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MAKING SUSTAINABLE ENERGY ATTAINABLE

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Abstract

Technology has formed a monarchy in the 21st century. However, its negative environmental impacts are as superior as the technology - especially the escalation in ICT (Information & Communication Technology). This paper centers on the sustainability of green communication, with network energy reduction techniques to improve the energy efficiency of these communication networks.

Keywords:*Energy efficiency, energy consumption, wireless communication networks, CO_2.*

INTRODUCTION

The use of wireless devices has multiplied to an extent where infrastructure for wireless communication networks, for connecting people and objects, is a need. A substantial amount of data is being transferred daily in the form of files, storing information on the cloud, making online transactions, etc. As a consequence, the volume and coverage has increased with the mobile traffic in these communication networks. Bandwidth storage, capacity, slower data rates and interference were some obstacles faced by the generation of 4G. As a solution, 5G has been considered as the best option to prevent these inconveniences. 5G can serve numerous devices with 1000 times greater capacity and bandwidth. Due to this new advent, the connected devices will grow. [1]

It becomes vital to increase the number of transmission power to support these devices. In addition, telecommunications equipment contains a potential amount of scarce material; extracted through mining. Consequently, this extraction contributes to greenhouse gas emissions and adds to the scarcity of resources. Facts reveal that during the year 2020, the communication networks consume between 2-3% of global energy and produce 2% of global CO_2 emissions, among which wireless networks account for 57% of this energy consumption. [1]Heat in the form of waste is released when high amount of energy is consumed, and results in electronic pollution. Electronic waste (also referred to as E-waste) is caused when electronic devices become outdated or come towards the end of their useful life.[2] Technological convergence is a primary cause for an increase in electronic waste. The disposal of these electronic devices results in an overflowing of the landfill. Consecutivelythe toxic chemicals of electronic devices could cause serious health risks if they seep into the soil and the groundwater. Many of these devices aren't wasteful at all but are easily recycled for reuse. According to WHO (World Health Organization), recycling valuable minerals from e-waste has become a source of income for developing industrialized countries. Kyoto Protocol is an agreement between many nations,aiming to reduce therelease of greenhouse gases(methane, carbon dioxide, nitrous oxide

etc) in the atmosphere.[3]Great Lakes Electronics in the United States is a recycling center for E-waste recycling with a zero-landfill policy in all locations. [1]They have portrayed sustainability and contributed to the conservation of the environment. An increase in energy consumption increases greenhouse gases, causing global warming and climate change. It is necessary to know that every greenhouse gas has a different global warming potential (GWP).

The greenhouse gas emissions in the telecommunications industry are minimal than any other industry. However, it is imperative to take precautions to reduce it after the evident increase in the demand for digitalization. [4] If sources are believed, the carbon footprint can contribute to 14% greenhouse gas emissions by 2040. Specific Absorption Rate (SAR) calculates the contact between human tissue and radio signal. Higher the SAR number, the more it becomes detrimental to not only the health of humans but also the environment. The rapid growth in the IT sector has disturbed the ecological balance.

What is green communication?

Green communication is a sustainable approach towards carbon footprint reductions by the networking sector through efficient use of scarce resources and energy-efficient technologies. It entails using such software and hardware techniques that can minimize the energy consumptions of network components.

It is quintessential to have energy efficiency for the extended battery life of wireless devices to sustain. On witnessing a daily rise in mobile users, efficient batteries should be available for a lengthy working-life of these devices. In the next section, this paper exhibits a review of a few green communication techniques used in 5G.

Theory

Green Communication Techniques

Renewable energy sources do not harm the environment with CO_2 emissions. Therefore, these resources are useful for improving the energy efficiency of cellular networks. Fossil fuels (majorly oil resources) are depleting significantly. Techniques like energy harvesting is used to obtain energy from the external resources of surrounding environment and convert it into usable electric power.[5] One of the drawbacks is the tiny amount of power produced from this method.

