Energy Consumption Paradigms in 5G and 6G

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Abstract
The wireless market has grown tremendously over the past decade. After every ten years' new wireless technology is introduced in the market and continues to do so, with the increase in the requirement of large coverage areas and an increase in the number of users. It is challenging to full fill the demands of subscribers especially in the context of minimum operation cost for the mobile network operators (MNOs). The intensification in the demands of resources is constantly growing globally. So, Energy consumption is the main challenging state for MNOs. After fourth-generation(4G) of wireless technology 5G is successfully launched this year by some companies Also sixth-generation(6G) work is started to tackle the future requirements. In this paper the researcher highlights the energy consumption aspects in future technologies and focuses on the technologies which can enable a low power consumption smart environment. Make a comparison of different methods and technologies which can reduce the energy use in cellular networks. These technologies recently attract the world attention to think and analyze their potential industry of wireless communication. Significant technical challenges regrading energy consumption in 5G and 6G are concern in this work.

Keywords:
Fifth Generation(5G), Sixth Generation (6G), Information and Communications Technology (ICT), Energy consumption (EC) Quality of Experience (QoA), Wireless energy transfer (WET), Mille Meter Wave) MM Wave, Multiple input, Multiple output (MIMO), Index Modulation(IM)

1. Introduction

Wireless networks have significant role in this fast growing society communication needs. Day by day Cellular networks are emerging with potential techniques and innovations [1]. Which inspire the users to adopt the new modification in networks. In last ten to fifteen years' wireless networks communication have significant revolution. The wireless communication generations are basically shows the speed, data rate, transmit rate and network standard which is used in this generation. Massive increase in the data is not fully expected to handle in current year launched fifth generation(5G). There has been a vast advancement in wireless networks and still its continues. To handle the upcoming challenges are expected to control in 6G commination technology. The study focused on the hurdles and the primary driver comparison of 5th generation and 6th generation wireless networks on the basics of energy. These technologies recently attract the world attention to think and analyze their potential industry of wireless communication.

1.1 Wireless technolgy growth trends

Studies shows that there is vast advancement in the mobile communication. It is possible due to the coming of interactive the user friendly screening and variety of available options in choosing mobile technology. Here is a stats shown in [16, Fig.1]

Almost after every ten years a new mobile communication generation is introduced with new facilities and features. The concept of smart city and global village directly affect the wireless communication demands. Mobile communication is tremendously increase because of these technological concepts. The massive growth of traffic will be more than 67% is expected in upcoming decades [17].

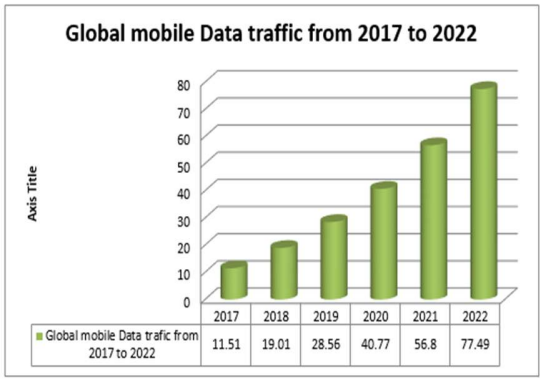

Fig. 1. Global mobile traffic trends

1.2 Fifth generation (5G) wireless technology

Andrews and Boccardi work shown that 5G systems will be deployed in about to 2020 [12]. The fifth era of versatile innovation (5G) is currently serving and accepted to full fill the business needs. The

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correspondence and request of a completely associated society dream is getting valid as far as manageability, efficiency, and prosperity. To portrayed a completely associated society in term of traffic rate and development in cell phones there will be required a multi-layer densification arrange which empowers the need of business.

Thusly, in 5G, there is a need to push the envelope of execution to give, where required, for instance, a lot more prominent throughput, much lower idleness, ultra-high unwavering quality, a lot higher availability thickness, and higher versatility go. By picking these it is relied upon to make a maintainable and exceptionally control heterogeneous condition which increment the presentation and capacity and security [12].

