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RESEARCH ARTICLE

Enhanced routing strategy of wireless sensor network based on fifth generation communication technology

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Abstract

Fifth-generation (5G) innovation refers to the most recent version of handheld device communication in the field of wireless communication. Assessments pertaining to the subject of wireless communication are provided in this particular piece of writing. At each stage of progress, a variety of obstacles had to be overcome, but with the assistance of contemporary wireless networks, those obstacles were conquered. When compared to all of the other wireless networks that have come before it, 5G is the only one that offers a capability for high-speed internet access anytime, wherever, and to anybody. 5G is a little bit different owing to the fact that it has certain innovative functions, such as managing gadgets, materials and processes as well as networking with individuals. The 5G wireless network will deliver varying degrees of performance and capabilities, which will result in new user experiences and the connection of new businesses. Compliantly providing service-customized communications to a broad range of services *via* interconnected internet reserves and aerial/wired networking assets, which may be offered by different infrastructure suppliers and/or operators, will be one of the primary goals for subsequent 5G wireless networks. This will be accomplished as one of the basic goals of prospective 5G wireless networks. Recent years have seen the launch of a number of research works and initiatives aimed at laying the groundwork for the technological foundation of 5G mobile communications. These endeavors involve major mobile infrastructure manufacturers, academic institutions, and international mobile network operators. However, the 5G mobile services that will be made accessible for usage, as well as their design and performance, have not been explicated in a clear and concise manner. In this article, we offer a comprehensive review of 5G, the wireless communication system that will replace 4G in the near future.

Keywords: Wireless communication, Fifth-generation, Routing strategy.

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Introduction

Radio waves (or bandwidth) are used by wireless networks to transmit data wirelessly (Zhou, Z., *et al*.,2020). Fifth-generation (5G) works in the same way as 4G, although it runs at higher, less crowded radio frequencies. Because of this, it can transport more data at a much higher rate. We refer to these higher frequencies as "millimeter waves" (mm waves). Authorities had previously ignored them, but now they're available for licensing. Since the necessary tools are difficult to obtain and it is prohibitively expensive, they were mostly untapped by the general populace. 5G Technology refers to the next generation of mobile communications. The term "5G" is used to refer to the next generation of mobile communication standards after the soon-to-be-released "4G" (Metin, T, *et al*., 2020). Services in device engineering, which is records, online transactional assistance, and more, are available thanks to 5G technology. The more informed a consumer is about mobile phone technology, the more likely he or she is to opt for a comprehensive plan that includes all the latest bells and whistles. In order to stay ahead of the competition, the world's biggest cell phone manufacturers

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constantly hunt for cutting-edge technologies. Figure 1 depicts the 5G broadcasting spectrum architectural diagram clearly with proper specifications.

A 5G-based telecommunications network aims to address the problems that the 4G model would inevitably cause if it becomes widely used. Broad geographical protection, high speed at millimeter-wavelengths (10–1 mm) in the radio frequency spectrum from 30 to 300 gigahertz, enabling a 20 Mbps data rate at distances up to 2 km; these are the hallmarks of wireless systems employing the technique of orthogonal frequency division multiplexing. Most of the current increase in wireless Internet use can be accommodated by using the millimeter-wave frequency. The 'wireless world wide web' (WWW) may be accessed with these requirements (Senthilkumar, C., *et al*., 2021).

The 'WWWW' makes it possible to have a dynamic ad hoc wireless connection (T.J. Nagalakshmi, *et al*., 2023) with a channel bandwidth that ranges from 5 to 20 MHz (ideally up to 40 MHz). To achieve bidirectional high bandwidth, as in the transfer of a large volume of communicating information in GB, maintain over 60,000 hyperlinks as well as offer 25 MB per second communication, this process makes use of intelligent antennae (such as shifted beam antennas as well as adaptable group antennae) and the adaptable modulation technique. With 5G, users may stream full movies, even in 3D, on their portable devices, as well as play games and get remote medical care. Piconet and Bluetooth will become antiquated when 5G rolls out. With a 5G phone, you could stream HD shows without any hiccups, much as on an electronic device.

