POTENTIAL OPTICAL WIRELESS TECHNOLOGIES IN MOBILE COMMUNICATIONS

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Abstract:-

The focus of this study is on creating the infrastructure for 5G networks, providing an improved wireless and optical network segment transport architecture with domains for mobile phone application domains. To provide 5G mobile services in an energy-efficient manner, a two-stage optimization framework and the premium route are required. Identify the suitable set of power grid wireless (optical/optical) and processor modules are needed. In the first iteration, a multi-objective strategy is used for optimization, where each component of the transport network works to jointly lower the cost of investing in the 5G mobile network. The goal of this is to identify the minimal mobile technologies for optical and wireless power grids. The second step focuses on the web server branch and identifies efficient processing modules to which 5G operational systems should be assigned. Using several clustering methods, realistic traffic statistics selections such mm-wave and optical passive networks (PONs) for optical grid transfer, fixed, and elastic networks in Bristol, UK, through a city-wide topology, the performance of the idea is examined. Our article presented a 5G communication employing optical wireless technology to boost the benefits of 5G applications.

Keywords:- Optical, Wireless Networks, 5G, R-R and PON

1. INTRODUCTION

The fifth generation (5G) of broadband cellular network technology is expected to be nationally deployed by mobile operators in 2019 and will be comparable to the 4G networks that now link to the majority of existing cell phones directly. The GSM Alliance estimates that by 2025, the 5G network would have more than 1.7 billion users globally. The business zone is split into the following cells, known as rural towns, in 5G networks, which are digital platforms, including their previous predecessors. Such a local antenna in the cell connects all 5G wireless devices to the phone and internet networks via radio waves. The main benefit of new networks is that they will eventually develop greater download speeds and an aggregate of up to 10 gigabits per second (Gbit/s). Networks are now expected to provide general internet services for laptops and desktop computers, compete with other ISPs like cable internet, and enable new Internet of Things (IoT) and machine-to-machine applications due to the drastically increased bandwidth. This includes serving not only mobile devices like current cellular sensors. 5Compliance concerns are also needed for new networks. 4G mobile phones cannot be made via wireless equipment. Most often, faster speeds are attained by employing radio waves with a higher frequency than those used by earlier cellular networks [1]-[5].

Higher frequency radio waves may be used across a smaller physical area, necessitating fewer regional cells. For worldwide presence, 5G devices may broadcast on up to three frequency bands: low, medium, and strong. A 5G network will be made up of up to three cellular organelles, each of which is intended for a different antenna arrangement and has a different trade-off between download latency and range and coverage. Mobile 5G devices employ a low-band frequency range of 600-850 MHz, which is close to that of 4G devices and offers slightly greater throughput than 4G: 30 to 250 megabits per second (Kbit/s) The fastest antennas in their range are used by wireless devices to connect to the server at their location. The same low-band cell towers' 4G stairway range and coverage area. With speeds of 100-900 Mbit/s and a range of up to several miles for each cell tower, the same 5G mid-band technology employs microwaves operating at 2.5-3.7 GHz. This is the level of service that is used the most often. By 2020, it ought to be accessible in the majority of major cities. For certain countries, there are no low-band implementations, hence this is the minimum rate of the item. High-band 5G operates between 25 to 39 GHz in the millimeter-wave spectrum, although higher frequencies will be utilised in the future. Additionally, it keeps download speeds in the gigabit per second (Gbit/s) range consistent with the streaming service. A smaller number of microwaves (mmWave or mmW) is possible, but numerous cells are required. Walls and windows are two examples of materials that have problems allowing air to pass through them. Plans call for integrating these cells exclusively in dense metropolitan settings and places where many people congregate, such as sports stadiums and conference centers, because to their greater cost. The latter speeds are those that were generated for 2020 in the standard findings, and they are anticipated to rise for the year roll-out [6]-[10].

2. OPTICAL WIRELESS TECHNOLOGIES

The next development in mobile communications standards is called fifth-generation (5G) communication. With ultra-high system capacity, huge device connection, ultra-low latency, ultra-high security, ultra-low energy consumption, and exceptionally high experience quality, it will provide novel services. It is anticipated that 5G communication would use very dense heterogeneous networks, with a 1000-fold increase in mobile data volume per area and a 100-fold increase in the number of wireless devices connected, compared to current wireless networks.

