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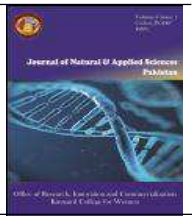

GREEN COMMUNICATION IN WIRELESS NETWORKS AND IOT

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Abstract

Wireless Communication is the developing, prolific and accepted area of the communication field. With the encroachment of technology, there is a considerable increase in the usage of mobile phones and other telecommunication devices. Green communication technologies pay particular attention to the wireless communication system to face the challenges of increasing mobile data. This paper deals with energy efficient wireless networks and energy conserving mechanisms within communication. The overall pattern of accomplishing proficiency in cell systems is propelling to acquire upgrade the foundation of the system. In this article, we present the most proficient method to enhance control effectiveness and backer advocate some techniques to improve wireless networks and energy conserving mechanisms. The IoT alludes to internetwork physical sensors, gadgets, and substances to empower gathering and trading information and signs. There are various ideas significant to green IoT in various settings, for example, green machine-to-machine correspondences, and green gadget to-gadget interchanges. We propose a specter to make an automation more productive.

INTRODUCTION

Green technologies have predictably become the design components of future communication systems. Energy efficiency has been as an important metric to access the performance of communication. The wireless network systems are relied upon to have unnecessary speed web access. The creating information activity and the prerequisite for pervasive access have upgraded the expansion of infrastructures of the network and it also accelerates energy demands. Wireless networks have grown to be crucial a part of contemporary existence. Wireless network systems are essentially green correspondence.

If we cannot utilize a wireless network system framework, we require a physical medium to convey a message from a source to a goal or goal to a source, which is not an efficient technique to enhance improvement in the green communication system. Data communication services decreases carbon dioxide. The vehicular wireless networks can affect their movement: traffic light, condition / synchronization, traffic congestion on the current route, useless high speeds. Regardless, the effect of interchanges arranges on a green planet can't be ignored.

“Green Communication” is designed a framework of telecommunication networks, which objectives to a boom of telecommunications networks of wireless networks. By an amplified vitality effectiveness of wireless frameworks, we reduce electromagnetic radiation. The essential method to diminish the energy consumption of a network is to remove critical or inexperienced communication. Efficient the communication system according to the user point of view is also a very important factor. From the client perspective, the energy efficiency mechanism means enhancement in the battery life performance of cellular terminals.

However, techniques to enhance the vitality proficiency execution just pointed the decrease of the power without contemplating the purported calculation control, i.e. the quality required for sign handling and in addition, encoding and translating, that is a key thing of the framework wide power utilization. The efficient energy consumption mechanism is an enormous major concern in green communications. Power efficiency in mobile networks is an intrinsically problem for cell operators We enterprise to make not only maintain the best hold effectiveness, but additionally to lessen the overall surrounding's consequences. This developing pattern of accomplishing vitality effectiveness in cellular systems is spurring experts and system administrators to consistently investigate future innovations.

The Internet of Things (IoT) is turning into an inescapable worldview that will significantly affect future ages of uses in numerous fields, including computerization, software engineering, broadcast communications, e-wellbeing and modern building. The effect of IoT is especially obvious in the expanding innovative work exercises in the field of modern models and procedures, and additionally in the inevitable cutting edge advances in various zones like the remote low power interchanges, independent framework, 5G. Given that IoT may help in preparing towards a general green "objective", the investigation on how the IoT, its design models, its conventions and advances and the subsequent applications can be characteristically "green" is a compulsory advance toward this path. Since various tradeoffs emerge when planning IoT systems administration and correspondence innovations while considering their vitality productivity, we anticipate getting unique surveys and research papers introducing new approaches, measurements, execution, estimation, test-beds, and results in the field of green IoT correspondences and systems administration.

