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Cell-Sweeping: A New Paradigm for Cells Deployment in Radio Access Networks

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***Abstract*—Good network coverage is an important element of Quality of Service (QoS) provision that mobile cellular operators aim to provide. The established requirements for the existing Fifth Generation (5G) and the emerging scenarios for upcoming Sixth Generation (6G) cellular communication technologies highly depend on the coverage quality that the network is able to provide. In addition, some proposed 5G solutions such as densification, are complex, costly, and tend to degrade network coverage due to increased interference which is critical for the cell-edge performance. In this direction, we present a novel concept of cell-sweeping for coverage enhancement in cellular networks. One of the main objectives behind this mechanism relies on overcoming the cell-edge problem which directly translates into better network coverage. In sequence, the concept operation is introduced and compared to the conventional static cell scenarios. These comparisons target mostly the benefits at the cell-edge locations. Additionally, the use of schedulers that take advantage of the sweeping system is expected to extend the cell-edge benefits to the entire network. This is observed when deploying cell-sweeping with the Proportional Fair (PF) scheduler. A 5^{th}-percentile improvement of 125% and an average throughput increase of 35% were obtained through system level simulations. The preliminary results presented in this paper suggest that cell-sweeping can be adopted as an emerging technology for future Radio Access Network (RAN) deployments.**

***Index Terms*—Cell-edge, Cell-sweeping, Cellular Technologies, Network Coverage, Radio Access Network Optimization.**

I. Introduction

In order to meet the ever increasing requirements of network users in terms of mobile services and applications, the technology advancements of mobile networks have been focused on improving Key Performance Indicators (KPIs) such as the network capacity, throughput, and latency. These are the main metrics of concern when evaluating the performance of a mobile network, and the metrics to be maximized when envisioning legacy and future wireless communication technologies. However, there are other important challenges in mobile networks that might be overlooked. The network coverage quality and the cell-edge interference problem are examples of concerning network issues, whose good performance is critical for the enhanced operation of the existing and upcoming technologies.

In traditional cellular networks architecture, the Base Stations (BSs) are deployed in a sectorized manner, using difference cells with directive antennas. This architecture improves the transmission power directivity, enhancing the network performance and conditions of the users located in the antenna main lobe. On the other hand, this sectorized approach affects the users located at the cell-edges, *i.e.*, the users located in the frontier between sectors. Since the cell-edge is typically characterized by high levels of interference and bad radio conditions, users struggle to benefit from the advantages of recent technologies. When moving to higher frequencies, this situation can have even more repercussions since the beams tend to be narrower in order to increase directivity and overcome the high attenuation.

New technologies such as the network densification and the Heterogeneous Networks (HetNets) are expected to bring important advantages in terms of network performance, as a result of the substantial increasing number of Access Points (APs) in the network [1]. Several drawbacks and challenges have however been raised regarding these approaches [1], [2]. Some reports and studies show that densification has a limitation due to the fact that the network interference will also massively increase. This is crucial in terms of network coverage since additional interference highly contributes to the performance drop typically experienced at the cell-edge. Technologies such as Coordinated Multi-Point (CoMP) and beamforming can help to overcome network interference issues [3]. Nonetheless, these techniques are very complex. For example, CoMP requires the channel estimation of all relevant channel components, proper cooperation areas setup, and dealing with feedback overhead [4]. Some studies have shown that millimeter waves (mmWaves) can be an efficient method to manage interference by taking advantage of its higher propagation attenuation while increasing the capacity [5]. Nonetheless, this attenuation can be critical and a limiting factor in many deployments, providing very short cell ranges. This shows that there are current and upcoming challenges for coverage in wireless networks whether it is because of limitations of new designs or due to the complexity behind these mechanisms.

In this paper, a new technology based on the BS cell-sweeping is proposed. The main target is to overcome the network coverage dead-spots problem, mostly resulting from cell-edge issues. This sweeping mechanism aims to provide a more uniform coverage around the site serving area, targeting a better resource distribution among all users in the network.

In the cell-sweeping mechanism, the cell-edge concept varies in time, in the different stages of the rotation process, and it is anticipated that there will be improvements in the overall coverage of the network. Furthermore, the BSs footprint will approach an omnidirectional pattern, but preserving the advantages of the sectorized deployments, *i.e.*, increased directivity, efficient bandwidth use, and improved capacity. Such a scheme is expected to highly contribute for enhanced coverage and performance at the cell-edges.

