fig. 5, which shows the Cumulative Distribution Function (CDF) of the obtained spectral efficiency at the different building positions served by BS9 with and without the RUE. It can be observed that, without the RUE, around 30% of positions are in outage (i.e., have a spectral efficiency lower than S_{min}), while the outage is reduced down to approximately 5% with the RUE. Without the RUE, only 50% of the positions achieve a spectral efficiency higher than 4 b/s/Hz, while when adding the RUE this percentage increases up to 80%. Moreover, with the RUE, about 50% of the positions achieve the maximum spectral efficiency of S_{max}=7.4063 b/s/Hz, while this value is only about 30% without the RUE.



(a) (b)

Fig. 4. Spectral efficiency in the building at the left of BS9 without any RUE (a) and activating the top RUE of BS9 in one simulation of Timeframe 1 (b)

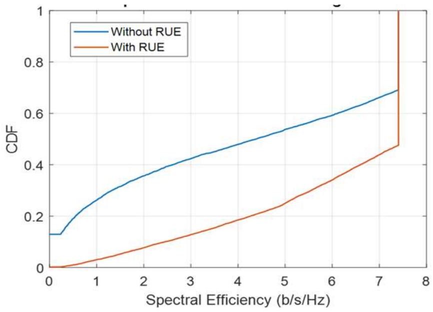


Fig. 5. CDF of the spectral efficiency of the positions served by BS9 without any RUE and when activating the top RUE of one simulation of Timeframe 1.

The improvement obtained with the RUE activation algorithm across the different BSs of the scenario is shown in Fig. 6, which plots, for each BS and Timeframe 1, the percentage of outage probability reduction that is achieved when the top N

available RUEs in each BS with the highest utility are activated with respect to the case without any RUE (i.e., N=0). It can be observed that outage probability reductions are quite significant for all BSs. For N=1, they range from 11% at BS11 to 26% at BS1, and these improvements further increase for N=2, ranging from 22% at BS11 to 42% at BS 1. Overall, for the whole scenario the average reduction in outage probability for N=1 is around 15% and for N=2 it increases up to 27%.

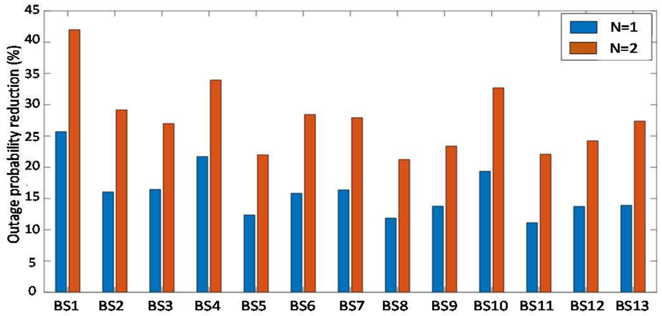


Fig. 6. Percentage of outage probability reduction in each BS when activating the top N=1 and N=2 RUEs per BS in Timeframe 1.

Regarding the analysis of Timeframe 2, it is worth noting that the amount of indoor traffic increases substantially compared to Timeframe 1, as noted in the traffic distributions of Table I. This leads to an overall increase in the outage probability with respect to Timeframe 1 if no RUEs are considered. However, the worse outage probability can be compensated with the activation of a larger number of RUEs to improve the coverage footprint. This is shown in Fig. 7, which plots the number of RUEs N that need to be activated in each BS during Timeframe 2 in order to achieve the same outage probability that was obtained in Timeframe 1 with N=2 RUEs. The figure reveals that this number varies among BSs, ranging between 5 and 13. On average terms around 8 RUEs per BS are needed in Timeframe 2 to get the same performance than in Timeframe 1 with 2 RUEs per BS.

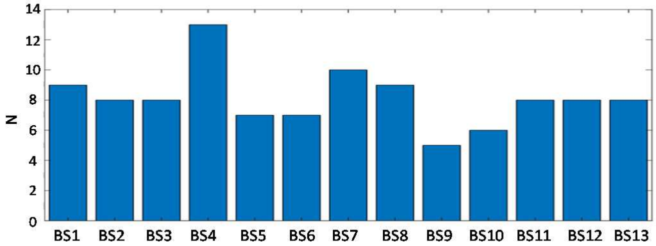


Fig. 7. Number of RUEs to be activated in each BS in Timeframe 2 to achieve the same outage probability than in Timeframe 1 with N=2 RUEs.

V. CONCLUSIONS AND FUTURE WORK

This paper has presented a functional architectural framework for supporting the relay UE activation problem in scenarios where UEs are used to enhance the coverage of a B5G RAN through relaying capabilities. It includes a database with the different candidate RUEs, each one characterized with a utility metric that indicates how suitable the candidate RUE is for acting as relay. To accelerate the determination of this utility metric, a Network Digital Twin is used that allows assessing different situations of activated and deactivated RUEs in the network. Based on the proposed framework, the paper has presented a RUE activation algorithm that decides the RUEs to be activated in each base station.

The proposed approach has been evaluated under different traffic distributions, reflecting that important outage probability reductions ranging from 22% to 42% depending on the considered base station can be obtained just with the activation of 2 smartly selected RUEs. Results also show that in more coverage challenged scenarios, as it could be the case during evenings/nights when more users are indoors, the activation of a higher number of RUEs (8 on average in the considered scenario) can avoid an increase in the outage probability.

Future work intends to further elaborate the practical implementation mechanisms of the proposed framework, including the enabling technologies for relaying and the control procedures for activating/deactivating the relay UEs. Moreover, the possibility of exploiting machine learning tools for developing a RUE activation algorithm will be analysed.

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