5G Wireless Communication Technology Attributes

- The technology used in 5G is more appealing as well as effective because to its cutting-edge invoicing connections.
- The 5G standard provides enhanced clarity for today's pixel-hungry smartphones as well as high-speed, simultaneous information transfer.
- In addition, 5G technology offers subscriber oversight capabilities that may be used immediately.
- The error-free 5G connections are founded on a strict adherence to policy.
- Communicating at gigabit speeds, 5G connectivity has the capacity to handle over 65,000 devices at once.
- Establishing Links.
- The reliability of 5G gateways is on line with that of the carrier class.
- The use of 5G technology improves the accuracy of traffic data.
- The user can receive a better and faster solution using remote administration made possible by the 5G connectivity.
- Another fantastic aspect of the 5G system is remote diagnosis.
- Connectivity speeds of up to 25 Mbps are made possible by 5G technology.

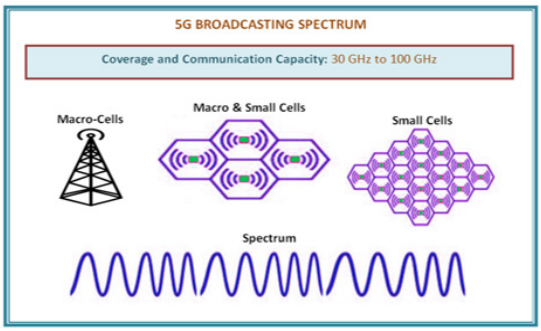

Figure 1: 5G broadcasting spectrum - architectural diagram

- The 5G network may potentially function as a VPN.
- The advent of 5G technology will render all delivery services obsolete.
- 5G technologies are reaching their maximum upload and download speeds.

Related Study

The rise in IoT adoption can be attributed, in part, to the inclusion of massive machine-type communication (mMTC) as a subset of fifth generation (5G) mobile communication (Zhang, J., *et al*., 2022). One of the most important parts of any gadget connected to the internet is its sensors. Although sensors have been around for a while, the rise of wireless technology and the need for IoT applications have expanded both their significance and the difficulties inherent in their design, integration, etc., including a traditional definition, an in-depth study of the many modules involved in the design of a WS node, and the means by which they may be utilized to gauge system performance, this review provides a comprehensive (historical and architectural) overview of wireless sensor (WS) nodes. An expanded taxonomy of WS nodes is offered in light of the definition and analysis of a WS node. Additionally, the rationale behind creating a wireless sensor networks (WSN), its implementation, and its associated communication protocols are detailed. Several use cases for WS nodes have been suggested. In addition, the difficulties and limitations encountered by these WS nodes in a variety of settings and throughout production are reviewed. Important ongoing advances that will bolster WS nodes to accommodate rising system needs are also discussed.

For 5G networks, spatial modulation (SM) has great promise since it ensures a high data rate with little complexity. Since information is conveyed in both the transmit antenna's indices and the constellation symbol, energy efficiency and data rate may both be improved using spatial modulation. To mitigate interchannel interference and synchronization issues among transmit nodes in wireless sensor networks (WSNs) and to maximize multiplexing gain, a cooperative multiple-input-multiple-output (MIMO) approach based on spatial modulation is presented. To enhance the power

savings of WSN, a cooperative MIMO framework is built by taking into account geographically dispersed nodes, each with a single antenna using spatial modulation. The minimal Euclidean distance between transmitted symbols is used to calculate the theoretical pair wise error probability (PEP) in the suggested method (M Kanthimathi, *et al*., 2022). Results comparing the suggested method's bit error rate (BER) performance and energy consumption per bit to those of the SM methodology are provided.

