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Increased Traffic Efficiency in Green Communication by using a New Load Balancing Technique

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Abstract: Remote control of critical infrastructure, vehicles, low latency, and mobile traffic speeds is the driving force behind the research in 5G networks. Deployment of an energy-efficient cloud radio access network (C-RAN) will be crucial to reduce electricity utilization and operating expense. This paper presents a novel method for load balancing based on the selection of dynamic points. This method emphasizes energy efficiency and quality output by minimum utilization of network utility grids. This proposed load-balancing approach tries to balance network services based on the base station (BS) coordination method in a cluster. Cel-sleep technology is intended to conserve energy by disconnecting weakly charged base stations (BS) in situations when traffic is low. The suggested CoMP algorithm for load balancing expertly manages resource allocation for new users and improves energy efficiency. System-level simulations show that the proposed design enables a scalable trade-off between radio efficiency and energy efficiency, reduces grid energy usage by 22%, and boosts the ES score by 32%.

Keywords: 5G, CoMP, Wireless Communication, Load Balancing.

1. Introduction

This section consists of the related work previously done on this topic. In paper [1]author provides information about green network technologies. The major purpose of the EARTH project is to cut cellular network power usage by 50%. This document is an interim assessment on the energy efficiency gains projected from WP3's green network technologies research. WP6 will use the report to create an "Integrated Solution."

In paper [2] author provide a review of an energy efficient green communication. Green communication has the potential to provide a viable solution to radio communication problems. It has attracted the attention of researchers to reduce CO2 emissions and improve performance. Green communication is also thought of as communication that is energy efficient. The forthcoming 5G networks must consume the least amount of power possible.

In paper [3] author make a survey on green wireless communication system. Green wireless technology must consume less energy and emit less radio pollution to people who aren't the intended users. As people become more conscious of the importance of energy-efficient cellular networks, new technologies for constructing green cellular networks have emerged. Green wireless networks are a great place to start when it comes to developing green wireless systems. In paper [4]author provide information about green computing in communication networks. This article discusses a variety of technologies with a focus on green computing, including those connected to communication network types and an analysis of network energy-saving studies in various data-transformation-related fields.

In paper [5] author provide information about green energy communication. The researchers looked at scenarios in which single cells and heterogeneous cells were deployed. They discovered that the challenge was to match the spectral efficiency aim to the system's actual load.

Author in [6] purposed a new technique for green communication. The main considerations for green communications in 6G are discussed in this article. We'll look at how artificial intelligence (AI) is being used to manage the network and increase energy harvesting as we move toward a greener future. We also cover the current issues and the obstacles that these new techniques will face in a future 6G network.

In paper [7] author provide information about green telecommunications in smart grid. Green telecoms aim to increase energy efficiency while lowering environmental effect and increasing telecommunications' energy independence. In this study, we look at some of the communication research difficulties and potential in the smart grid and smart meter space. Green transmission systems, energy-efficient green data centers, and cognitive radio are also covered. In paper [8] author provide information about green communication networks challenges. The issues of green communication in the smart grid have been examined in a study. The study also uncovers the potential of green communications as a means of resolving environmental communication issues, according to the report. In paper [9] author make a review on green communications. They give a review of the literature on protocols for boosting energy efficiency in green communication networks. It delves into the many areas of protocol and architectural analysis, design, dissemination, and extension in green communications and networking. In paper [10] author gave information about the status and future of green communication. Researchers from the and look at what challenges remain to be overcome in the field of green communication. They identify the key difficulties that the research community has yet to overcome, as well as potential future initiatives in the direction of greener communications in paper [11] author provide information about the green communication and network. In this paper introduction of the green communication and its use in different era are given. Also, the steps are also given which can make the use of green communication possible. The relation between the green communication and different fields like IOT is also studied.

Because of rising numbers of users each year, development in ICT has accelerated a lot in recent decades. According to statistics, there are around 3.5 billion smartphone users worldwide. To keep up with rising demand, more base stations must be installed. As a result, energy utilization and consumption are growing, along with this requirement for network infrastructure and maintenance is also increasing. Because 70% of energy is spent at a mobile base station. Energy consumption at base stations in the mobile network must be concentrated more to achieve effective energy usage. Green's wireless connection provides an effective alternative for increasing energy efficiency and lowering environmental impact. The study proposes the use of Time Reversal (TR) technology to increase the energy efficiency of base stations. Time Reversal technology employs high-resolution, spatial and temporal focused communication-based multi-path propagation as well.

