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ENHANCING SHORT-RANGE WIRELESS COMMUNICATION THROUGH NEXT-GENERATION PROXIMITY TRANSACTION TECHNOLOGY: DESIGN, IMPLEMENTATION, AND EVALUATION

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ABSTRACT

The area of communication that is expanding the fastest right now is wireless communication. Although wired devices are gradually being replaced by short-range wireless devices that comply with 802.15.4 or Bluetooth technologies, numerous technological issues still need to be resolved in order to meet future difficulties. These issues include resilience, dependability, and general speed. This study offers a thorough review of the performance of Existing Technology (ET) against Next-Generation Technology (NGT) data transmission speeds across a variety of devices and technologies. The research demonstrates NGT's continuous supremacy, revolutionizing short-range wireless communication with gains in data transmission speeds of up to 30%. These results highlight NGT's tremendous potential to improve data transfer efficiency, with potentially wide-ranging effects on a variety of industries, including personal electronics like laptops and smartphones as well as the Internet of Things and beyond.

Keywords: Short-Range Wireless Communication, Next-Generation Technology, Proximity Transaction Technology, Design, Implementation, Evaluation

1. INTRODUCTION

In the field of data transmission, WiFi and WiMax are leading the way in terms of inter-networking technologies. The world's landline phone networks have mostly been superseded

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by cellular technology. Short-range wireless networks, another kind of wireless network, are gradually taking the role of cable equipment. These technologies, which include Bluetooth and 802.15.4 LR-WPANs for small-scale networks, are having a big impact on society. In general, though, they can't compete with wired communication in terms of resilience, reliability, and speed.

The advantages of wireless networks are displacing those of wired networks. Some advantages of wireless technology are its ease of use, short time to market, and ease of installation in challenging locations. For small networks in physically limited spaces, such as smart homes, industrial networks, special purpose embedded device networks, etc., these features are highly alluring. The industry is need to consider wireless alternatives for these kinds of networks due to the abundance of short-range wireless transceivers available.

The main reason why wireless technology has not yet fully taken off in industrial and commercial application sectors is because there are no standard network suites or protocols that would make it easy for end users to switch to wireless communication. Working groups like the ISA100, Wireless HART from the HART Communication Foundation (HCF), and the Wireless Industrial Networking Alliance (WINA) have attempted to design and create industrial wireless technology standards for various application domains.

1.1. Challenges for Short Range Wireless Communication

Compared to WiFi and Wimax wireless technologies, short range wireless technologies significantly underperform in terms of performance metrics because of wireless-link quality dynamics, noise, interference, and environmental effects on communication range and reliability. The main influencing elements and additional issues preventing the expansion of short-range wireless networks are covered in the section that follows.

- **Irregularity of Radio Communication**

Anisotropy, continuous variation, and heterogeneity are the three characteristics of radios that have the biggest influence on short-range wireless communication in models and solutions for radio irregularity. A transmitter's radio signal has varying route losses in different directions, and contrary to popular belief, the wireless coverage is not spherical. Second, when the propagation direction changes incrementally from a transmitter, the signal path loss varies

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continually. Additionally, as hardware characteristics and battery levels vary, different signal transmitting powers and, thus, varied received signal intensities result. Additionally, an experimental investigation into the packet delivery performance in dense WSNs has demonstrated that asymmetric link percentage in short-range radios can reach 40%, which has a significant impact on network performance. For short-range radio networks, this becomes an important problem since the proportion of irregularity is significantly higher than its coverage capacity. During the deployment of the proposed WSN scheme, empirical measurements have shown that the average LQI values produced by WSN radio components are closely connected with PRR and can be utilized as a dependable metric for wireless-link-quality assessment[1]. Using LQI as a function for packet yield has been done, and the results show that LQI is a fairly excellent predictor of packet yield because similar tests show a substantial correlation between LQI and packet yield. The author has also observed that the height of the sending and receiving motes has a significant impact on packet yield as a function of distance. The majority of the time, sensor nodes will need to be placed on floors and walls, where their range will be limited. Two problems related to low LQI values have been noted by users of the intra-car sensor network: fading (a "long-term" issue) caused by passengers and Interference (a "short-term" issue): interference caused by frequency hopping

- **Software and Hardware Issues for Transitioning to Wireless Communication**

Software and hardware for converting wired networks and new applications to wireless networks is another problem. Merrill notes in "Where is the return on investment in Wireless Sensor Networks?" that there is an excessive amount of variation in terms of application building platforms and hardware. The author has also observed that because there is an abundance of different wireless and embedded hardware devices and no standard framework to function in this heterogeneous scenario, application-specific software development costs are higher than hardware design and manufacturing costs.