Several limitations arise during the routing procedure in heterogeneous 5G WSN (Mateen, A., *et al*., 2023). Heterogeneous 5G wireless sensing networks face the challenges of reduced prices, limited energy utilization, and reliable data transfer between nodes. The transmission procedure at nodes uses the greatest energy when there are gaps in the network. Location errors, as discussed above, and node battery consumption are the two biggest issues with heterogeneous 5G WSNs. However, the network's performance is severely impacted by the loss of data packets and the high use of power. This is why there are so many methods for conserving power in routing systems. In contrast, this study proposes a routing approach to minimize network instability by eliminating voids. Through comparison with other, more advanced protocols, we further show that the suggested one is scalable and effective. In order to improve the network's performance, this research also presents the concept of location inaccuracy. The scalability of the proposed systems has also been investigated. In addition, extensive simulations were run to test how well the suggested method worked. The results demonstrate the superiority of the suggested routing technique over the other approaches.

Fifth-generation mobile networks (5G) and AI are two of the few technologies that complement one another so well (Gunturu, V., *et al*., 2023). Service assurance in a 5G environment is complicated and cannot be addressed by human resources alone. The use of artificial intelligence in network diagnostics, cyber-security, and tailored applications by the fifth-generation of network operators will significantly alter the dynamic between companies and their customers.

The fact that over half of internet services have already integrated some kind of artificial intelligence into their 5G networks shows that substantial investment has already been made in the marriage of the two technologies. The importance of data lies at the heart of the symbiotic relationship between AI and 5G; 5G provides a floodgate for data, which AI may then analyze and learn from more speedily to develop one-of-a-kind consumer experiences already tailored to the varying demands of customers. The 5G network supports AI's simulations of analysis, reasoning, data fitting, grouping, and optimization in the background, bolstering the results' credibility and importance. The volume of data will increase dramatically as 5G-powered Internet of Things (IoT) devices become more commonplace in areas as disparate as factory floors and autonomous automobiles. The reason for this is that 5G will allow for far faster data transmission. All of these devices and the sensors they incorporate produce fresh information that may be utilized to teach computers to be smarter (Sachdeva, T., *et al*., 2023).

As the number of devices connected to a network grows, the networks themselves become more and more heterogeneous (Zhou, Y., *et al*., 2021). This ecosystem is particularly vulnerable to cyberattacks because of its dispersed nature, the number of broadband devices it supports, the mobility of those devices, and the dynamic fluctuations in the networks themselves. This study thus provides a comprehensive analysis of the literature on 5G network security, highlighting the most promising approaches. We compare and contrast many methods to find the one that will best protect our 5G networks from threats. Those concerned with making their 5G networks as secure as possible in the face of constantly shifting security threats (Gautam, K.K.S., *et al*., 2022) will find this review paper to be an invaluable resource (Jamshed, M.a., *et al*., 2022).

Methodology

The term "5G" is shorthand for the IEEE 802.11ac-based next-generation mobile wireless standard. While 4G LTE intends to increase internet speed, 5G promises to increase capacity by allowing more mobile network users per geographic area and more data consumption in gigabytes per second. If this were the case, a sizable section of the population could use their mobile devices to stream high-quality content for extended periods of time every day, even when they were not in range of a Wi-Fi network. Improvements in cost, battery life, and latency, as well as increased security and connection for a wide community, are all goals of 5G research and development. These goals apply equally to machine-to-machine communication, commonly referred to as the IoT.

A real-world network may be divided up into several virtual networks using 5G technology. This allows for more efficient network management by allowing operators to supply the appropriate "slice" of the network depending on the user's needs. For instance, the operator can switch between various slice capacities as needed. A corporation may allocate one slice to one individual who transmits video, and another to more complicated and resource-intensive tasks like the operation of self-driving vehicles. Plans are in the works to provide enterprises with the option of renting a dedicated, firewalled network segment that provides isolation from all other Internet traffic.

Fifth-Generation Radio Frequency

(Poornachandu, C. V., & Ayyadurai, M. 2022, November), 5G uses the radio spectrum of the electromagnetic spectrum

to transmit data wirelessly. There are several different frequency bands within the radio spectrum, some of which are utilized for this cutting-edge technology. You may have heard about 5G frequency bandwidth, frequency auctions, millimeter-wave 5G, etc., despite the fact that 5G is still in its infancy and is not yet accessible in every nation. The electromagnetic spectrum includes frequencies from 3 kHz to 300 GHz. Each band of frequencies throughout the electromagnetic spectrum has a unique name. Bands in the radio spectrum range from very low to very high frequencies and include extremely low to very high frequencies as well as low to medium and medium to high frequencies.