2. Literature Review

In paper [12] author provide a literature survey on green networking. The purpose of this survey is to draw out the main ideas in research on various aspects of communications networks. The goal is to identify areas where mathematical modelling tools can be used to solve the problem of reducing carbon emissions from energy and other human-caused sources.

In paper author [13] gave information about green networking. A look at the present state of green networking, with an emphasis on wired energy-aware networking. Adaptive link rate and interface proxying are two of the four branches of green networking research that emerge from various insights on the fundamental causes of energy waste. In paper[14] author provide detail information about different parameters of green communication network. Like signals, data analysis, energy efficiency, resource management in green system, security protocol for green system and MAC, routing and transport protocols for green communication networks.

In paper [15] author provide information about green communication as challenge for current protocol. Understanding the dynamics required to participate in the creation of next-generation wireless cellular networks requires analyzing demand and response strategies in smart grids. Broadband wireless access with fiber-connected massively distributed antennas is presented in this study as a new approach for delivering green last-mile access.

In paper [16] author provide an introduction of green communication network. As the amount of data transmitted via communications networks increases, the power and environmental effect of these networks has become a concern. Green Communications attempts to reduce energy usage and environmental effect while maintaining a high level of service quality for users. Government, academia, and industry have all expressed interest in the project.

In paper [17] author make a study of energy efficient green communication network. Personal Digital Assistant (PDA) advancements have shifted us toward a smart society. Rapid advancements in wireless communication technologies result in an imbalance in resource usage, as well as an increase in PDA energy consumption. Green communication is becoming a hot topic in the world of mobile and wireless networks. In paper [18] author provide information about green communication network for cognitive radio networks. In cognitive radio, a new mechanism for distributed power regulation has been presented. The non-cooperation game phenomena and price strategy are used to create CR networks. To boost the pricing of the most distant users, price is specified as an actual function of transmission power. The proposed model is unique and has Nash equilibrium. In paper [19] study a (USCS) method for green communication network. They look into a possible transmission method for green communication networks in this article. A water-filling emission spectrum is suggested, which is based on a novel conception of a radius basis neural-network. In addition, to improve reception performance and reduce energy usage, a low-complexity non-coherent detection approach is proposed. In paper [20] purposed a new method for green communication based on interference alignment network. To the Interference-Alignment. An (IA) based networks, a new security and green communication technique is proposed. The simulations demonstrate that AN has no effect on the target. Average transmission rate, but it can considerably improve secrecy's performance. In paper [21] provide information about green communication network and its challenges. Different techniques for green communication technology are presented in this study, as well as some problems. Device-to-device communication (D2D), huge Multiple-Input Multiple-Output (MIMO) systems, and the Green Internet of Things are examples of techniques (IoT). In paper [22] study green network as major component for communication. A Green Network is one in which all of our data is safely stored in highly efficient, dependable Data Centers that typically run at low energy per Gigabit per second speeds. Whatever the future holds, Green Networking will aid in reducing the ICT industry's carbon impact. In paper [23] provide information about green communication in 5G network. Beam forming is one of the most essential technologies in fifth-generation (5G) systems due to the usage of smaller base stations, higher frequencies, and millimeter waves. It lowers the likelihood of broadcasting by adaptively guiding signals towards the intended receivers while lowering the reception for surrounding receivers. In paper [24] make a survey about the use of green communication in next generation cellular networks. The energy usage in mobile networks has increased as a result of 5G cellular technology, with the carbon footprint increasing at alarming rates. This has a negative impact on the ecosystem as well as human health. A survey of approaches for making next-generation cellular networks green is presented in this research. In paper [25] make an analysis on green communication. The effectiveness of ARQ protocols is generally unaffected by the length of the codeword's. The usage of power-adaptive ARQ reduces the average power when compared to an open-loop configuration. Furthermore, optimal power allocation significantly improves the ARQ protocol's diversity gain

3. Materials and Methods

The increased demand for energy and the emission of greenhouse gases in the telecommunication industry served as the foundation for this study on the EE performance of green wireless communication. As it is evident that a significant amount of research is done on various objectives and network models. To the best of our knowledge, the multi-point load balancing system for dynamic point selection of green mobile communications was first investigated in this study.

In order to achieve load balancing through adaptive cell zooming, an entirely novel user-BS energy-efficient connection method is being developed. By feeding BS the best EU signal, the offered method combines radio efficiency with energy efficiency. Following that, the requirements for EE, grid energy savings, radio efficiency, and spectrum efficiency were explored. The most significant contributions can be expressed as follows.