While expanding the presentation envelope of versatile systems, 5G ought to incorporate by configuration installed adaptability to streamline the system use, while pleasing a wide scope of utilization cases, business and association models. The 5G engineering ought to contain the secluded system works that could be sent and scaled on request, to meet the different expense and ability requests.2 Procedure for Paper Submission

1.3 Sixth generation (6G) wireless technology

With the development and approaching commercialization of the 5G, the desire and improvement of the 6G versatile system have pulled in a lot of consideration. In these years numerous districts show they are beginning exploration on 6G Like, the European Union propelled an examination venture on the essential 6G innovations. The fundamental focal point of the examination to discover the mistake adjustment coding, channel balance advances for remote terabit arranges, and propelled channel coding for the new age of remote advances. (https://futurecomresearch. EU). In 2017 numerous organizations of China like Hawaii started to contemplate the 6G versatile correspondence framework to meet the irregular and rich requests of the Internet of Things (IoT). (www.china.org.cn). Finland reported an eight-year inquire about the program, "6Genesis," to conceptualize 6G through a joint exertion of the University of Oulu and Nokia in 2018. All the more as of late, the U.K. government has put resources into some potential procedures (e.g., €15 million in quantum innovation examines) for 6G and past (https://www.standard.co.uk/tech/quantumtechnologies), a few colleges in the United States have propelled inquire about on terahertz-based 6G remote systems, and South Korea Telecom (SKT) has begun 6G investigate dependent on the sans cell and non-earthbound system methods. "Another worldview of remote correspondence, the 6th era (6G) framework, with the full help of man-made consciousness is relied upon to be conveyed somewhere in the range of 2027 and 2030"[31]. To conquer the imperatives of 5G for supporting new difficulties, a 6th era (6G) remote framework should be created with new alluring highlights. The key drivers of 6G will be the union of all the past highlights, for example, organize densification, high throughput, high unwavering quality, low vitality utilization, and monstrous network. The 6G framework would likewise proceed with the patterns of the past ages, which included new administrations with the expansion of new advances [13]. The new administrations incorporate AI, keen wearables, inserts, self-ruling vehicles, processing reality gadgets, detecting, and 3D mapping [4]. Man-made reasoning is the most significant and recently presented innovation for 6G correspondence frameworks [5].

1.4 Energy consumption (EC)

Energy is costly for administrators and clients and its creation has natural impacts. Present-day cell systems have the most versatile and strong end-clients organization as the drawn-out development. The exponential development in cell phone clients (with Internet-based applications) requests a high information rate, less data transmission utilization, and least postponement based correspondence and they are relative to high energy utilization [2]. It rouses the scientists to present a new front line specialized strategy, which should bolster the high information rate, least data transfer capacity use, least Energy utilization, moderate and best start to finish Quality of Experience (QoE) [3],[4].

The innovation utilized for remote transmission utilize more energy than LTE correspondence devours. The energy effectiveness of the systems is a key factor to limit the TCO, alongside the ecological impression of systems. In that capacity, it is a focal plan rule of 5G. Energy proficiency is characterized as the quantity of bits that can be transmitted per Joule of energy, where the energy is registered over the entire system, including conceivably inheritance cell advances, Radio access, and Core systems, and server farms. 5G should help a 1,000 times traffic increment in the following 10 years' time period, with an energy utilization by the entire system of just a large portion of that commonly devoured by the present systems. This prompts the necessity of an energy productivity increment of x2000 in the following 10 years' time period. Each exertion ought to be made to acquire the energy gain without corrupting the exhibition, however the innovation should permit local adaptability for the administrator to arrange exchange off between energy productivity versus execution where advocated.

1.5 Motivation

World resources are tremendously declining due to the conversion of all work on the machine and make it more reliable and fast for humans. Now there is an issue with 5th generation and 6th generation wireless technology. Here are the paradigms which are discussed the energy consumption in wireless technologies. In this paper discuss the methods which can be helpful for overcoming and scale down the power consumption and the modern generation.

2. Backgroud

2.1 literature review

A study conducted in Ahmedabad, India by Ms. Lopa J. Vora in which mobile technologies and generation evaluation are review the concern the most prominent technologies will be used in 5G [6].