Device-to-Device communication

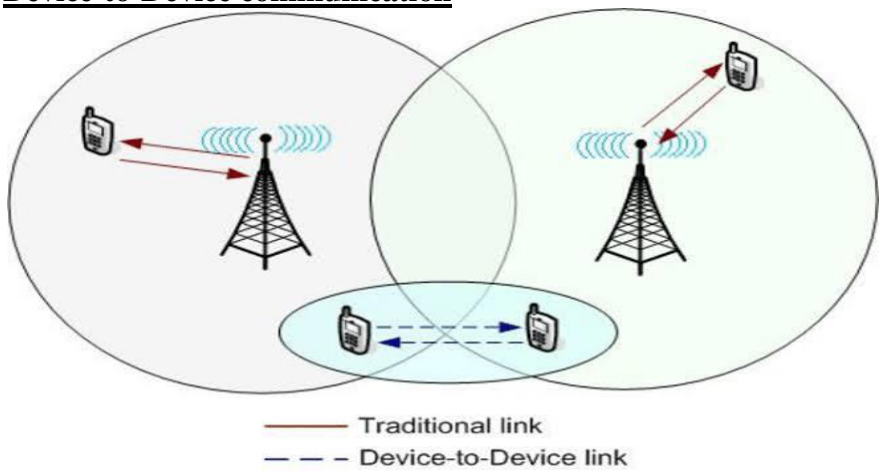

Fig.1. Device-to-Device communication.

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Device-to-Device communication, also referred to as D2D communication, is a radio access technology that gives users living in closer proximity an opportunity to communicate directly, eliminating the need for a network infrastructure (illustrated in Fig.1). A lot of transmission of power takes place when the users are at the edge of their cells. Due to this technique, delays for data transfer are removed and data traffic is reduced at the base stations. The base stations are enabled to store power by going into a sleep mode. As an outcome, lower levels of energy will be consumed, thereby lessening the CO_2 emissions. In this way, energy efficiency comes in wired and wireless networks. [5]

Green IoT

IoT is a vast network with devices connected. All the data is saved and transferred from the device through sensors. Digital technology's exponential growth is complementing the transformation of work in all sectors. The change in tastes and fashion favors availing the smart and connected devices which make the Internet of Things (IoT) famous amongst everyone. IoT is a comprehensive infrastructure of the network that involves using sensors and actuators. [6]When these devices are inserted into a physical object, they gain the ability to sense, operate and transfer information over the network. About IoT devices, their hardware is categorized into general and sensing devices. The sensing devices are connected with wired and wireless interfaces and are the major center for exchanging information. Sensing devices are sensors actuators that calculate temperature, humidity, light intensity and, other criteria. The IoT devices are controlled by gateways that transfer the data collected to the Cloud. To summarize, the cloud acts as a storage unit.

Fig.2. Green IoT.

Green IoT focuses on the sustainable smart growth of the world. It believes in innovation and applications for societal changes with lower energy consumption of IoT devices. Thereby, it emphasizes the energy efficiency of IoT devices, as mentioned in Fig.2, to reduce the contribution to the greenhouse effect from its present appliances. It aims to make the complete IoT process green.Green IoT prioritizes the conservation of natural resources that will lessen the burden on the environment caused by the technology and even lessen the costs. Hence, green IoT focuses on green manufacturing, green utilization, green design, and green disposal. [7] Green manufacturing can be achieved by using electronic components and other subsystems which have minimum impact on the environment. Green utilization can be achieved by utilizing the information systems in an environmentally sound manner that reduces the energy consumption. Energy-efficient IoT equipment, servers, computers, and sound components can be designed to achieve green design. Lastly, green disposal can be achieved by recycling and reusing unwanted computers and other equipment from electronic waste.

Green IoT even involves using the Green WSN and Green CC.
Green WSN: Wireless Sensor Networks (WSN) include base nodes and automated sense nodes. To adopt a green system, these nodes can: use the devices sleep mode, reduce the working time, use renewable energy sources harnessed from the environment, effectively use radio transmission techniques and use data reduction techniques. [5]

Green Cloud Computing (Green CC): In cloud computing, users can pass a large number of resources. As a sustainable approach, these shared resources produce the adoption of energy-efficient hardware and software. Many power-saving techniques energy-efficient models can be used. [5]

Massive MIMO

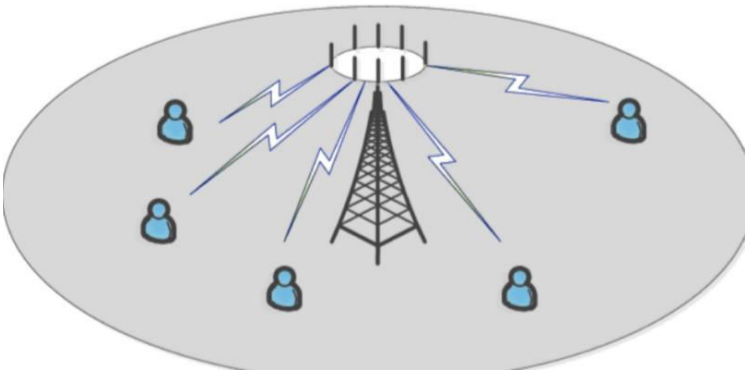

Fig.3. Massive MIMO.
Multiuser Multiple Input Multiple Output (MIMO) is a base station of multiple antennas that serve multiple users, with single-antenna equipment at the same time. Multiplexing is a technology that allows many communication signals to come together. [8] When independent data signals from individual antennas are transmitted, multiplexing gain happens. All users share the multiplexing data, as illustrated in Fig.3. A greater number of antennas in massive MIMO makes it energy efficient and produces overall benefits of good energy efficiency, latency