In order to overcome problems associated with energy efficiency, a PV/grid-bonded hybrid power supply architecture is created for central access networks. While conventional grid storage options remain accessible in times of green energy shortage. Certain solar photovoltaic modules are utilized as primary sources of energy, integrating significant battery bank capacity for storage.

The heuristic output for energy-efficient load balancing includes the CoMP dynamic selection point, which has not previously been investigated. To assess the efficacy of the proposed technique, a full simulation is performed with other existing benchmarking methodologies for various system features.

Multiple performance metrics, including radio efficiency, energy saving index, and energy reduction benefits, have been identified as an alternative for the investigation of the system's optimal efficiency. However, system performance is assessed in light of some limited parameters, such as intercell interference, a fading model of route loss constructed in a non-LOS environment, and so on. Furthermore, the BS model is explored in terms of the speed-spatial domain and the temporal variation in green energy.

4. Model Configuration

A large two-level network consisting of N BS numbers (B) and BBUs B = {B1, B2, BN} is considered. Geographical coverage area A = {A1 ǀ A2. – AN} – R is defined, the overall user equipment (EU) being distributed uniformly (U). Please notice that Ai is BS Bi {1... N} coverage area, i.e., that I timetable is BS index. The Hexagonal Grid Pattern tri-sectoral in the remote head (RRH) between the transmission antenna and the baseband unit is expected to organize all BSs (BBU).

Signal transmissions connected to the EU's wireless connection between BBU and RRH are through optical cable and RRH. All base stations have a common energy supply, such as solar panels and battery banks, which may also improve energy storage with grid supplies. However, the option of entering sleep mode is contemplated for further grid savings, i.e., the BSs may toggle between state and state modes according to traffic volumes. A smart energy management unit (EM) has been installed, with photovoltaics, storage devices, and a local power grid.

(Figure 1) explain proposed architecture. These EM units can prevent battery banks from overloading and regulate the primary source of energy. Each slot has a total T-duration of sec, where "T" the cell size is updated in seconds, the transmission strength is adjusted to the strongest signal, and traffic arrival is redistributed. OFDMA technology cancels intra-cell interference, whereas coordinated multi-point technology significantly decreases inter-cell interference (ICI). In both the uplink and downlink directions, the BBU pool manages sophisticated signal RF processing. The centralized BBU pool control server, on the other hand, governs signal strength, circulation intensity, and the overall load in each slot.

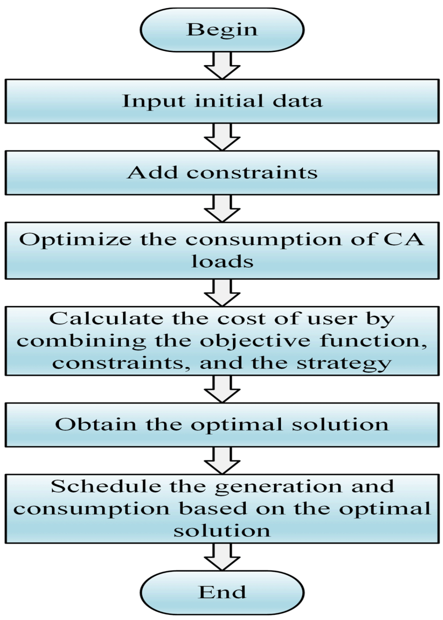

Figure 1. Proposed Architecture

5. Results

(Figure 2) illustrates the variations in energy usage (ECG) resulting from different load-balancing methods. In accordance with the ECG statement, a lower value indicates superior system performance compared to the corresponding reference scheme. The ECG demonstrates consistent trends, wherein it progressively decreases as the zoom level of cells increases. Consequently, the ECG exhibits remarkable performance at higher cell zoom values.