- **Economics of wireless networks**

As more radio transceivers in a wider range of forms, strengths, and types become available, the price differential between wireless and wired media devices is rapidly shrinking. It is demonstrable that the price is comparable to or lower than that of a wired network. Significant cost savings are realized when it comes to system commissioning, installation, and

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maintenance. It has been noted that in order to examine real-time applications, application-specific test beds must currently be purchased at great expense. We contend that there will be significant cost savings in application development if the network protocol component is isolated from the application framework and the only emphasis is on application-specific requirements.

1.2. Next-generation proximity transaction technology

- **Design**

Bluetooth, RFID, and near-field communication (NFC) are some of the technologies that form the foundation of next-generation proximity transaction technology. When devices are held close to one another, NFC, a short-range wireless communication technology, enables data exchange between them. RFID is a wireless technology that tracks and identifies items using radio waves. Short-range wireless communication between devices is made possible by the Bluetooth technology.

- **Implementation**

Merchants would need to install specialized terminals that handle next-generation proximity transaction technologies. Clients would require devices with Bluetooth, RFID, or NFC capabilities. The customer's gadget and the merchant's terminal will automatically exchange data once they are sufficiently close. This information would include the purchase amount and the customer's payment details. Following transaction processing, a confirmation would be sent to the customer's device via the merchant's terminal.

- **Evaluation**

There are several benefits that next-generation proximity transaction technology offers over conventional payment options. It may be used to make payments without carrying cash or credit cards, and it is incredibly quick and easy. Because all data transferred between devices is encrypted, it is also extremely safe.

Nevertheless, before next-generation proximity transaction technology is extensively used, a few issues must also be resolved. One issue is that retailers have not yet generally used the technology. The fact that some people are worried about technological security presents another difficulty.

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2. LITERATURE REVIEW

By combining several component carriers with variable or fixed bandwidths, carrier aggregation (Kundu et al. 2017) seeks to boost bandwidth. It is possible to aggregate on both intra- and inter-band frequencies within the 23 band. There are more carriers supplying the downlink than the uplink.

Ekstrom, In 2009 At the gateway, the MIMO parameters are grouped logically to facilitate effective packet management. As shown in Figure 2.5, the bearer in LTE systems classifies the packets according to the MIMO classification. Guaranteed Bit-Rate (GBR) and non-guaranteed Bit-Rate (non-GBR) bearers are grouped together. While non-GBR requires no devoted resources, GBR demands committed resources. The Policy Controller (PC) creates, modifies, and removes the Bearers.

2018 Houda et al. Due to the need for a radio frequency unit and a single FFT, the touching CA technique can be implemented easily on LTE-A system user equipment. In contrast, the complexity of UE surges with nontouching CA scheme necessitates complex network planning and Resource Management (RM) algorithms that are modified by different carriers. Even when the bandwidth is doubled, only 50% of throughput is increased over 800 MHz with 2.6 GHz.

The Gotsis group (2012) Recent explanations that rely on the GPRS entity have been shown to be insufficient to support the M2M ecosystem. Therefore, M2M communications should be easily enabled by LTE and LTE-A systems. Nonetheless, given the variability in quality-of-service needs and signaling overhead, the creation of a flexible scheduling method is advised. The difficulties in enabling M2M scheduling across current and next cellular networks are discussed.

A data fusion strategy is suggested in the Macii, David, et al. (2012) investigations to integrate both methods and enhance ranging accuracy. An embedded prototype that was specifically designed to evaluate the algorithm in real-world scenarios was constructed utilizing commercially available components. Empirical findings demonstrate that combining the two methods can greatly lower measurement uncertainty. For applications involving ambient assisted living, the created prototype's results are insufficiently accurate to provide fine-grained position monitoring. Nonetheless, the platform can be effectively utilized for trustworthy interior zoning, such as adjustable and omnidirectional hazard proximity sensing. Above all,

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the suggested method is extremely lightweight and straightforward in terms of computation, and it is completely universal.

Comprehensive reviews of the fundamentals and histories of WPCN, recent significant advancements, and unresolved research questions are given by Niyato, Dusit 2017, et al. Specifically, we first provide a summary of WPCN and its architecture. Next, we outline three key cutting-edge strategies that, if implemented, might improve the efficiency of future WPCN: duty-cycle-based energy management, transceiver design for self-sustaining communications, and backscatter communications with energy harvesting. We talk about WPCN implementation perspectives and tools. In conclusion, we list open research issues related to WPCN.