(Pandi, V. S., *et al*., 2021) The millimeter band, so-called because its wavelengths are between 1 and 10 mm, spans the radio spectrum at extremely high frequencies (EHF) of 30 to 300 GHz. mmWaves describe electromagnetic radiation with a wavelength in this region. In addition to its use in 5G networks, mmWaves have found a home in radio telescopes, communications and even infrared weaponry. The lower portion of the radio spectrum, known as ultrahigh-frequency (UHF), is also being utilized for 5G. The UHF band, which spans from 300 MHz to 3 GHz, is utilized in a wide variety of applications, including but not limited to TV transmission, global positioning systems, wireless internet and mobile phones with cords.

Figure 2 depicts the security barriers associated with 5G clearly with proper specifications.

5G's Velocity and Punch are Linked to Its Frequency

Although all radio waves propagate at the rate of illumination, not all waves have the same interactions with or behaviors in their surroundings. The speed and range of a 5G tower's broadcasts are determined by the wavelength of the frequency it uses. The relationship between frequency and wavelength is inverse; therefore shorter wavelengths correspond to higher frequencies (Boobalan, S *et al*., 2021). Wavelengths at the more extreme ends of the spectrum (where the frequencies are) are so low that the shape of the wave is so small that it is readily distorted. This explains why extremely high frequencies have a shorter range than lower ones.

Results and Discussions

With customers demanding greater speeds of internet and the amount of traffic predicted to climb by the hundreds, 5G networks have the distinct goal of accommodating the rise in mobile data consumption. We may expect 5G networks to be tasked with moving data at minimum reference point speeds of 100 MB per second and maximum peak rates of 10 GB per second. Both the overall volume of traffic and the mediation of traffic in certain regions, such as commercial centers and commuting centers, will necessitate novel strategies. Since wireless technologies are rapidly approaching the statistical limitation for ranges on individual electromagnetic connections, the attention must shift to densely squeezing in additional base stations in a given region, to obtain significant increases in bits/Hz/km^2 (Anitha, G., *et al*., 2022).

Spectrum

The acquisition and ingenious application of spectrum will take on more significance as the demands placed on wireless communication networks increase. Better utilization of the existing spectrum for mobile networks, access to extra capacity at similar frequencies, and management of greater frequencies in the centimeter-wave and millimeter-wave bands will all be required to meet the upcoming needs (Ayyadurai, M., *et al*., 2022).

Figures 3, 4, and 5 portray the resulting efficiency of the proposed approach by means of throughput, communication speed and frame success ratio, in which the resulting metrics are cross-validated with the 4G networking applications to prove the efficiency of the proposed approach clearly.