This paper is organised as follows. Section II introduces the cell-sweeping concept and presents a preliminary model for its application through the antenna gain expression. In Section III, the simulation environment is introduced and initial results of cell-sweeping are presented and discussed. Section IV concludes the paper, presenting a summary of the main results and potential future work directions.

II. Cell-Sweeping - A novel way for cells deployment

This section introduces the cell-sweeping idea. It explores the concept and the main objectives behind this mechanism.

A. The Cell-Sweeping Concept

The cell-sweeping targets the coverage uniformization around the BS serving area. In the conventional tri-sector static architecture, the antennas transmit the signal in a directive manner towards the direction of the antenna main lobe, *i.e.*, the cell-centre. This configuration is presented in Figure 1. It shows a generic wideband Signal to Interference plus Noise Ration (SINR) map of a network with 7 tri-sectorial urban sites. The red color represents high SINR values while the blue color represents low SINR. It is shown that the tri-sector configuration maximizes the performance at the boresight locations, but it does not overcome the so-called cell-edge problem. When network users are located in the boundaries of a cell, the intensity of signaling arriving from neighboring cells causes destructive interference which results in severe communication performance degradation. This problem results in very low SINR which is represented in Figure 1 by the dark blue areas. The impact on the SINR is then propagated to the throughput, resulting in bad end-user experience. In this direction, it can be assumed that the traditional tri-sector configuration provides unbalanced resource distribution between users located at the cell-centre and the cell-edge.

Interference is not the only factor related to the cell-edge problem. As the cell transmission increases in directivity, the narrower the beam becomes. Thus, the side-lobe areas will suffer from bad or no coverage as the angle between the cell boresight and the user location increases, *i.e.*, the off-boresight angle. In addition, the distance to the BS is also a factor in the cell-edge definition since the transmitted signal is exponentially attenuated as a function of the distance to the BS. Therefore, it can be stated that the cell-edge problem is also a function of the off-boresight angle as well as of the distance to the serving and neighboring BSs. Two different types of cell-edges can be considered: the intra-site cell-edge that results from the coverage dead-spots between cells of the same site, and the inter-site cell-edge representing the coverage dead-spots between cells of different sites.

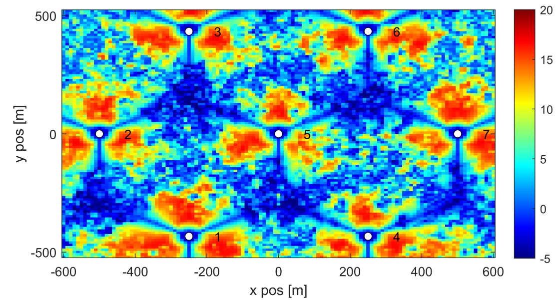

Fig. 1: Wideband SINR Map in a Conventional Cell Deployment Scenario.

The autonomous cell-sweeping mechanism aims to provide a much fairer resource distribution for any location around the site serving area. This can be achieved by continuously sweeping the cells to provide uniform coverage. This mechanism is illustrated in Figure 2. In the initial stage, the sectors are static as in the traditional configuration. As soon as the sweeping mechanism is in place, the sectors start to continuously rotate in a certain direction of the azimuth plane. Considering a clock-wise rotation, Figure 2 shows the sector position after a 60º and 120º sweep in the central and right-hand images, respectively. In addition, the cell-sweeping is not limited to a continuous movement in the same direction. It can also be implemented in a limited sweeping manner, where cells continuously sweep back and forward within a certain range of the azimuth plane.

The cell-sweeping redefines the concept of both cell-edge and cell-centre as they vary in time during the different stages of the rotation process. This means that any location in the network will at some point be either cell-edge or cell-centre irrespective of the initial off-boresight angle. Figure 3 provides a wideband SINR heat map sample of this cell-sweeping scenario after synchronously sweeping the cells of all 7 sites by 360º, in steps of 10º per Transmission Time Interval (TTI) or 1 millisecond. This can be directly compared to the network of Figure 1 that shows the wideband SINR map of static sectors in the same network conditions. It is clear how much the coverage dead-spots, *i.e.*, the dark blue areas are mitigated when comparing the static to the cell-sweeping scenario. The intra-site cell-edge is fully overcome while the inter-site cell-edge is considerably attenuated. This impacts the cell-edge user experience as its throughput will be significantly improved. However, it is also possible to verify that the high-intensity SINR areas (intense red) became lighter as a result of this process. This is a consequence of not having the sectors radiating constantly at their maximum into a fixed direction.