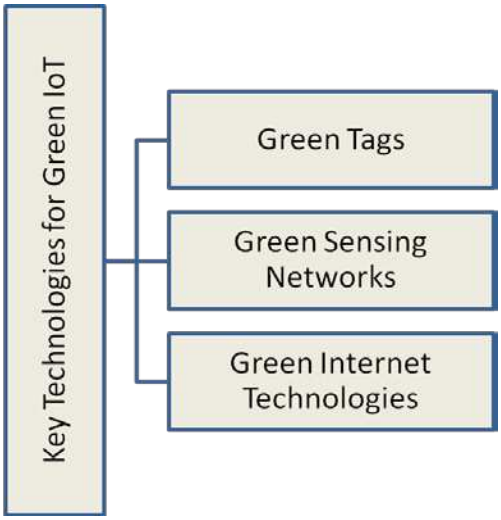

Figure 2: Technologies for Green IOT

The Green Internet of Things (G-IoT) is anticipated to present critical changes in our day by day life and would help understanding the vision of "green surrounding knowledge". Inside a couple of years we will be encompassed by an enormous number of sensors, gadgets and "things", which will have the capacity to convey by means of IP, act "cleverly", and give green help to clients in dealing with their assignments. These new savvy items will likewise be setting mindful and ready to play out specific capacities self-governing, calling for new types of green correspondence among individuals and things and between things themselves, where control utilization is improved and transfer speed use is boosted. This improvement would not exclusively be important to scientists, yet in addition to companies and people alike. It is henceforth the point of our workshop to concentrate on both structure and execution angles in green systems, or systems that can be used in giving green frameworks through IoT empowering advancements. In the meantime, our workshop call is open for themes important to IoT as a rule.

The experts and system administrators battled with accomplishing vitality productivity in cell systems to make a satisfying domain. This will ask moreover to procure redesigns the entire framework establishment. Thusly, in this paper, we talk about for what reason to spare vitality, where it must be connected and on what purpose of perspectives it has been considered. The quantity of clients requests information settlement in cell. Green correspondence remote system is the framework that perhaps utilizes vitality proficient systems administration advances, items and limiting assets. IT benefit divisions and information of association administrations are impressively expanding the vitality utilization of correspondence systems.

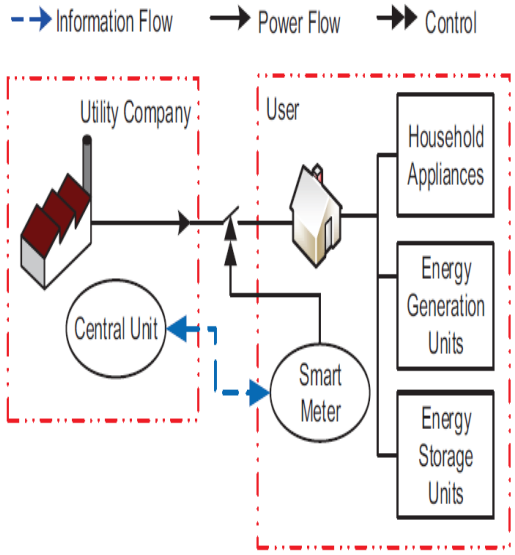

Figure 3: System model of smart grid

The proficient equipment gadgets likewise a basic factor in decreasing the vitality utilization of the framework. We present a short survey to overhaul in the cell frameworks and accomplice degreed examine some investigation issues and challenges to modify an imperativeness capable or "green" cell sort out. We will give a careful outline on methodology to get imperativeness sparing and enhancement in a web arrange system. We tend to propose an investigation vision to make these progressions greater essentialness capable and prepared.

LITERATURE REVIEW

"A CoMP Based LTE-A Simulator for Green Communications" [3] concludes that novel methods can be utilized to limit the vitality utilization and the proposed test system can be utilized for 5G innovations. The paper depicted a technique to use solar oriented vitality productively by embeddings solar based system on every BS. The proposed model can be actualized on a bigger scale and it is skilled and

proficient to deal with extensive power supplies.

The paper titled "Software defined energy harvesting networking for 5G green Communications" [4] proposed an energy exchanging model for hubs and different outcomes show that SD-EHN bolsters vitality planning which can enhance the vitality proficiency which can be utilized for vitality sparing. Vitality rich hubs are empowered to transfer surplus vitality to the portable charger, prompting a bidirectional vitality stream. This makes another worldview wherein vitality streams exist together with information streams, which offers ascend to new issues in controlling the vitality streams and information streams. Programming characterized organizing empowers brought together control to enhance stream booking. We propose SD-EHN engineering for 5G green communication.

The paper titled "A Green Communication Model for 5G Systems" [5] present a systematic model to ascertain the ideal number of little cells that should be kept dynamic at different occasions of the day keeping in mind the end goal to limit control utilization while meeting clients' nature of administration requests. In light of our basic examination of backhaul control utilization, we additionally detach and present two vitality proficient backhauling answers for 5G Het Nets. Reproduced results uncover that the proposed green correspondence display sets aside to 48% more power than other existing models.