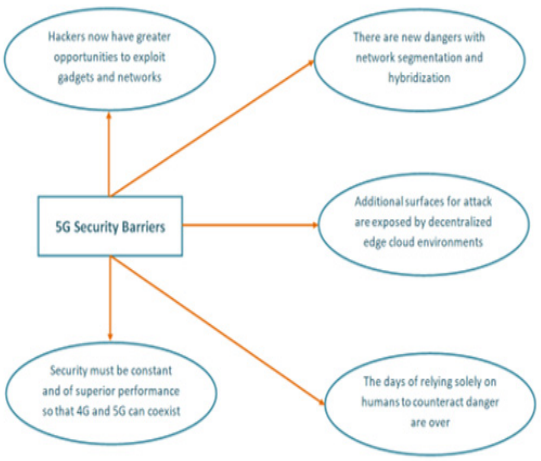

Figure 2: 5G security barriers

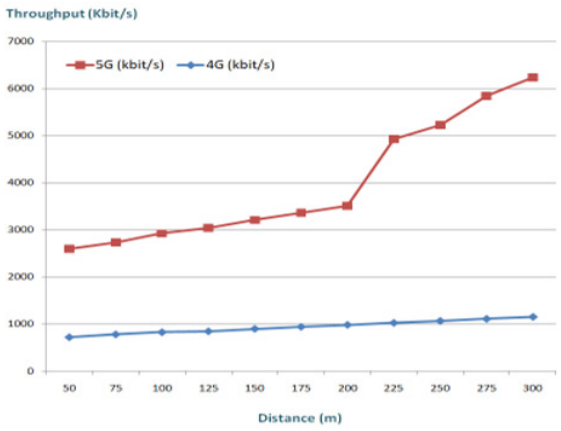

Figure 3: Throughput analysis

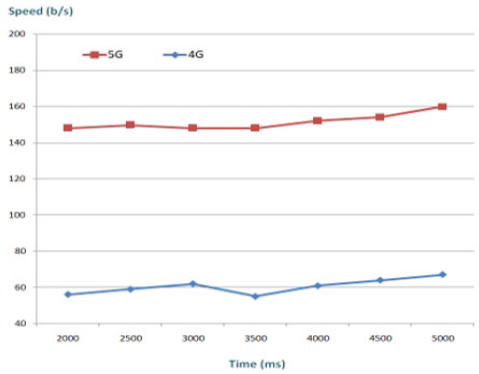

Figure 4: Communication speed

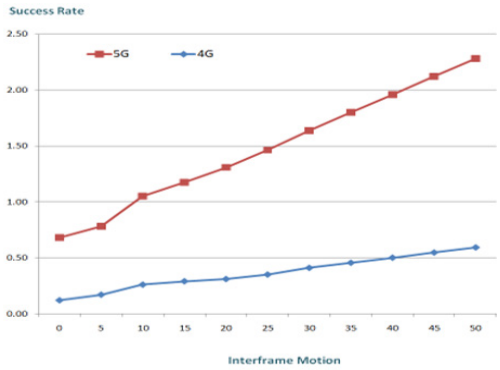

Figure 5: Frame success ratio

Benefits of 5G Technology

• Extreme accuracy and massive, bidirectional bandwidth shaping.

• A unified system for managing all networks that can be wrinkled.

• Increased energy and productivity.

• Rapid response solutions for managing subscribers made possible by cutting-edge technology.

• More than 60000 interconnections will be possible because to the abundant broadcasting data (in GB) that will be made available.

• Easily controlled by earlier models.

• Ability to serve a wide variety of service areas (including private networks) with reliable technology.

• Affordably available worldwide connection that is consistent, reliable, and uninterruptible.

Problems with 5G Networks

Although 5G is studied and envisioned as the panacea for all radio signal issues and mobile global hardships, it is constrained by factors like security concerns and a lack of technological advancement in most regions.

• There is now an active study on the feasibility of technological silence throughout the production process.

• The speed at which this technology operates is appealing, but it may prove difficult to achieve in the future due to ineffective technical infrastructure in most countries.

• Many existing gadgets would be unable to connect to 5G, necessitating the purchase of brand-new products at a high price.

• It's expensive to build new infrastructure.

• There are still unresolved issues with security and privacy.

Conclusion

The future for handheld devices and wireless technologies is bright because it promises to embrace the all internet protocol approach and push data rates to levels never before achieved. Every year, portable devices have more powerful processors, greater inside memories and better battery life - all while running the same applications. The use of mobile devices at extremely high data rates has been revolutionized by 5G mobile technology. Such a high-value technology has never previously been consistently experienced by users. These days, people who use mobile devices have a deep understanding of how these devices work. All the different kinds of cutting-edge frameworks that make 5G wireless communication so potent as well as in so demanded in the coming years are a part of the technology known as 5G. With the advent of 5G, an individual's smartphone may act as a wireless modem, connecting them to the internet on their computer. Anyone can do a lot more with 5G connectivity than anyone ever imagined possible with its device, audio files player, movie, huge smartphone memory, sound player, etc.

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