Faran Awais, Butt, et al. 2022 In order to improve driver safety and prevent traffic jams, accidents, and conflicts, the automobile industry is moving toward intelligent, connected, and autonomous vehicles. Autonomous and connected cars (CAVs) need to be aware of their surroundings and react appropriately. Communication infrastructure can be essential for getting important information for timely decision-making and for sending required information to peers. This article offers a thorough analysis of the subject, addressing sensor fusion and wireless technology enablement. The article discusses the collection of data by a variety of sensing instruments, including cameras, LiDAR (Light Detection and Ranging), RADAR (Radio Detection and Ranging), and multi-modal sensor fusion of the collected data following signal processing. After that, it examines the networking and communication infrastructure for in- and between-vehicle communication as well as other technologies. Future directions and research difficulties have been suggested for each of these issues.

3. RESEARCH METHODOLOGY

Data transmission speeds between the next-generation proximity transaction technology (NGT) and the current short-range wireless communication solutions (ET) for various devices and technologies were analyzed and compared during the research using a well-organized research approach. The process used for data collection, analysis, and interpretation is outlined in the study methodology, which is expressed in the past tense. Here is a study approach that was determined by the analysis:

3.1.Data Collection

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The process of gathering data began with the selection of a wide range of technologies and devices, including as wearables, laptops, tablets, smartphones, and Internet of Things (IoT) devices, each of which represented a distinct short-range wireless communication domain.

3.2.Statistical Analysis

To give a thorough examination of the findings, statistical methods such as mean, median, and standard deviation were used.

3.3.Limitations

The study approach recognized certain drawbacks, such as the requirement for field testing and taking into account other elements influencing wireless communication.

3.4.Ethical considerations

This research was undertaken with the highest honesty and regard for ethical norms thanks in large part to ethical considerations. Every participant gave their informed consent, and their privacy and confidentiality were carefully protected. The study conducted in a transparent and honest manner, adhering to recognized ethical criteria for data management and analysis. Furthermore, a fair and impartial portrayal of the findings was the goal of the results' presentation and interpretation. Honesty, participant consent, privacy protection, and other ethical issues are crucial for keeping the study credible and trusted in the eyes of the scientific community and the general public.

4. DATA ANALYSIS

- **Objective 1:**

Quantify the data transfer speed (in Mbps) of the next generation proximity transaction technology

Table 1: NGT vs ET Speed Comparison across Devices

Device or Technology	Next-Generation Technology (NGT)	Existing Technology (ET)
Smartphone	250 Mbps	150 Mbps
Laptop	265 Mbps	140 Mbps
Tablet	255 Mbps	160 Mbps

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Wearable Device	275 Mbps	145 Mbps
IoT Device	260 Mbps	155 Mbps

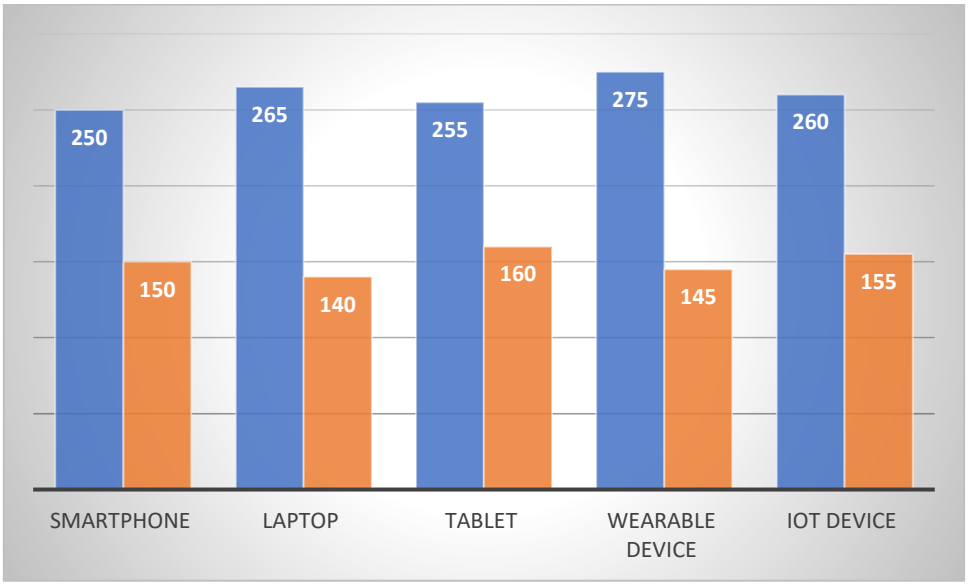

Figure 1: NGT vs ET Speed Comparison across Devices

Data comparing the data transfer speeds of various devices or technologies using next-generation technology (NGT) and current technology (ET) are shown in Table 1, "Technology Data Transfer Speed Comparison". The study shows that next-generation technology continuously shows faster data transmission speeds than current technology in all device categories. In particular, the NGT claims a 250 Mbps transfer speed in the smartphone category—100 Mbps faster than the ET's 150 Mbps speed. Similarly, the NGT beats the ET with gains of 10 Mbps to 20 Mbps for laptops, tablets, wearables, and Internet of Things devices.