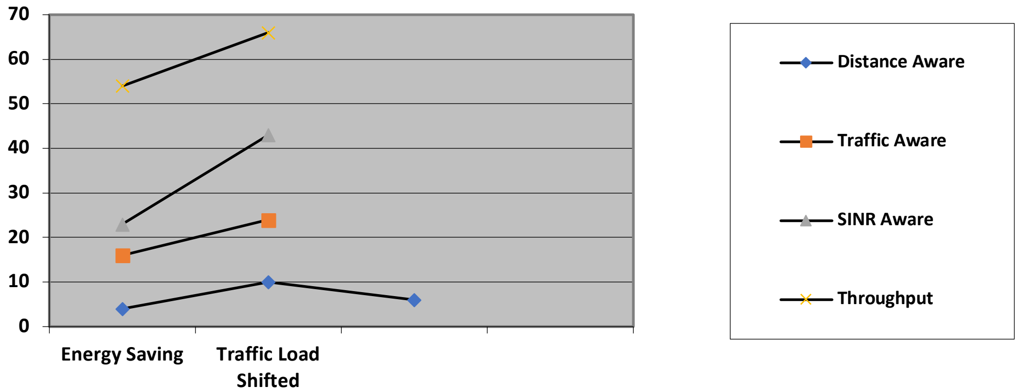

Figure 1. Cell Zooming Level vs Energy consumption gain (ECG)

Among all user association strategies, comparable performance is observed under conditions without zooming. However, the UE-BS connection approach based on SINR offers superior performance, whereas the conventional cell-sensitive distance zoom method exhibits decreased performance and interplays the traffic method.

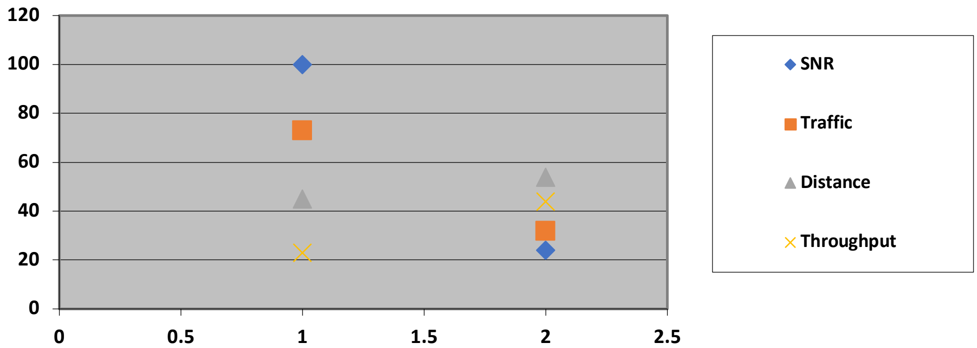

Figure 2. Energy saving achieved by transferring traffic demand

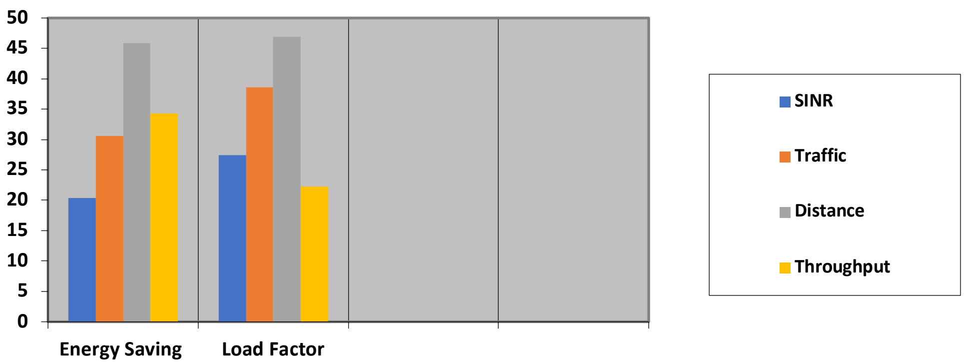

Figure 3. Energy conservation using load factor

The SINR-based mechanism demonstrates superior performance compared to other systems, particularly at the highest zoom-out level where the highest load balance is achieved. For SINR-based user relationships, BS provides the highest signal quality. The load factor, load change to the collocated BS, and BS sleep periods are represented by average energy efficiency savings for three different UE-BS systems combined, as illustrated in (Figure 3), (Figure 4), and (Figure 5), respectively.