reduction, increased throughput, and high capacity gains. In this system, choosing the correct antenna becomes quintessential. To control the consumption of power, energy-efficient antennas are required. Its structure simplification also contributes to reducing power consumption. Antenna muting is a technique to reduce energy consumption for LTE (Long term evaluation) cells by working for a shorter time scale. [9] The power can be saved significantly up to 50% when the antenna is muted in a low load or no-load environment. While considering this, an antenna with two or more ports can turn off the rest of the ports, while keeping only one of them on. This will not have an impact on the performance of the system and will conserve substantial energy. [7]

Heterogeneous Networks

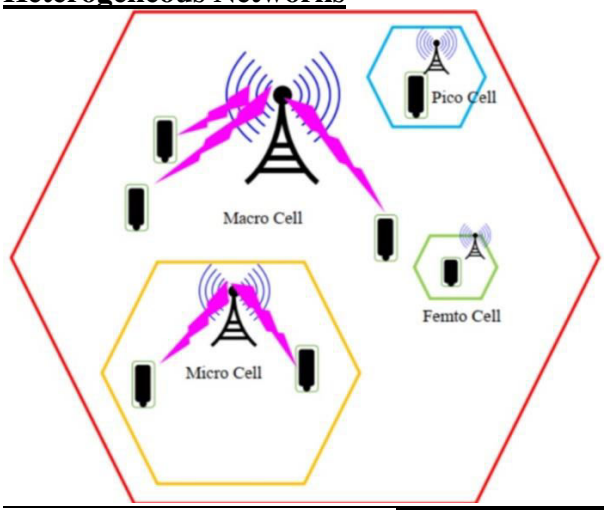

Fig.4. Architecture of HetNets

The concept of heterogeneous networks (HetNets) for green communication is illustrated in Fig.4. HetNets are a combination of individual cells. In the architecture of HetNets, there is one macrocell and several small cells such as microcell, picocell, and femtocell. A lesser number of macrocells in a HetNet reduces the consumption of power. Due to this type ofmixed wireless system, the Het-users are bought nearer to the network. This leads to a higher Signal to Interference noise ratio (SINR). This method provides a strong link and good QoS (Quality of service). Moreover, HetNets has lower bandwidth issues due to frequency reuse. When there is little or no load, the microcells can be put into a sleep mode to reduce the energy consumption. [10]

Challenges

While green communication provides myriad benefits, they are even associated with a price. Some key problems can slow down the deployment of green solutions.Green communication is expected to have high energy efficiency. To make devices energy-efficient, a high cost is involved. Similarly, a massive MIMO system also increases the cost significantly. Techniques such as heterogeneous networks require new infrastructure to be built. Therefore, the cost is a primary challenge for green communication.

In the previous section, several greenhouse techniques were studied. Particularly for 5G cellular communications, Massive MIMO is said to be the most effective energy-efficient technique. However, a significant numbers of antennas requiredcan increase power consumption. [7] Therefore, it becomes imperative to select the correct antenna. Additionally, massive MIMO is a complex architecture and, the multiplexing and demultiplexing unit can consume a large amount of power.

Energy harvesting techniques can also be unreliable. For example, solar energy cannot provide sufficient power during cloudy conditions and at night.

To achieve conservation of energy and reduced CO2 emissions, the communication equipment can be treated in two ways. Firstly, the development of by-products should be a boost by reducing the level of the optical-electronic system. Alternatively, the PCB (Printed Circuit Board) single disk density can be reduced.

CONCLUSION

Energy consumption metrics are the energy consumed per unit. These details are required toanalyze and compare how much energy is consumed by the various components of cellular network. These metrics support reducing energy consumption by setting long-term research goals. This paper portrays an overview of energy consumption issues and explains several green communication techniques like Device-to-Device communication, Green IoT, Massive MIMO, and Heterogeneous networks. Drawbacks involved with these techniques are also discussed. More efforts are required to design and develop wireless access networks. There is a drastic increase in green communication along with the growth of information and communication technologies. Network security and secured power optimization also need to be considered for the future of green communication. Overall, green communication is a way towards a sustainable future.

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