This mechanism differs from other solutions such as beamforming/beam tracking (as is done in mmWave bands) due to its blind-sweeping nature. It does not require extensive user tracking, channel knowledge, or feedback mechanisms. This stands for a continuous sweeping movement rather than steering the beam towards a fixed location. Therefore, it results in an almost omnidirectional coverage area pattern with preservation of the tri-sector architecture and its inherent benefits. In

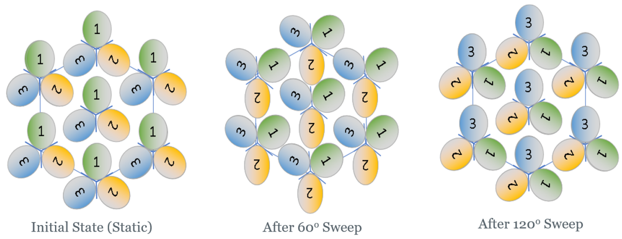

Fig. 2: Cell-sweeping mechanism design.

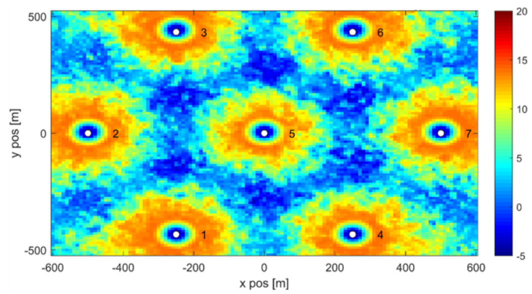

Fig. 3: Wideband SINR Map after a Cell-Sweeping Simulation.

addition, cell-sweeping applies to both high and low-frequency bands. Furthermore, it is a radiofrequency solution that does not affect the digital baseband, and hence, it only requires an antenna update at the BS. The overall mechanism performance is evaluated by averaging the performance of each sweeping step during a certain period. Further extensions of the concept are expected to result in optimized coverage and capacity not only at the cell-edge but for the entire network. Additionally, despite being discussed as a mobile technology in the current context, it is compatible with most wireless technologies.

B. Antenna Radiation Pattern With Cell-Sweeping

The concept of cell-sweeping fundamentally relies upon a continuous or discrete sweep or rotation of the antenna radiation pattern in the azimuth plane. Let us consider the second dimension (2D) antenna radiation pattern from the Third Generation Partnership Program (3GPP) [7]:

$$G_T(\phi) = -min\left\{-A_H(\phi), G_{T_{max}}\right\} \quad (1)$$

where $G_T(\phi)$ gives the antenna gain towards a certain direction, and $G_{T_{max}}$ is the transmission gain in the direction of the transmitter boresight, typically defined as 15 dBi. The $A_H(\phi)$ is the horizontal antenna attenuation. It is computed as follows:

$$A_H(\phi) = -min\left[12\left(\frac{\phi}{\phi_{3dB}}\right)^2, A_m\right] \quad (2)$$

where ϕ represents the horizontal angle between the orientation of a serving BS antenna and the User Equipment (UE) location, *i.e.*, the off-boresight angle, and ϕ_{3dB} is the horizontal half power beamwidth aperture in degrees (typically 65º). The A_m is the maximum horizontal attenuation, with a typical value of 30 dB. The off-boresight angle ϕ is computed as given below:

$$\phi = \phi_{B_x,U} - (90 - \phi_a) \quad (3)$$

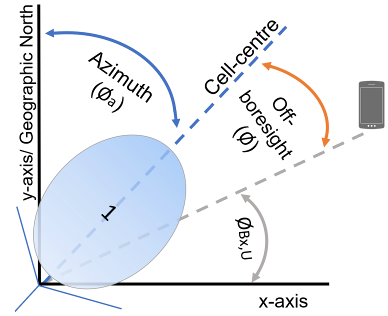

Fig. 4: Azimuth (ϕ_a), $\phi_{B_x,U}$, and off-boresigth (ϕ) angles illustration.