The paper titled "Energy-Efficient Device-to-Device Communications for Green Smart Cities" [6] proposed to manage the subcarrier task sub problem and a power conspire was additionally made to explain the non-convex control distribution sub problem. D2D correspondence has been perceived as one of the key advances to enhance information rate and diminish control utilization, which permits two physically close-by found user equipment to discuss specifically with one another.

"A solar energy solution for sustainable third generation mobile networks" [2] presents the sending and operational issues of a solar based fueled widespread versatile media communications framework that is presently conveyed. Furthermore, this investigation utilizes a half breed improvement for an electric inexhaustible programming test system created by the American national renewable energy laboratory. Four key viewpoints are examined in this examination: ideal nearby planetary group design, vitality generation, the income of the solar oriented fueled must node b venture, and the monetary plausibility of a sunlight based controlled framework contrasted and customary sources.

"Techno-economic evaluation of a stand-alone power system
based on solar power/batteries for global system for mobile communications base stations" [9] paper issues of organization and activity of two solar powered worldwide framework for versatile interchanges that are being conveyed
at present (gsm bs 2/2/2 and gsm bs 4/4/4). The examination depends on the qualities of solar based radiation presentation. The ideal criteria and financial and specialized plausibility for different bss are break down utilizing a cross breed streamlining model for electric renewable. Furthermore, initial capital, substitution, tasks, upkeep, and aggregate net present expenses for different solar oriented controlled bss are talked about.

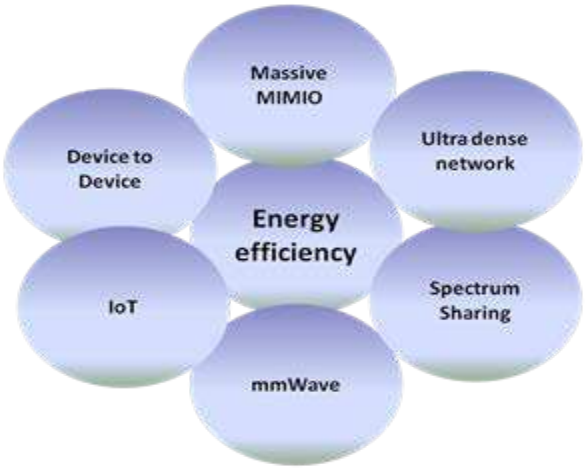

Figure 4: Energy Efficient Network

"Optimization design and economic analysis of energy management strategy based on photovoltaic/energy storage for heterogeneous cellular networks using the homer model" [10]. The present study to address the maintainability of intensity assets and natural conditions for heterogeneous cell systems. Furthermore, this investigation thinks about the practicality of

utilizing a solar power framework to nourish heterogeneous cell systems versus a traditional vitality source i.e., people in general electric matrix. This investigation demonstrates that the organization of the solar based power framework can acceptably meet the vitality needs of the base stations in heterogeneous cell systems cost successfully, productively, economically, and dependably and can enhance arranging by giving cleaner vitality.

"Performance analysis of the energy consumption of the scheduling algorithms in long term evolution ITE (long term evolution) networks" [15] represent four distinctive planning calculations were examined to be specific, the Channel and Quality of Service Aware Proportional Fair, CQA Frequency Fading, Priority Set Scheduler Proportional Fair (PSS_PF), and PSS Carrier Over Interference to Average in light of the execution measurements of throughput, delay, vitality, utilization proportion (ECR) and decency. The outcomes demonstrated that the CQA calculation for the two strategies (CQA_PF and CQA_Ff) beat alternate calculations since it has the most noteworthy throughput with an expansion of up to 25%. In the time, for postponement and ECR, the CQA scheduler was the most reduced of up to 20% when contrasted with the PSS scheduler.