In order to provide very dense, extremely fast access networks, high-capacity backhaul connection is required for 5G and beyond communications. Additionally, the pace at which physical objects are linked to the internet is growing rapidly with the advent of the Internet of Things (IoT) idea. Radio frequency (RF) is now an extensively utilised technology in many wireless applications. The RF spectrum that is now in use, however, is not enough to support the IoT paradigm and the rising need for 5G wireless bandwidth. It is anticipated that existing wireless technologies will not be able to meet the enormous connectivity demand of future mobile data traffic because the electromagnetic spectrum, which has advantageous communication properties below 10 GHz, has almost been exhausted by current wireless technologies. In addition, this band (below 10 GHz) includes restrictions such a narrow spectrum band, laws governing the usage of the spectrum, and intense RF interference from neighbouring access points. As a result, for wireless communication connection, researchers are exploring for new complementing spectrum, such as millimetre and nanometer waves. The International Telecommunication Union (ITU) presented 11 additional candidate bands for International Mobile Telecommunication-2020 (IMT-2020), or 5G connectivity, during the World Radio Conference 2015 (WRC-15). [11]-[15]

The electromagnetic spectrum's RF band spans the range of frequencies from 3 kHz to 300 GHz. Local and international authorities have severe regulations on the usage of this band. Most of the time, only a few operators, such as point-to-point microwave connections, television broadcasters, and cellular phone companies, are granted full licences for RF sub-bands. Future high-density, high-capacity networks are predicted to be developed using the optical spectrum, which is seen as a potential option. Using the optical spectrum, wireless connection is known as optical wireless communication (OWC). OWC-based network solutions have distinct benefits over RF-based networks. For communication lengths ranging from a few nanometers to more than 10,000 kilometres, OWC systems may provide high-data-rate services. It can provide quality services both indoors and outside. However, OWC systems struggle because of their susceptibility to obstruction blocking and their low transmitted power. The amount of traffic carried by telecommunications networks, particularly wireless networks, has grown steadily over the previous ten years. The need for more innovation, research, and development in the new developing communication technologies capable of providing ultra-high data rates has been driven by the steadily rising demand for broadband internet services. One of the biggest technical success stories in history is the development of wireless technology, which made it possible for people to communicate at any time and from any place. Ten years ago, phone communications dominated the market. Today, however, wireless data and mobile Internet have surpassed voice communications in popularity and have added far richer multimedia content to voice interactions. The way we live, work, and socialise has already undergone a significant transformation thanks to wireless gadgets, apps, and services. The development of new, bandwidth-hungry apps is significantly increasing the demand for mobile data transmission [16]-[18].

By 2020, there will likely be three orders of magnitude more mobile data traffic than there was in 2010, and the available spectrum for mobile services will have about doubled. The fifth generation (5G) of wireless communication is addressing this issue, often known as the mobile spectrum bottleneck. The term "Internet of Things" (IoT) is a relatively new concept that has been most closely linked to machine-to-machine (M2M) communication. It further promises wireless connectivity among environmental sensors, natural and man-made objects, etc., realising ubiquitous machine-to-machine and machine-to-human communications. This would alter our interactions with the physical environment much further and make wireless communications a fundamental aspect of daily life. Because radio frequency (RF) devices and systems are so prevalent today, the word "wireless" is often used as a synonym for RF technology. The RF band, which is located in the electromagnetic spectrum between 30 kHz and 300 GHz, is highly controlled by national and international agencies. Sub-bands are often only licenced to operators, such as mobile phone companies, television networks, point-to-point microwave lines, etc. Congestion in the RF wireless spectrum is caused by a shortage of the available RF spectrum (or bottleneck). Such circumstances might occur in high-density settings, when user demands may dramatically affect access. In a congested urban context, multi-path effects in current RF-based wireless communication systems (WCS) cause the connection performance to degrade. Due to spectrum congestion and these systems' limited capacity, only a small number of HD channels can be supported in a given location. This issue is especially prevalent in indoor applications where there is not enough bandwidth to support the high user density. According to estimates, more than 70% of wireless traffic occurs inside, such as at homes, workplaces, etc. Therefore, to allow a smooth indoor WCS, low-cost and highly dependable solutions are needed.

There are only two options: making better use of RF-based technologies or switching to another approach, including optical technology. There are only three methods to enhance the capacity of wireless radio networks, regardless of the technology (such as 3G, 4G, 5G, or Wi-Fi) being used: I the opening of a new spectrum, resulting in increased bandwidth; (ii) the addition of additional nodes; (iii) the removal of interference; and (iii) much enhanced frequency reuse of the present frequency resources. Finding extra bandwidth is not a huge issue, but acquiring more spectrum is quite expensive and it is plainly insufficient since it is limited. Cell splitting, which is somewhat expensive, may be used to incorporate more nodes. Due to interference problems, two nodes do not provide double the capacity of one. Additionally, increasing infrastructure by twofold won't increase income by twofold.