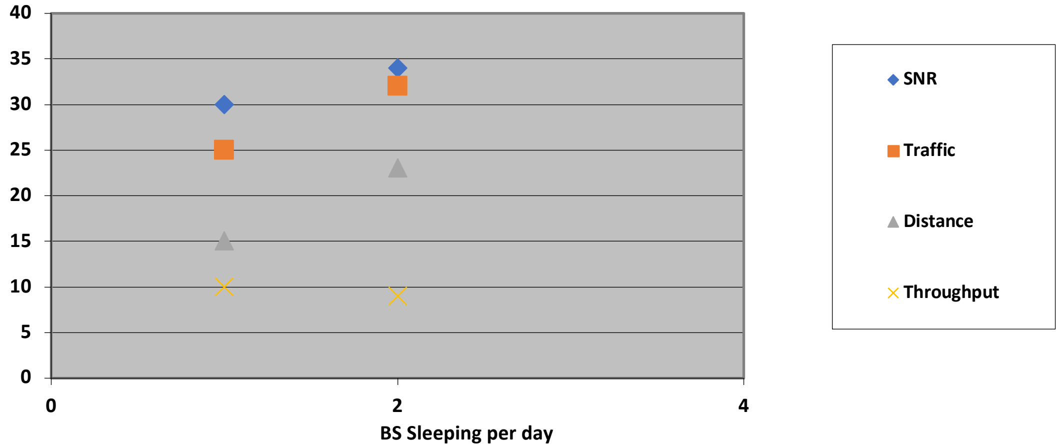

Figure 4. BS Sleeping hours per day

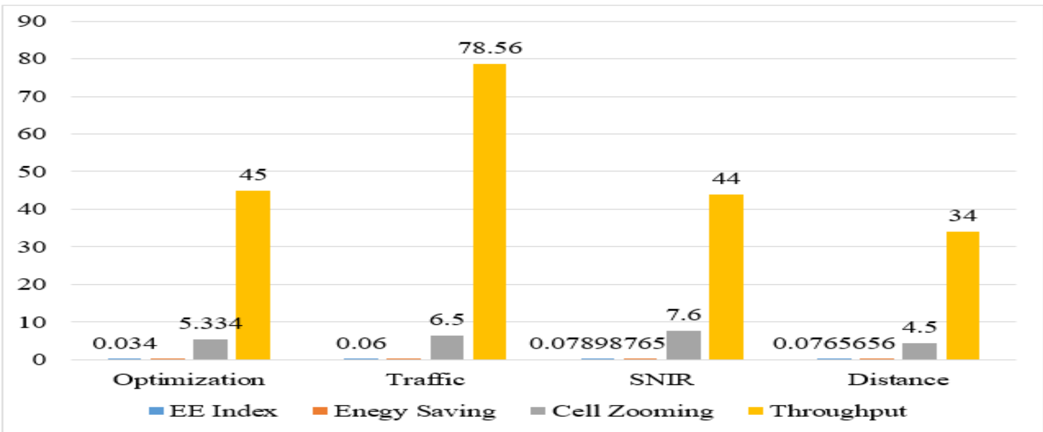

Figure 5. Energy saving by Cell Zooming

(Figure 6) presents the energy savings achieved by moving traffic demand to BS. The lesser the amount of vacant resource blocks, the higher the demand. However, as the LF level increases, all three energy-saving curves decrease, as seen in Fig. 5. It should be noted that the energy savings for the higher LF value are quite minor since they limit the ability of load balance. SINR is approximately 10% more energy-efficient than half-conscious distance. The percentage of energy saved in relation to load transfers, on the other hand, is obviously quantitatively equivalent in (Figure 6). By increasing traffic percentages, the system minimizes its overall energy use. Because the BS can go into sleep mode to save energy.