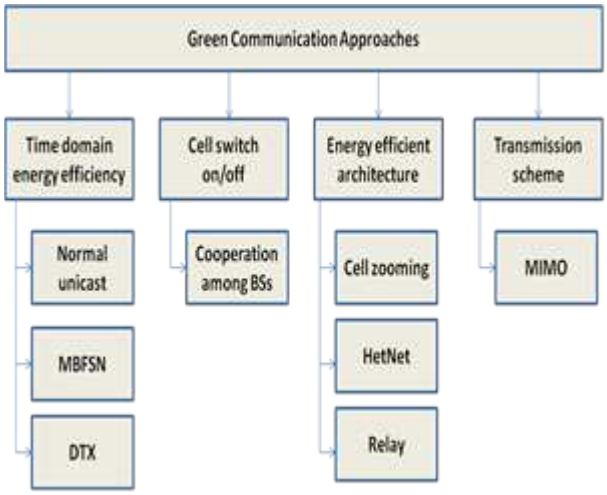

Figure 5: Classification of green communication

"Multi-factorial Energy Aware Resource Management in Edge Networks" [13] planned Network Device Power Model to investigate the power dispersal attributes of recurrence versatile devices. On-request Energy-proficient Resource Allocation display is composed in light of this model. OERA highlights acknowledgment proportions that are 11% - 17% higher than existing arrangements and 9% bring down power utilization. A novel calculation is displayed for asset arrangement in edge systems, which can oblige higher activity stream requests and dissemination separate than existing arrangements. This uses Mixed Integer Linear Programming to at the same time augment the total stream requests and to limit the system vitality utilization. An Iterative calculation and heuristic Greedy Edge Network Device Placement calculation are executed that tackle this NP-Hard issue, as well as altogether diminish the system vitality utilization.

In "Remote sensor organizes: a review, Computer Networks " [17] the creator purposed of research is to comprehend the practicality of IoT in transport transportation framework in Singapore. The Singapore, which is in fact exceptionally progressed yet at the same time has extent of headway in their transportation framework the made a framework by the utilizing the IOT for the customer to comprehend and assess distinctive transport alternatives in a proficient way. Auxiliary research was utilized to anticipate landing timings of transports and additionally the group inside each transport.

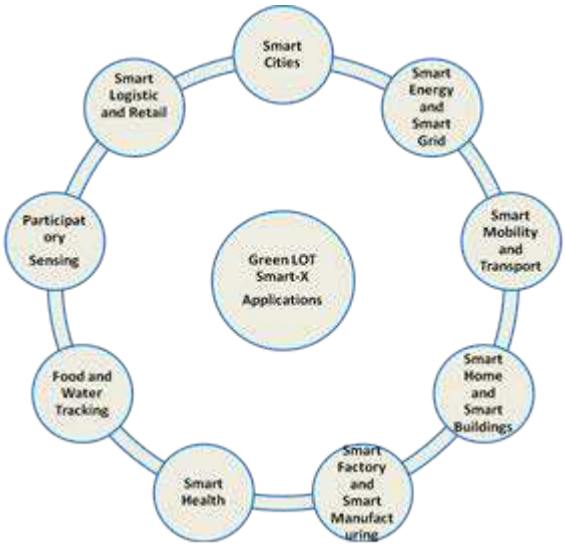

Figure 6: Green IoT application

"Usage of web of things in transport arrangement of Singapore" [12] presents a three-layered system development of Internet of Things (IOT) specialized strategy for high-voltage transmission line which includes the remote self-sorted out sensor organize (WSN), optical fiber composite overhead ground wire (OPGW), general bundle radio administration (GPRS) and the Beidou (COMPASS) route satellite framework (CNSS). The technique can address the issues of interconnection between the observing focus and terminals, lessen the terminals‟ GPRS and CNSS setup and OPGW optical passageways, and guarantee the on-line checking information transmission continuous and dependable under the circumstance of remote area, extraordinary climate and other ecological conditions.

PROBLEM STATEMENT

The rapid development of wireless communication correspondence empowers devices to speak with one another and trade data to perform ideal control or show important data. However, lacking cooperation among mobile node is not only a low communication quality, but also imbalances of the resource utilization in mobile wireless networks and hence, greatly increases the unnecessary energy consumption. The objective of Green Communication is to guarantee that correspondence frameworks expend less vitality and an efficient wireless network system. Low vitality utilization is critical factor to diminish the expense of expanding the portable administrator's vitality charge. The vitality utilization ought to at any rate be kept at indistinguishable level from today (in spite of the movement development, the monstrous measure of gadgets, and new necessities), however we trust that it is conceivable to go more remote than that.