A comprehensive and detail article is published by Federico Boccardi, Robert W. Heath, Angel Lozano, Thomas L. Marzetta and Petar Popovski in IEEE magazine about 5G. "This article describes five technologies that could lead to both architectural and component disruptive design changes: device-centric architectures, millimeter wave, massive MIMO, smarter devices, and native support for machine-to-machine communications. The key ideas for each technology are described, along with their potential impact on 5G and the research challenges that remain" [12].

In 2019 Yajun Zhao and Hanqing Xu publish a paper about 6G mobile communication in which discussed the future vision if 6G and fundamental technologies like use of AI based communication and their challenges [13].

In October 2019 Walid Saad, Mehdi Bennis and Mingzhe Chen published a paper about 6G technologies they briefly discussed the complete road map towards 6G wireless networks also discussed the future expected technologies and the firstly concern the problems in existing technologies and find the primary key driver for 6G [4].

In 2019 Ping Yang, Yue Xiao, Ming Xiao, and Shaoqian Li sketch the potential prerequisites and present a review of the most recent research on the promising strategies advancing to 6G, which have as of late pulled in impressive consideration. In addition, purpose a layout various key specialized difficulties just as the potential arrangements related to 6G, including physical-layer transmission methods, organize plans, security draws near, and testbed improvements. [29].

In 2020 Giordani and his co-researcher discussed the use cases and technologies to meet the fully connective society demands in 6G networks [26].

Sennur Ulukus with six other authors briefly describe and "summarizes recent contributions in the broad area of energy harvesting wireless communications and How the wireless networks are harvesting the energy" also focus on new models and key factors and techniques like energy transfer are focused to get appropriate solution of problem [18].

3. Discussion and Results

EC is the most discussed topic in these years. Energy Resources are the main backbone of a wireless technology. To understand the energy consumption in modern generation we first understand "How to calculate the energy consumption in a wireless technology?". Here is the formula which is used to calculate the energy.

3.1 Formula

In term of EC in wireless technology is to get the benefit-cost analysis for concern technology. To get the cost of power consumption is get through this formula

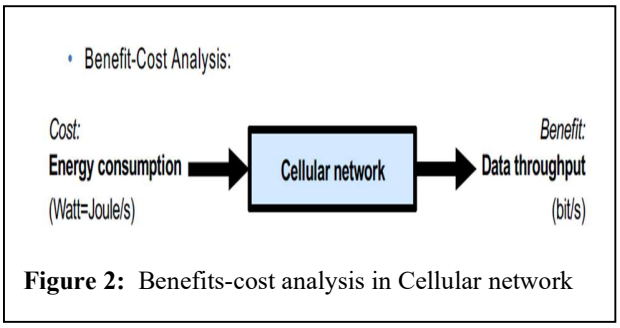

Figure 2: Benefits-cost analysis in Cellular network

By understanding the analysis, we can easily get the ratio by this formula

$$Energy\ efficiency\left[\frac{bit}{joule}\right] = \frac{Data\ throughput[bit/s/km^2]}{Energy\ consumption[joule/s/km^2]} \quad (1)$$

Equation (1) is purposed in the book "Massive MIMO Networks" by authors Björnson, Sanguinetti and Hoydis in 2017[22].

3.2 Optimization methods in 5G and 6G

The technologies are grown tremendously in the wireless communication world. Power consumption is a challenging task to tackle the resource consumption. Here we compare and analyze the power consumption methods which are used in 5th generation and 6th generation.

1.3 5th Generation Potential techniques

3.3.1 (Mille meter wave) mm wave:

Low-power gadgets remove energy and data from the MM-Wave signals. It Consumes more energy because of parameters, for example, the receiving wire pillar design influences the energy inclusion likelihood. To take care of this issue utilize more extensive shafts to give better energy inclusion when the beneficiaries are not lined up with a specific transmitter.

"Simultaneous wireless information and power transfer (SWIPT)" [18], [19]. We currently expect that the energy collecting collector is additionally furnished with a data disentangling circuit

3.3.2 Full Duplex Transmission

Full-duplex transferring, as an upgraded rendition of ordinary half-duplex handing-off, permits transfers to get and transmit flags at the same time utilizing a similar recurrence asset, which can accomplish all things considered twofold the framework otherworldly productivity once the self-impedance is suitably dealt with [20].