Optical wireless communications refers to the transmission of light beams employing signal carriers in the unguided visible, infrared (IR), and ultraviolet (UV) spectrum (OWCs). In specifically, the OWC uses visible light communication (VLC) and free-space optical (FSO) communications to operate in the near-IR and visible light bands, respectively. Well-known FSO and VLC transmitters with a large practical utility are laser diodes (LDs) and light-emitting diodes (LEDs), respectively. Due to its short range, large beam coverage area, and data speeds in the order of Gbps, VLC is often taken into consideration for interior communication since LEDs are more affordable and dependable light sources. VLC is a logical choice for providing intra-rack or brief inter-rack connections as a result. The LDs are strong tools to reach extremely far locations with desired high-speed connections in the order of Tbps since they can produce razor-sharp light beams. As a result, modern FSO research initiatives usually focus on addressing outdoor FSO channel impairments including misalignment and aiming errors, scintillation, atmospheric turbulence, etc. A significantly more welcoming atmosphere for the usage of FSO communications is provided by the acceptable ranges and accustomed interior setting of DCNs. Naturally, this also does away with the need for expensive, large-scale FSO transceivers outfitted with complex subsystems to reduce outside effects. Additionally, FSO and wavelength division multiplexing (WDM) together can provide the very high data rates and tremendous fanout needed by DCNs. An outdoor WDM-FSO connection may achieve 1.28 Tbps capacity on 32 wavelengths (32x40 Gbps) at a 212 m distance, according to research by Ciaramella et al. 16, It is clear that early research efforts (18, 19, 20, 21, 22) focused on physical topology design to demonstrate the viability of the optical WDCN idea by assuring the interoperability of OWC transceivers To demonstrate how reconfigurability and extensibility of WDCN may be leveraged to satisfy the needs of the large volume and constantly changing traffic characteristics of DCNs, logical topology design has yet to be fully investigated. Numerous intriguing open research topics, including resource allocation, interference management, routing, load balancing, congestion control, etc., are involved in logical topology optimization. Observe how the complexity of these issues grows when network components (such as servers, racks, switches, connections, etc.) are added, and how this complexity is further exacerbated by the quantity of created flows and their varied QoS needs. Despite having no control over DCN size, logical topology optimization may categorise flows and manage traffic according to the requirements of each class.

3. CONCLUSION

In this regard, we recently investigated a technique for grooming that combines mouse flows to produce rack-to-rack (R2R) jumbo flows. R2R jumbo flows are routed over dedicated lightpaths between each rack pair using a spine-leaf DCN architecture, in which ToR switches at the leaf layer are connected to the CSs at the spine layer via WDM-FSO links. Elephant flows are routed over server-to-server (S2S) express lightpaths as opposed to the R2R approach, whose capacity is established based on the available capacity after ensuring the low-latency requirements of mice flows. To prevent the performance degradation of mice flows brought on by bandwidth-hungry elephant flows, we separated these two classes. The proposed traffic grooming approach handles these crucial flows with the highest priority over the S2S express paths and provides the delay analysis utilising queuing theory because DCNs are also required to serve mission-critical flows that require ultra-reliability and low-latency. The proposed scheme performs much better than its competitors in terms of throughput and timely flow completion, according to the results.

It would be challenging to assess the minimal working conditions that are presented and introduced in a converged 5G network due to design and engineering in the most recent studies system. For the purpose of providing BH and FH services, the proposed network consists of point-to-point microwave connections and passive and active IOT application technologies. In order to improve the suggested architecture, a multi-stage optimization process has been researched. The analysis of quantities, the use of rational traffic statistics, and the 5 G topology of the capital in Bristol, UK, have demonstrated the viability of the power grid technologies available in the capital and the allocation of individual BBU functions to specific programming modules that are currently being used to improve fuel efficiency. The front-end structure, the telecommunication geometry, and the resulting wireless optical channel are all discussed in relation to the dynamics of an OWC setup. The basic components of the transmitter and receiver were addressed. Additionally, LOS and NLOS contact options have been created. The indoor IR and VLC settings can be strengthened by combining the irradiance at the receiver and the coverage.

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