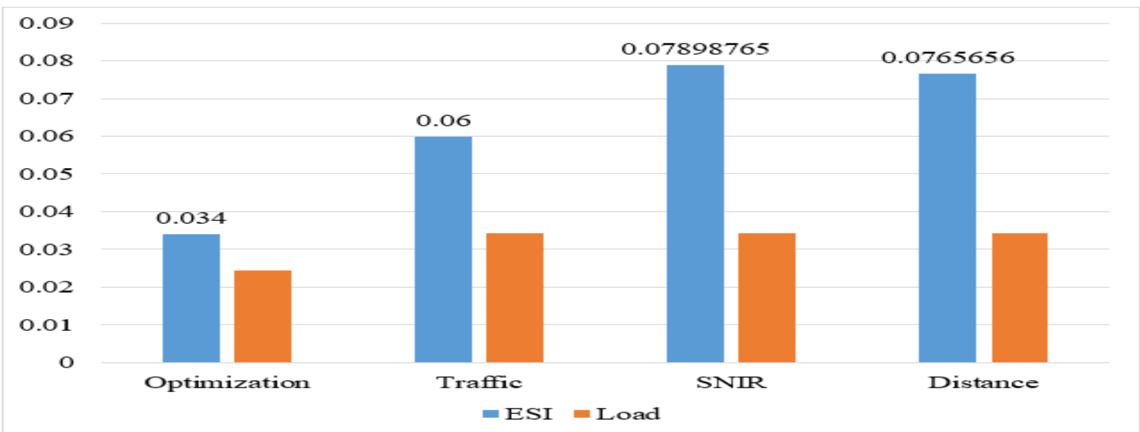

Figure 6. ESI with Load Factor

This Load balancing solution based on SINR drastically reduce the use of energy in grids. This is what makes it energy efficient. SINR-based systems clearly save 10% more energy when the amount of shifted load is increased from 6 to 20. Energy savings can be calculated based on the amount of load transferred to the surrounding BSs. The average energy loss depends on the number of BS sleeping hours each day, as shown in (Figure 7). As previously stated, increased sleep time leads to increased energy efficiency. By changing the load, the energy savings gap is seen in the same direction for additional hours of BS sleeping, as shown in the image. Given the unique Network topologies, the SINR conscious load shifting technique once again outperforms.

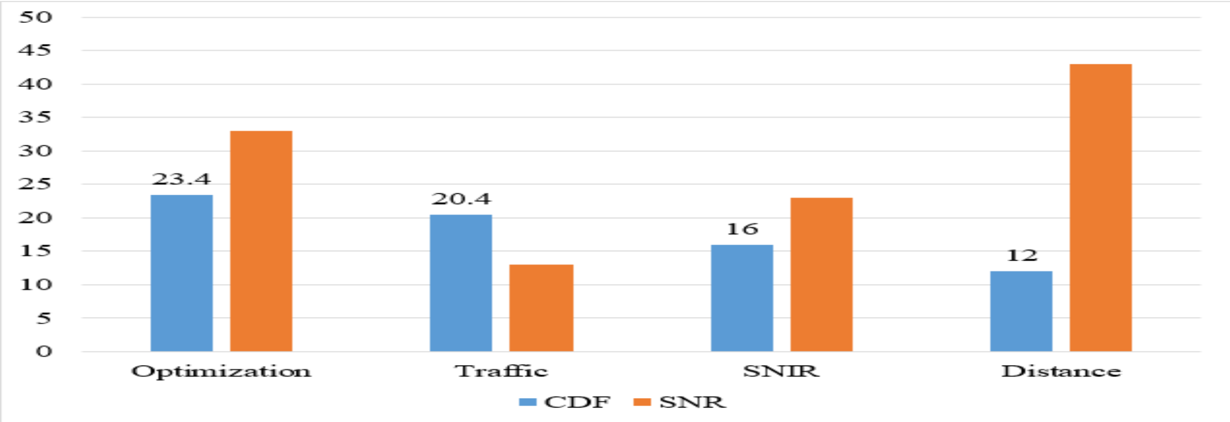

Figure 7. CDF with SNR

(Figure 8) illustrates a quantitative comparison of numerous EU association schemes using the energy savings index (ESI). The average grid saving energy percentage that combines the load balance technique with conventional technology is referred to as ESI. It should be noted that the traditional system includes a mobile hybrid system that does not take traffic transmission algorithms into account. All methods are projected to follow the trend movement by increasing the amount of zoom out, with SINR-based algorithms outperforming others. As the BS is entirely converted via traffic distribution in sleep mode, at 100% cell zoom levels, the current technique is about 22% more energy-efficient. SINR-based solutions, on the other hand, guaranteed 9% and 5% higher ESI performance as compared to distance and traffic knowledge techniques, respectively. The ESI display at various system bandwidths is shown in (Figure 9). If there are no RBs and the load factor falls, the ESI falls to zero.