"We focus on a two-hop decode-and-forward relay system [21], where the relay has one receive antenna and one transmit antenna, and both the source and the destination have a single antenna. Results showed that the maximum energy efficiency of the half-duplex relaying is always higher than that of the full-duplex relaying with only a relay transmit power constraint". So the full-duplex transmission consumes less energy.

1.3.3 Massive MIMO

In small cells and multiple antennae's hard to achieve an energy-efficient system for wireless communication because energy efficiency is determining by transmission power and circuit power. The both of this is not possible to handle with smaller cell and use of massive number of antenna. TO tackle this problem, use the network design variable which purposed in [22], [23] [24], and optimize these variables to achieve an energy-efficient communication.

TABLE 1. COMPARSION ON EENERGY CONSUMPTION METHODS IN 5G AND 6G

Sr. No	Energy optimization			
	5G technologies	***Power Consumption reducing methods***	***6G technologies[29]***	***Power Consumption reducing methods***
1	**Massive MIMO**	Network design variable optimization	**Wireless energy transfer (WET)**	Distributed Antenna Systems Energy Beamforming (EB)
2	**MMWave**	Use Wider beams Wireless information and power transfer	**Multi domain Index Modulation**	Multiple Antennas Multiple Subcarriers
3	**Full Duplex**	A Two-hop Decode and forward relay system	**Super flexible integrated network**	Node to Node communication using cloud Flying base station

3.4 6th Generation Potential techniques

3.4.1 Wireless Energy Transfer (WET)

6G could be the cell framework that can give energy. As remote energy moves [29] is developing, we anticipate 6G base stations giving fundamental force move to gadgets, especially embeds and sensors Adjunct energy-driven thoughts, for example, energy reaping and backscatter, will likewise be a segment of 6G.

WET is a promising answer for controlling future Internet of things systems where a colossal number of gadgets will require consistent and continuous activity as imagined by 6G [30]. The utilization of the accompanying techniques wet could be conceivable. Dispersed Antenna Systems and Energy Beamforming utilizing high-gain reception apparatuses to center the energy in thin shafts toward the gadgets improves effectiveness.

3.4.2 Multi domain index modulation(IM)

As a rule, the IM transmit signals created in the utilized asset spaces will in general be inadequate. Also, IM strategies are equipped for making appealing exchange offs among the scope of clashing framework necessities, for example, the rate-per-channel use, unwavering quality, equipment cost, multifaceted nature, and energy productivity, which give chances to their utilization in vehicular correspondences.

Contrasted with great adjustment/transmission plans, IM can be seen as the accompanying: ¦ another multidimensional mixture tweak plot that misuses the records of the transmit assets as extra measurements separated from the exemplary PSK/QAM ¦ a novel, sporadic group of stars structure, whose heavenly body outline comprises of scaled renditions of complex-esteemed, channel-hasty reaction taps; [28] the subsequent group of stars will, in general, be unpredictable and persistently esteemed. All the more significantly, IM can be reasonably adaptable for differing framework arrangements. By utilizing these strategies Multiple Antennas and Multiple Subcarriers it is very conceivable to make balance energy productive.

3.4.2 Super flexible integrated network

A too adaptable incorporated system is a purposed method which can be utilized in 6G. To make the system power-effective utilize the accompanying techniques initially is the utilization of flying base stations [17] is on the grounds that the creators exhibited through trial results that the sensor hubs which are one-bounce away from a base station channel their energy quicker than different hubs in the system. Use of numerous, portable base stations to build the lifetime of remote sensor systems.

Haze figuring is a quickly developing field of research, it ties numerous advances, i.e., distributed computing, information examination, information science, appropriated processing, shared systems, and so on. It gives a simple, dependable, quick, secure, and close access for computational administrations. In Fog processing, administration hubs are near the end-clients, and they play out all obligatory registering administrations. [26]

The principle thought regarding this exploration to utilize the Fog registering is settled on these angles:

- The Fog servers store the system information. It drives us to a quick information get to technique. In this manner, the information recovery is simply contrasted with focal information access, preparing, and the board procedures (as utilized by 4G/LTE systems).
- The information is accessible thickly in systems. It is open at a solitary bounce, it prompts less flagging overheads and deferral.