where $\phi_{B_x,U}$ represents the horizontal angle between the x-axis of the reference BS, B_x, and a certain user, U. This value only changes if the user moves. Since tri-sectorial BSs are being considered, the cell-centre direction of each sector depends on the antenna azimuth. The azimuth is defined as the angle between the sector orientation and the geographic north, and is represented here by ϕ_a. An illustration of the angles ϕ, $\phi_{B_x,U}$, and ϕ_a is provided in Figure 4. The cell-sweeping can be enabled by turning the azimuth angle into a dynamic configuration parameter since it defines the direction of the cell-centre. Therefore, the cell-sweeping effect can be obtained by changing this azimuth value according to a certain step size A in degrees, and a sweeping period P, in milliseconds or TTIs. This process is modelled as follows:

$$\phi_a(t) = mod(\phi_{a_{t-1}} \pm xA, 360) \quad (4)$$

where the $mod()$ function ensures that the azimuth ranges between 0 and 360º, $\phi_{a_{t-1}}$ is the initial or previous azimuth set, and x is given by:

$$x = \begin{Bmatrix} 1, & mod(t,P) = 0, \\ 0, & mod(t,P) \neq 0. \end{Bmatrix}. \quad (5)$$

This means that the azimuth in each instant t, $\phi_a(t)$, will result from the previous azimuth $\phi_{a_{t-1}}$, shifted by A degrees every P period. The following section goes through several scenarios and simulations providing initial numerical results of the cell-sweeping performance.

It is important to highlight that this proposed scheme is novel and directly affects the deployment of BS antennas. The mechanism presented above stands for a continuous sweep in a certain direction which would require an antenna redesign/upgrade that enables a radial movement over 360º, which implies that electrically steerable antennas are needed. In addition, there are alternative and simpler ways of deploying the cell-sweeping scheme. The sectors do not necessarily need to sweep over the entire horizontal plane but rather on a limited azimuth range. This would simplify a potential deployment since a continuous beam shift of ± 30º would also considerably improve the coverage performance with a limited sweeping range. Such cell-sweeping deployment and antenna designs, along with relevant theoretical analysis need to be investigated.

TABLE I: Simulation Parameters.

Parameter	Setting
Carrier Frequency	2.14 GHz
System Bandwidth	10 MHz
Cellular Layout	Tri-Sectorial Hexagonal Grid
Path loss model	Urban scenario from 3GPP [7]
Shadowing Standard Deviation	8 dB
Antenna Model	3GPP [7] 2D Antenna
eNodeB Tx Power	46 dBm
Inter-Site Distance	500 m
Cell-Sweeping Characteristics	
Sweeping Amplitude	Steps of 15°
Sweeping Speed	15° every 1 TTI
Sweeping Type	Full-Sweeping
Simulation Time	360° TTIs

III. System-Level Analysis of Cell-Sweeping

The cell-sweeping concept performance presented in this section results from the modification of the System Level Long Term Evolution (LTE)-Advanced Vienna Simulator. This is an open-source tool, freely available under an academic noncommercial use license [6]. The cell-sweeping approach was developed and added to the simulator through the antenna model modification presented in the previous section. In this section, a preliminary analysis of the cell-sweeping performance through simulation is presented. Initially, this analysis covers the study of the cell-sweeping effect on the network antenna gain and received power, considering all network locations rather than specifying users. Afterward, the impact of schedulers and user throughput is measured by dropping UEs within the network. All implementations consider a typical urban scenario. The results compare the cell-sweeping mechanism to the conventional three static sectors architecture. Most comparisons are performed focusing on the 5^{th}-percentile of the Cumulative Distribution Function (CDF) of the metrics under study. The 5^{th}-percentile is typically used for evaluation of the cell-edge performance, while the 95^{th}-percentile tends to represent the cell-centre [8]. In this scenario, a shadow fading standard deviation of 8 dB was considered. The default sweeping configuration is 15º every 1 TTI, *i.e.*, 1 ms. The cells sweep continuously in the same direction (clock-wise), in what is termed as full-sweeping. A summary of the simulation parameters is detailed in Table I.

A. The Antenna Gain of Cell-Sweeping

The first point of analysis is the effect of cell-sweeping on the antenna gain following the modified antenna pattern presented in section II-B. Firstly, Figure 5 presents the gain of the 3GPP static antenna diagram as a function of the angle, θ, between the cell-centre and a user. It shows that the gain of a user close to the cell-edge, in this scenario at an angular distance of 60º from the cell-centre (0º), has an estimated antenna gain of 4.8 dBi. The average and boresight (maximum) antenna gains of 12.5 dBi and 15 dBi, respectively, are also presented. The cell-sweeping is expected to result in increased edge gain since the user will at some point hit the cell-centre during the sweeping process. This means that after several sweeping iterations, an edge user is expected to experience an average gain close to the 12.5 dBi average antenna gain mark.