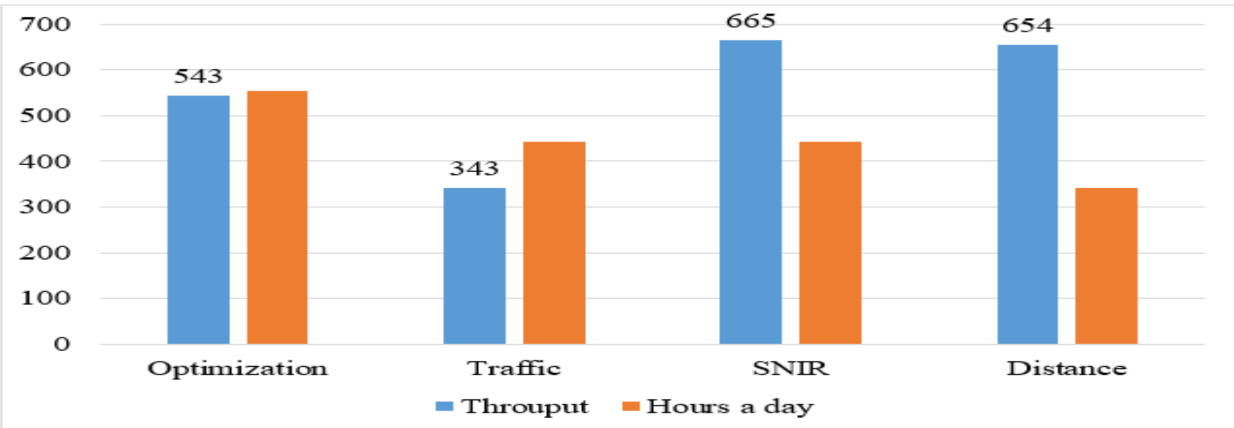

Figure 8. Throughput awareness

Please keep in mind that this simulation is based on the UE-BS SINR-based load-shifting approach. In fact, if the graph shows a rise in traffic arrivals, the energy-saving index performance with Zoom and CoMP decreases. The high operational bandwidth approach improves ESI performance by approximately 14%. A wide bandwidth typically allows for more RBs, lowering power consumption and efficiency.

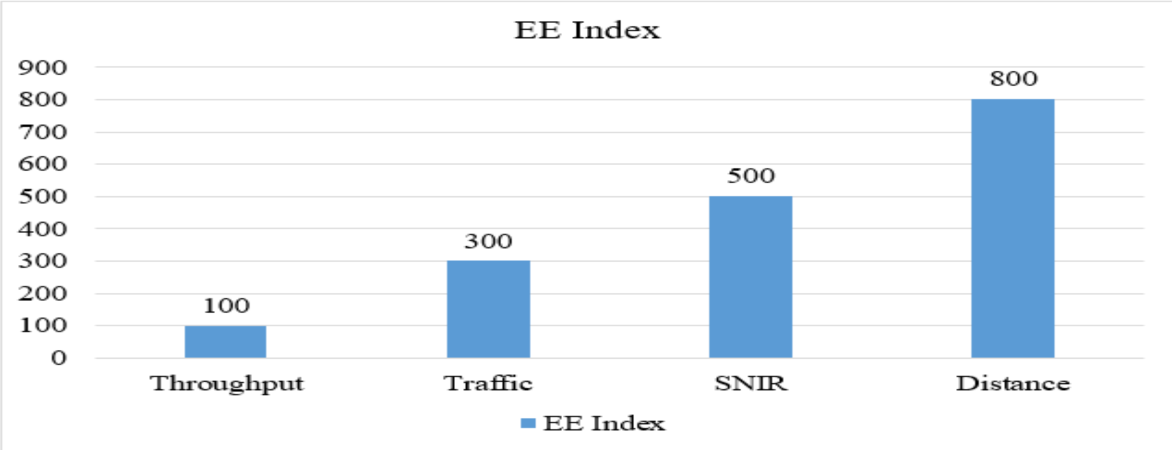

Figure 9. energy efficiency index.

(Figure 10) depicts a cumulative empirical distribution of the distribution throughout the user's two-tier network coverage. The system runs in a 10 MHz bandwidth and is completely filled by the RBs (i.e. =1). The Figure shows the considerable variance in the distribution of SINR between three probable techniques. As demonstrated, the DPS CoMP Technique (SINR aware) maintains its optimistic inclination over the whole SINR spectrum. The distance-conscious technique, on the other hand, produces negative results since it is dispersed throughout a wide range of SINR distributions. Meanwhile, the CoMP-enabled DPS algorithm achieves the lowest route loss and intercell interference, and hence the highest SINR quality in the UE over other systems. However, the traffic-conscious load balancing system falls between the other two systems since traffic management between adjacent cells is based on their capacity to carry the thresholds regardless of signal quality or UE-BS distances. Because of the stochastic nature of shadow fading, the nearest BS to the user is notably unable to provide the best signal quality. As a result, regardless of the connection distance, the user receives the highest signal level using the SINR technique.

6. Conclusion

The study examined a multi-point adaptive load balancing system for C-RAN networks for dynamic point selection. The development of long-lasting 5G cellular networks is the main objective of this study. that address energy efficiency and spectrum efficiency while taking full use of renewable energies and CoMP technologies within the constraints of available resources. With this in mind, the simultaneous integration of the cell zooming method enabled by CoMP substantially reduces utility grid usage to provide adequate signal quality.