This strategy underpins the base system framework subordinate correspondence. The association is set up along these lines; Node base station imports the necessary data from close by Fog servers. The recovered snippets of data are prepared in information systematic units (DAUs). The DAUs are in-manufacture handling units and intently tie-up with Fog servers/gNBs. The Fog servers and information logical units are much of the time conveyed in the inclusion territory.

The 5G systems help hub to hub correspondence. It requires the base framework to help set up an association. In considering paper scientists use N2N correspondence over the Fog systems to make the least foundation architecture.in beneath the engineering is demonstrated which is purposed by Babu and Sanjay Kumar Biswash[27].

TABLE 2: ENERGY CONSUMPTION ASPECTS IN MODERN WIRELESS GENERATION'S

Sr. No	Results	
	Aspects	***Detail***
1	**Signal Processing**	• Coding • RF chain and Circuits
2	**Decoding processing**	• Decoding process is the main process which consume most of energy
3	**Network Architecture**	• Protocols and Signalling • Number of cells and Access points • Networks are designed for supporting busy hour traffic and focus on low recourses wastage
4	**Intelligent transmission**	• In 6G technologies solutions are expected with large intelligent interfaces and transmission • Smart power system, Micro grids

4. Results:

By conducted the comparison of above most favorable techniques for 5G and 6G technologies following Aspects are identified which mostly indicate the energy consumption in modern technologies.

4.1 Signal processing

Signal processing is an powerfull aspects in wireless technolgyes energy consumpution [23]. In signal processing different process are running like coding. RF chains and circuit are used which consume lot of energy. These are also on mobile devices. To overcome the mobile processing time is also used because the processing time of an antana and the proceeser in the celluer device consume energy. Different studies focus on the programming (coding) to scale down this issue. Celler devices are low power carriage devices [34] so to build a future network the signal processing and system process time must be reduced. A green readio technique is also used to make wirless

technology more energy efficient [35].

4.2 Decoding processing

Decoding process is the main task which consume most of energy [21]. ADCs and DACs are also major source of energy consumption; these are scale with the number of bits used to represent samles. Also in ad-hoc networks like "Advances in wireless networking and embedded microprocessor designs have enabled the creation of dense low-power sensor networks. These sensor networks consist of nodes endowed with a multitude of sensing modalities such as temperature, pressure, light, magnetometer, infrared, audio, video, etc. The nodes are typically of small physical dimensions and operated by battery power, making energy consumption a major concern. For example, failure of a set of nodes in the sensor network due to energy depletion can lead to a partition of the sensor network and loss of potentially critical information." [32],[33].

4.3 Network Architecture

The main infrastructure of the network is the core basic or life line of a network. The network efficeny can be meaure by its architecture significance [18]. In network which protocols are used, how much number of cells are used, number of access points [10]. Antanna location is also key role in propagation aspects [23]. So the architecture is important in enegy aspects and also the Networks are designed for supporting busy hour traffic and focus on low recourses wastage.

4.4 Intelligent transmission

In future generation the intelligent transmission is expected and also Artificual intelligence is used for 6G networks. In 6G technologies solutions are expected with large intelligent inter-faces and transmission [29] also Smart power system and Micro grids are used to provide high speed transmiison with minimum data loss. To handle power consumption in future technology will be more applicable if the following aspects are in concern.

5. Conclusion

In this article, we have summed up ongoing advances methods of energy effectiveness that have occurred in the expansive zone of energy reaping remote correspondence systems. We have secured an assortment of techniques for 5G and 6G correspondence systems. Our approach to gather the possible technologies to make a better understanding of network infusing variables that handle the power consumption. We presume that utilizing thorough ways to deal with improve energy use prompts a huge increment in network lifetime. Just as the recently developing worldview of energy move and collaboration that happen what's more or concurrent with data move for such systems. The researcher presented a vision for wireless communication energy-proficient paradigms. At that point audit some encouraging ongoing methodologies that could draw this vision nearer to the real world. At long last, we concentrate on resources securing sure about in 5G and 6G correspondence frameworks, which will ideally fill in as rules for their future turn of events.

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