There are a few difficulties identified with the arranging, creating and overseeing of frameworks for IoT applications, and one of these difficulties requires arrangements that can make IoT a green and a vitality productive worldview. Actually, the misuse of remote sensors, self-sufficient frameworks (robots, vehicles, UAVs), Machine-to-Machine, modern and therapeutic IoT and other comparative innovations will require on the one side improved interchanges and systems administration capacities and on the opposite side their maintainability and power effectiveness, particularly for wide-scale organizations of IoT applications.

Be that as it may, the greenness of IoT is essential for the accomplishment of IoT. In particular, different things (e.g., sensor gadgets, cell phone terminals, distributed computing frameworks) in IoT are devouring a lot of vitality. In addition, the association of things (e.g., RFID organize, GPS arrange, 5G organize) in IoT is with generous vitality utilization. At long last, the cooperation of things (e.g., information detecting, information interchanges, information registering) in IoT needs a considerable measure of vitality. Specifically, with the predominance of cell phones, electronic gadgets, cameras, interpersonal organizations, web based life, and so on., our reality is creating huge information and sight and sound enormous information, which further total the vitality request as far as the information transmission of IoT.

PROPOSED SOLUTION A HYBRID APPROACH

There are various diverse difficulties and necessities that systems should have the capacity to deal with later on. Probably the most essential ones from a green plan point of view will be talked about in the accompanying subsections.

A. Data traffic efficiency

Today, there are more than 2 billion systems broadband memberships around the world. Hence, clearly portable frameworks later on should be equipped for conveying essentially more limit than today. This pattern is imperative likewise from a green outline point of view, since the portable system advancement (an extra organization of heritage 2G-3G-4G gear and establishment of new and productive 5G innovation) ought to be performed by dodging the danger of an outlandish over-provisioning of the system that in this situation will turn out to be increasingly unsustainable as far as expenses. The keys of the data traffic efficiency are:

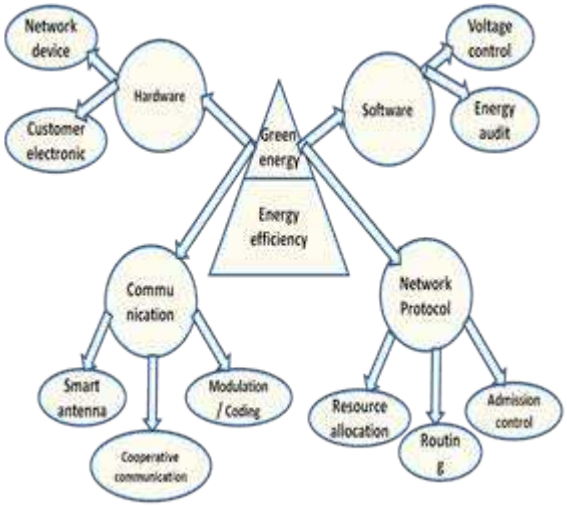

Figure 7: Utilization of green communication

- Dissect the execution of various plans that arrangement with channels and utilize a most extreme of N channels to convey the information.
- The normal effectively conveyed bits per vitality utilization utilized in this correspondence occasion.

In this paper, considered the split range system for limiting the cross-level impedance. To maintain a strategic distance from the obstruction between little cell organizes inside a similar level in 5G arrange, we considered the static recurrence reuse conspire. In this methodology, neighboring cells utilize diverse range to dodge obstruction for clients in their individual cells. The accessible transfer speed is part into sub-
groups, and every phone transmits on non-meddling sub-groups.

In this exploration, we consider the transient and spatial change attributes of system activity. This is valuable to explore the vitality effectiveness for system administrators in low and high load states of movement loads, which catches three sorts of activity data (i.e., conversational, gushing, and background) in a zone. Conversational movement (high need, for example, voice and video conferencing is exceptionally postpone delicate. Spilling activity (medium need, for example, gushing sound and video, has moderately less postpone affectability than conversational movement.

Then again, foundation activity (low need, for example, email, ftp, and telnet, utilize organize assets when the other two movement requests are completely fulfilled, add up to activity request is relied upon to surpass the accessible transfer speed in a full-scale cell amid pinnacle hours. To limit the entrance, organize control utilization, we have to ascertain the correct data transfer capacity prerequisite amid different hours of the day. This area presents transfer speed necessity details of a full-scale cell, utilizing the activity stack profile for the framework display. These details will be utilized to demonstrate the entrance organize control utilization.