References:

1. Kulkarni, A.V.K., et al. A Review on Energy Efficient Green Communication. 2020.
2. Li, B., Z. Zhou, and W. Zou, Ultra-spectra communication system (USCS): a promising way to energy-efficient green communication networks. EURASIP Journal on Wireless Communications and Networking, 2012. 2012(1): p. 47.
3. Li, R., et al., GM-PAB: A grid-based energy saving scheme with predicted traffic load guidance for cellular networks. 2012. 1160-1164.
4. Mahapatra, R., et al., Green framework for future heterogeneous wireless networks. Computer Networks, 2013. 57(6): p. 1518-1528.
5. Makki, B., T. Svensson, and M. Zorzi, Green communication via Type-I ARQ: Finite block-length analysis. 2014 IEEE Global Communications Conference, 2014: p. 2673-2677.
6. Malik, N. and M. Ur Rehman, Green Communications: Techniques and Challenges. EAI Endorsed Transactions on Energy Web, 2017. 4: p. 153162.
7. Mohamed, K.S., et al., Towards green communication in 5G systems: Survey on beamforming concept. IET Communications, 2021. 15(1): p. 142-154.
8. Mukhlif, F., et al., Green communication for cognitive radio networks based on game and utility-pricing theories. PLOS ONE, 2020. 15(8): p. e0235953.
9. Niu, Z., Green Communication and Networking: A New Horizon. IEEE Transactions on Green Communications and Networking, 2020. 4: p. 629-630.
10. Patil, A.P. and A. Goti, Green Computing in Communication Networks. International Journal of Computer Applications, 2013. 68: p. 1-5.
11. Pattnaik, S.K., et al. Future Wireless Communication Technology towards 6G IoT: An Application-Based Analysis of IoT in Real-Time Location Monitoring of Employees Inside Underground Mines by Using BLE. Sensors, 2022. 22, DOI: 10.3390/s22093438.
12. Penttinen, A. Green Networking-A Literature Survey. 2011.
13. Ramirez, I.U. and N.A.B. Tello. A Survey of Challenges in Green Wireless Communications Research. in 2014 International Conference on Mechatronics, Electronics and Automotive Engineering. 2014.
14. Rathore, R.S., et al., Green Communication for Next-Generation Wireless Systems: Optimization Strategies, Challenges, Solutions, and Future Aspects. Wireless Communications and Mobile Computing, 2021. 2021: p. 5528584.
15. Schmidt, J.S. and R.M. Corbin, Telecommunications in Canada: The regulatory crisis. Telecommunications Policy, 1983. 7(3): p. 215-227.
16. Wajda, W.M., et al. INFSO-ICT-247733 EARTH Deliverable D 2 . 3 Energy efficiency analysis of the reference systems , areas of improvements and target breakdown. 2012.
17. Wu, W., et al., Energy-Efficient User Association with Congestion Avoidance and Migration Constraint in Green WLANs. Wirel. Commun. Mob. Comput., 2018. 2018: p. 10.
18. Xie, Z., et al., Secured green communication scheme for interference alignment based networks. Journal of Communications and Networks, 2020. 22: p. 23-36.
19. Chilamkurti, N., S. Zeadally, and F. Mentiplay, Green Networking for Major Components of Information Communication Technology Systems. EURASIP Journal on Wireless Communications and Networking, 2009. 2009(1): p. 656785.
20. Bianzino, A.P., et al., A Survey of Green Networking Research. IEEE Communications Surveys & Tutorials, 2010. 14: p. 3-20.
21. Qian, L., J. Zhu, and S. Zhang, Survey of wireless big data. Journal of Communications and Information Networks, 2017. 2(1): p. 1-18.

22. Gandotra, P., R.K. Jha, and S. Jain, Green Communication in Next Generation Cellular Networks: A Survey. IEEE Access, 2017. 5: p. 11727-11758.
23. Hamdi, M., et al., Green Communication Networks Challenges, Opportunities and Future Role. Journal of Communications, 2020. 15: p. 256-262.
24. Farhan, L., et al. Energy Efficiency for Green Internet of Things (IoT) Networks: A Survey. Network, 2021. 1, 279-314 DOI: 10.3390/network1030017.
25. Imoize, A.L., et al. 6G Enabled Smart Infrastructure for Sustainable Society: Opportunities, Challenges, and Research Roadmap. Sensors, 2021. 21, DOI: 10.3390/s21051709.