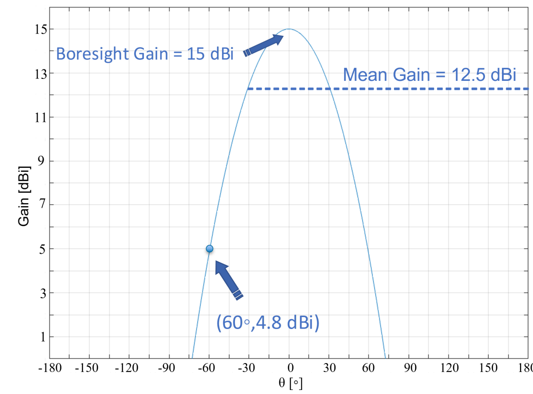

Fig. 5: 2D Antenna Pattern and Gains.

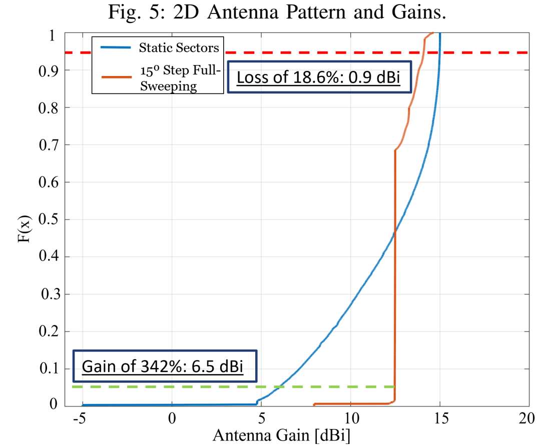

Fig. 6: Cell-Sweeping and Static Antenna Gain CDF comparison.

Figure 6 presents the comparison between the antenna gain CDF of the static (in blue) and cell-sweeping (in orange) deployments. Both curves consider the influence of the 7 sites in the network. In each location, the antenna gain is calculated, summed every time a new cell-sweeping step occurs until the sectors complete a total sweep of 360º, and then averaged by the total number of steps. It does not matter what is the initial off-boresight angle at a specific location since after completing the 360º sweep, all locations around the site should have experienced similar antenna gain conditions. Therefore, while the CDF of the antenna gain in a static scenario follows its typical trend, the CDF of cell-sweeping is almost a straight line. This means that on average, every location will get the same antenna gain with cell-sweeping. In this direction, the 5^{th}-percentile antenna gain is enhanced in 6.5 dBi as shown by the green dashed line. If this value is summed to the 4.8 dBi gain of the edge user represented in Figure 5, it reaches an average 11.3 dBi gain which comes close to the average antenna gain of 12.5 dBi as aforementioned. This comes at the cost of a 1 dBi drop at the 95^{th}-percentile. The latter is a consequence of non-existing locations constantly in the center of the antenna main lobe.

B. Received Power of Cell-Sweeping

The cell-sweeping outcome observed in the antenna gain analysis will be propagated to all other network metrics. Its impact on the received power is evaluated in this section. Since the received power does not uniquely depend on the

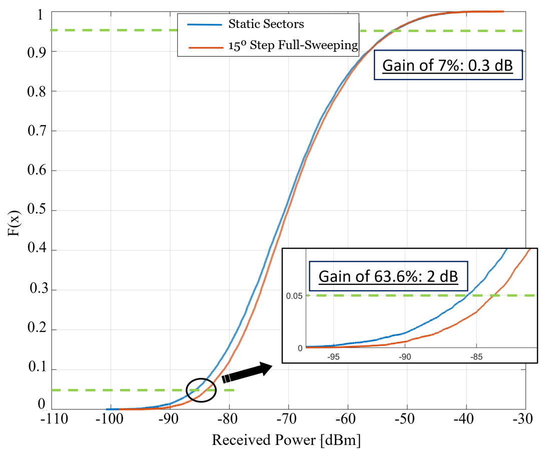

Fig. 7: Cell-Sweeping and Static Received Power CDF comparison.