B. Energy Consumption

Vitality effectiveness upgrades through system organization procedures have been contacted upon in a few ventures. 5G system can be viewed as an ultra-rapid innovation. Distributed computing, Internet of things (IoT), and (SDN) have turned into a portion of the center innovations for the 5G arrange. Cloud-based administrations give adaptable and proficient answers for data and interchanges innovation by lessening the expense of putting resources into and overseeing data innovation foundation. Case of the organization procedures are distinctive topologies of cells, disseminated reception apparatus frameworks and base station participation. Particularly heterogeneous system organizations, where little cells are sent under an umbrella large scale cell inclusion, have increased extraordinary intrigue and have been introduced as a promising answer for enhancing vitality productivity. This is because of the way that if effectively put the little cells can altogether offload the full-scale cells with a general vitality sparing as result.

Keeping in mind the end goal to deal with the future limit requests and the gigantic measures of various gadgets, it is normal that considerably denser organizations, purported ultra thick arrangements, will be fundamental. The keys are as pursues:

- A system model is utilized to spares control by putting excess little cells into rest mode.

- Selective-retransmission plans are utilized to bargain
- with different channel frameworks.
- Analyzed as far as possible and normal deferral for the plans. Despite the fact that observing the execution of different measurements is critical.
- The vitality effective backhaul presented to supplement 5G get to organize.

Consider a correspondence interface between a transmitter and a recipient with autonomous channels utilizing distinctive recurrence groups. The information goes through the channels after legitimate coding, adjustment and sequential to parallel stream transformation. We expect the accessibility of a solitary criticism bit for every channel between the transmitter and the beneficiary.

If there should be an occurrence of pronouncing blackout, the collector sends one-piece criticism to the transmitter asking for information retransmission. Both the transmitter and the beneficiary are outfitted with supports, where the transmitter utilizes it to hold the information until accepting positive affirmation from the recipient. Then again, the beneficiary uses it to store the past perceptions to be utilized in joint discovery when blackout situation is accounted for.
The transmitter continues transmitting similar information until the point that fruitful or N-transmissions are depleted.

Other diverse plans that convey a similar measure of information with different assets utilization abilities. The plan manages various channels framework that can't change the transfer speed of their channels. Also, the recipient isn't furnished with any supports, in this manner it translates the present perception autonomously of the past ones. Subsequently, the input is sent by the recipient to the transmitter just dependent on current perception for each channel. The transmitter retransmits similar information along the channel when it gets a negative affirmation from the collector. Then again, it quits transmitting similar information in the event that it gets a positive affirmation. The recognition procedure is done just dependent on the current transmission round. Same process is rehashed till every single transmitted datum is recognized accurately or a greatest number of transmissions is come to.

C. Energy Efficient for IOT

Creative green correspondences advances and conventions appropriately intended for the IoT; structures, ideas, techniques and instruments for arranging and designing green IoT correspondence stages and systems administration frameworks; green IoT applications and consequences of their functional organization.

The base stations work in three unmistakable operational states as Sleep, Active and Overload. Minor movement conditions realizing low use of a base station results in the base station going into Sleep state. The base station working in Sleep mode endeavors to use vitality required just to help essential tasks, in this manner diminishing in general utilization. All the approaching movement is given over to the dynamic base stations until the point that they are over-burden. An endeavor is made to serve the greatest approaching movement with least dynamic base stations to preserve vitality. This endeavor is however constrained by extraordinary conditions like call drops happening by redirection of UE to base stations situated over a long separation and over-burden dynamic base stations. So as to determine these extraordinary conditions, a base station is restored from Sleep state to serve a region related to high movement loads. In the event that the asked for asset for the base station is inside the ordinary scope of use, the base station guarantees most astounding QOS/QOE for the client, hence entering an Active state.

The Green Cellular Algorithm works in the accompanying grouping:

- If (UE asked for data transfer capacity assets)
- then Base Station register for data transfer capacity
- If (requested Base Station inside typical scope of use)
- then the Base Station serves the UE.
- If (requested Base Station > typical scope of use)
- then limit a gathering calculation is started pointed towards load adjusting over the system.

- If (requested Base Station < ordinary scope of use)
- then the Base Station is turned off and the UE is given over to a functioning base station with most astounding serving limit.

The gathering estimation is begun by the central control unit if the base station is requested information transmission resource higher than the commonplace range limit yet not as much as its most prominent serving limit. All the base stations are related with the central unit checking the LA (Local Area), which keeps up the benefit status of the framework related with it. The central control unit keeps up information for each base station identifying with its utilization and the serving state it is in this moment.

RESULT DISCUSSION

The capacity to convey correspondence administrations at least vitality cost (i.e. Green correspondence) is a key outline
issue in the rising remote systems. This paper has introduced hybrid model in the 5G to enhances the data traffic efficiency. Rather, advanced versatile systems ought to fulfill the expanding activity request by an adaptable accessibility of limit, (in time and space) keeping in mind the end goal to maintain the information rate improvement that has been seen amid ongoing decades.

The examination for Green Communications is an
interdisciplinary exertion since it relies upon different regions
from PC engineering to systems administration. The need of

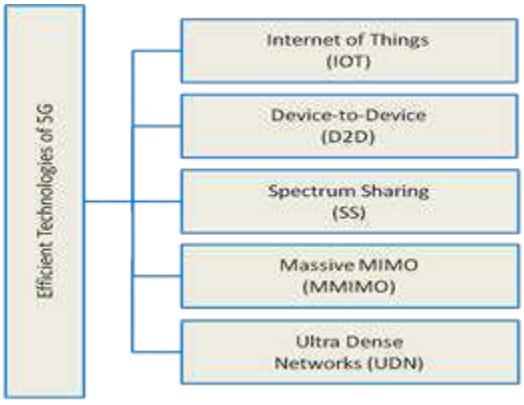

Figure 8: Technologies for 5G

embracing Green Communication has been acknowledged around the world. Green Communication has been realized worldwide. System densification utilizing little cells is relied upon to play a noteworthy job in the data transfer capacity shortage issue of 5G frameworks. Be that as it may, organize densification presents another measurement of issue as higher power utilization. From the result of our examination, it can be presumed that our green correspondence demonstrate expends a lot of less power than existing arrangements. A critical end drawn from this examination incorporates that the expanded power utilization issue credited by organize densification, can be relieved, as it were, by utilizing systems, where repetitive components are put into rest mode.

CONCLUSION

This paper displays an outline of the vitality utilization issues of remote correspondence organizes and depicts the systems that have been utilized to enhance the vitality effectiveness of these systems. Multiple approaches based on changes in traffic load is possible and can help to maximize energy savings under low downlink traffic conditions. For instance, the traffic loads in the areas are low for long periods of time, especially at night and over weekends and holidays. Precedents of such difficulties incorporate VoIP calls or video streaming loading with no postponement, similarity between signaling loads and channel capacity, and communication overhead due to handovers. Compatibility between the signaling load and channel capacity, inter cell interference, coverage, and the maximum capacity achievable are all issues that need to be further studied and analyzed thoroughly.

IoT turns into an utility with expanded advancement in detecting, activation, correspondences, control, and in making information from huge measures of information. This paper has given answers for battery-worked IoT gadgets from remote systems administration viewpoints. The surviving arrangements have handled different operational parts of IoT gadgets, including the modification of obligation cycles,

impact/clog shirking plans, systems to oversee gadget rest time by turning off radios or expanding a backup time, effective radio asset booking, the shrewd choice of heterogeneous radio interfaces, etc. The genuine appropriation of the arrangements onto IoT gadgets ought to think about a blend of joined remote radio access innovations.

This paper has analyzed the writing in regards to developing IoT innovations and their vitality moderating issues from an explicit point of view of remote systems administration. It will include to other ongoing reviews IoT, for example, vitality proficient mixed media gushing, correspondence standard bodies, and IoT semantics. Overhauling the SDRs at present executed to LTE handsets having MIMO highlight will bolster usage for an abnormal state of information streams and adaptability.

REFERENCES

Rong Yu, Jiawen Kang, Yue Gao, Sabita Maharjan, Xumin Huang, "Software Defined Energy Harvesting," IEEE Wireless Communications, 2017.

E. Veldman and R. A. Verzijlbergh, ""“Distribution grid impacts of smart electric vehicle charging from different perspectives"," in IEEE Trans. Smart Grid, 2015.

and Padmavathy N. Sasi Kiran Sajja, "Green Communication: An Emerging Telecommunication Technology-Its Research Challenges, Techniques and Applications," Information, Communication and Computing Technology, 2017.

Q. Zhu, Y. Zhang, S. Gjessing, and T. Basar S. Maharjan, "Dependable demand response management in the smart grid: A stackelberg game approach," IEEE Trans. Smart Grid, 2013.