TABLE II: Antenna Gain and Received Power performance results.

Metric	Antenna Gain [dBi]		Received Power [dBm]	
	15º/TTI Full-Sweeping	Static	15º/TTI Full-Sweeping	Static
5^{th} %tile	12.5 (+6.5 dBi; 342%)	6	-83.8 (+2 dBm; 63.6%)	-85.8
95^{th} %tile	14.1 (-0.9 dBi; -18.6%)	15	-52.3 (+0.3 dBm; 7%)	-52.6
Average	12.8 (+0.1 dBi)	12.7	-58.4 (+0.2 dBm)	-58.6

antenna diagram but also on the distance to the BS, the improvement with cell-sweeping is not expected to be an exact mapping of the results observed for the antenna gain. Figure 7 shows the CDF results for the received power in a similar fashion to the antenna gain CDF. The 95^{th} and 5^{th}-percentiles are highlighted in green. A 2 dB improvement in the cell-edge is achieved when comparing the sweeping system to the conventional static approach.

Despite the significant gain at the 5^{th}-percentile, the received power does not show the exact same improvement as observed for the antenna gain due to the distance to the BS being also a factor. On the other hand, there is no drop at any point when comparing the static and sweeping approaches, even at the 95^{th}-percentile. One of the reasons for this behavior is related to the Minimum Coupling Loss (MCL). For closer distances to the BS, the received power is very high due to the low impact of pathloss. However, there are always minimum or default losses irrespective of the user location. These can be related to the components and connections in the path between the BS and the UE. This minimum loss is usually defined as 70 dB [7]. This factor leads to no considerable changes in the higher values of received power whether the sectors are sweeping or not. Therefore, not only the high values of received power will match in both scenarios as the cell-sweeping adds approximately 2 dB improvement in the 5^{th}-percentile.

C. Cell-Sweeping Impact on the Average Network Performance

The implementation and initial concept validation provided in the previous sections showed the anticipated considerable gains in the 5^{th}-percentile and some performance drop in the 95^{th}-percentile (for the antenna gain). Hence, a balance should exist between these two factors. This balance is provided by the average system antenna gain and received power. It is of great importance that the average performance with cell-sweeping does not fall below the static scenario. This requirement is, however, achieved for both metrics and was validated in the simulator.

The antenna gain only depends on the off-boresight angle. In the cell-sweeping mechanism, in each sweeping step, the overall antenna gain is the same as in the previous azimuth orientation. Therefore, on average, it should be the same to sweep the orientation of the sectors or keep them in a fixed position. This results in an identical average antenna gain in both the static and cell-sweeping scenarios. The same behaviour was initially expected for the received power. However, as observed in the received power CDF of Figure 7, the sweeping system provides the expected gains at the 5^{th}-percentile but also matches the static in the 95^{th}-percentile due to the MCL. This factor results in a small average gain for the cell-sweeping mechanism. These results are summarized in Table II.

D. User Scheduling Analysis with Cell-Sweeping

The cell-sweeping results explored in the previous section were focused on a system area analysis, considering all locations around the sites serving area, *i.e.*, users were not considered. This section explores by means of simulation, the impact of cell-sweeping on user throughput when network schedulers are taken into account, highlighting the potential of appropriate scheduler selection in the cell-sweeping performance. The Rayleigh fast-fading channel is considered in the system level simulator. The cell-sweeping is expected to further benefit from certain schedulers that better exploit the fact that at some point in the sweeping process, each user will face very good network conditions as the cell-centre approaches its location. This means that a much better performance can be provided if the UEs are mostly scheduled when they are closer to the sweeping cell-centre. Let us explore the effect of two of the most well-known scheduling algorithms in wireless networks, the round-robin (RR) and proportional-fair (PF).

The RR scheduler is characterized by providing maximum fairness. It distributes the available resources equally through all users served by a certain sector. This algorithm works in a queue manner where users that are not scheduled in one TTI due to limited amount of resources, are prioritised in the following TTI. On the other hand, the PF prioritizes users with better network conditions. However, it also adds some complexity in its operation to provide a balance between maximum user performance and fairness. In each TTI, the PF considers not only the users with best conditions but also the ratio between the amount of bits that it can transmit with the total amount of bits already transmitted. Therefore, a user that has not been able to transmit bits or has been transmitting at a lower rate considering its necessity during a certain period of time, will be prioritised. In addition, this is done in a way that maximizes the sum throughput in the entire cell [9].

Table III presents a summary of the throughput performance results when comparing cell-sweeping and static cells with RR

TABLE III: Round-Robin and Proportional-Fair scheduler cell-sweeping performance compared to the static scenario.

User Throughput Improvement [Mbps]				
Metric	Round Robin		Proportional Fair	
	15º/TTI Full-Sweeping	Static	15º/TTI Full-Sweeping	Static
5^{th} %ile	0.0229 (+381.4%)	0.0048	0.1504 (+125.5%)	0.101
50^{th} %ile	0.1514 (+13.6%)	0.1333	0.4309 (+41.6%)	0.27
95^{th} %tile	0.4251 (-7.2%)	0.4580	0.8611 (+20.5%)	0.605
Average	0.1819 (+6.6%)	0.1706	0.4616 (+35.2%)	0.304

and PF. The simulation environment remains unchanged apart from the addition of 50 users per cell. The RR scheme results are very consistent with the standard expectations of the cell-sweeping approach. It follows what was previously stated for the antenna gain and received power. The 5^{th}-percentile gains are very high with up to 380% increased throughput for the cell-edge users. The 95^{th}-percentile suffers a drop of 7.2% and the average throughput increased by 6.6%. Both the cell-sweeping and RR potentiate the resource fairness allocation, therefore the 5^{th}-percentile throughput is highly maximized with this solution. Since this scheduler deals with all users equally, it is similar to give the same weight to any location of the network as previously observed for the antenna gain and received power. In this direction, the results follow a similar trend to what was stated before.

The conclusions are different when the PF scheduler is used. The 5^{th}-percentile is not as highly impacted as it is with the RR. However, the entire network throughput is maximized. Not only there is no drop for the cell-centre users but both the 95^{th}-percentile and average throughput are enhanced by 20.5% and 35.2%, respectively. This is related to the balanced nature of the PF operation. The PF prioritizes users with good network conditions, typically located at the cell-centre. Since the cells are sweeping, all users will be at the cell-centre at some point. Therefore, they will mostly be served at the cell-centre every 2 or 3 TTIs irrespectively of their location, maximizing the overall network performance. Additionally, the scheduler fairness characteristics and the sweeping process itself continue to benefit the cell-edge performance.

IV. Conclusions

This paper introduced a novel cell-sweeping mechanism for coverage enhancement in wireless networks. This solution presents a possible candidate to address the inherent network coverage imbalance of mobile networks, focusing specifically on improving the performance at the cell-edge. This occurs by continuously sweeping the BS cells resulting in a uniform service quality around all site locations.

The results presented in this paper focus on measuring the 5^{th}-percentile of the antenna gain and received power. Cell-sweeping provided the anticipated gains in terms of cell-edge improvement. Despite the occasional performance drop at the cell-centre (95^{th}-percentile) in some configurations, the average performance does not fall bellow the conventional static cell deployment. Further simulation analysis showed overall network gains in terms of throughput when fast-fading and the PF scheduler were considered. In particular, the PF scheduler provided optimized results since it is designed to balance resource fairness distribution with UE throughput maximization. Therefore, by sweeping the sectors, more UEs will have the chance to be served at the cell-centre. Not only significant improvement was achieved for the 5^{th}-percentile (125%), but also gains of 20.5% and 35.2% were obtained for the 95^{th}-percentile and average UE throughput, respectively.

In summary, the cell-sweeping fulfills its objective of decreasing the coverage dead-spots and cell-edge effects, providing a fairer service availability at any location around the site serving area. Furthermore, it was also shown that appropriate scheduler selection is crucial to maximize the benefits of cell-sweeping and to extend them to the entire cell rather than just focusing on the cell-edge. Nonetheless, there are potential challenges to the proposed mechanism. The handover rate (and respective signaling) with cell-sweeping is one of the major concerns. The continuous radial movement of the BS sectors may increase this procedure occurrence. This is an issue that needs to be carefully investigated, and a potential solution may rely on a limited sweeping range rather than a 360º full sweep. In addition, optimization of cell-sweeping configuration parameters such as the sweeping step and period, new schedulers design, impact on energy efficiency, and coordination between different BSs are factors that should further enhance this mechanism, placing it as a promising new technology for future cellular deployments.

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