Marcel Ohanga Odhiambo and Weston Mwashita, "Base Station Energy Efficiency Improvement for Next Generation Mobile Networks," International Journal of Electronics and Telecommunications, 2017.

Md Munjure Mowla, Iftekhar Ahmad, Daryoush Habibi, and Quoc Viet Phung, "A Green Communication Model for 5G Systems," IEEE Transactions on Green Communications and Networking, 2017.

Rosdiadee Nordin, Nor Fadzilah Abdullah, and Anabi Hilary Kelechi Mohammed H. Alsharif, "How to make key 5G wireless technologies environmental friendly: A review," Transactions on Emerging Telecommunications Technologies, 2017.

K. Wang, and L. He M. Gao, "Probabilistic model checking and scheduling implementation of energy router system in energy internet for green cities," IEEE Trans. Ind. Informat, 2018.

Pengcheng Liu, S R Chaudhry, Tao Huang, Xiaojun Wang, and Martin Collier, "Multi-factorial Energy Aware Resource Management in Edge Networks," IEEE Transactions on Green Communications and Networking, 2018.

H. Ghazzai and A. Kadri, ""“Joint demand-side management in smart grid for green collaborative mobile operators under dynamic pricing and fairness setup”," IEEE Trans. Green Commun. Netw, 2017.

Y. Wang, X. Hu, Y. Sun, D. J. Deng, A. Vinel, and Y. Zhang K. Wang, "Wireless big data computing in smart grid," IEEE Wireless Communication, 2017.

X. Hu, H. Li, P. Li, D. Zeng, and S. Guo K. Wang, "A survey on energy Internet communications for sustainability," IEEE Trans. Sustain. Comput, 2017.

H. Li, Y. Feng, and G. Tian K. Wang, "Big data analytics for system stability evaluation strategy in the energy Internet," IEEE Trans. Ind., 2017.

Ekata. (2016, Nov) Diagnosis of Pulmonary Tuberculosis using fuzzy Inference System. [Online]. HYPERLINK "http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7918726&isnumber=7915403"

Member, IEEE, Hui Li, Lei Xu, Yuzhou Li, Member, IEEE, and Tao Jiang, Senior Member Caihong Kai, "Energy-Efficient Device-to-Device Communications," IEEE Transactions on Industrial Informatics,

2018.

Priti Deb, and Debashis De Anwesha Mukherjee, "Natural Computing in Mobile Network Optimization," Natural Computing for Optimization Problems, 2016.

Mohammed H. Alsharif, "Techno-Economic Evaluation of a Stand-Alone Power System Based on Solar Power/Batteries for Global System for Mobile Communications Base Stations," Energies, 2017.

Mohammed H. Alsharif, "Optimization design and economic analysis of energy management strategy based on photovoltaic/energy storage for heterogeneous cellular networks using the HOMER model," Solar Energy, 2017.

Mohammed Alsharif, "A Solar Energy Solution for Sustainable Third Generation Mobile Networks," Energies," 2017.

Ramoni O. Adeogun, "A Novel Game Theoretic Method for Efficient Downlink Resource Allocation in Dual Band 5G Heterogeneous Network," Wireless Personal Communications, 2018.

Abu Jahid and Md. Farhad Hossain Abdullah Bin Shams, "A CoMP Based LTE-A Simulator forGreen Communications," IEEE WiSPNET 2017 conference, 2017.

K. Pappi, P. Kong, and G. Karagiannidis P. Diamantoulakis, ""Game theoretic approach to demand side management in smart grid with user dependent acceptance prices"," IEEE 84th Veh. Technol. Conf., 2016.

J. Ma, and L. Song P. Wang, "Balanced interest distribution in smart grid: a Nash bargaining demand side management scheme"," IEEE Global, 2016.

Y. Qian, and R. Q. Hu F. Ye, ""A real-time information based demand-side management system in smart grid"," IEEE Trans. Parallel Distrib. Syst., 2016.

G. Anandini, and M. Gupta I. Gupta, ""An hour wise device scheduling approach for demand side management in smart grid using particle swarm optimization"," National Power Syst. Conf., 2016.

X. Yu, W. Yu, G. Chen, and J. Wang C. Li, ""Efficient computation for sparse load shifting in demand side management"," IEEE Trans. Smart Grid, 2017.