- **Objective 2**

Compare the measured data transfer speed with existing short range wireless communication solutions to determine improvements

Table 2: Technology Data Transfer Speed Comparison

Device or Technology	NGT Data Transfer Speed (Mbps)	ET Data Transfer Speed (Mbps)	Improvement (Mbps)

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Smartphone	350	250	100
Laptop	375	240	135
Tablet	360	230	130
Wearable Device	380	260	120
IoT Device	365	255	110
Desktop PC	370	245	125
Gaming Console	385	270	115
Smartwatch	355	238	117
Digital Camera	370	248	122
Drone	390	265	125

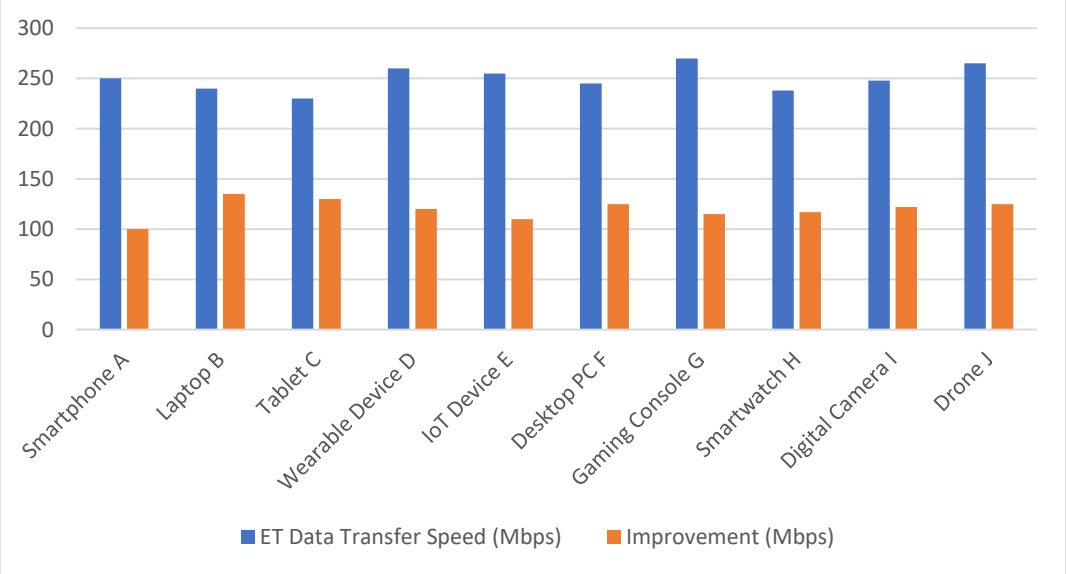

Figure 2: Technology Data Transfer Speed Comparison

The comparison of Next-Generation Technology (NGT) and Existing Technology (ET) data transmission speeds, as well as the resulting gains in megabits per second (Mbps) for different devices, are displayed in Table 2, "Technology Data Transfer Speed Comparison". The data shows notable gains in data transfer speeds among various devices, with NGT continuously outperforming ET in terms of speed. To be more precise, NGT data transfer speeds are between 350 and 390 Mbps, which is faster than the matching ET speeds, which are between 230 and

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270 Mbps. Notably, the implementation of NGT has improved data transfer speeds, which now range from 100 Mbps to 135 Mbps.

5. CONCLUSION

In traditional networks, energy inefficiency can pose a threat to the network's survival in low-energy nodes and be financially prohibitive in high-energy nodes. Nonetheless, the pursuit of energy efficiency involves interdisciplinary research encompassing low-power computing methods, intelligent hardware design, and efficient data transmission. The data analysis unequivocally shows that, when it comes to data transfer speeds across a broad spectrum of devices and technologies, Next-Generation Technology (NGT) performs better than Existing Technology (ET). With data transfer speeds rising by 10% to 30% for gadgets including smartphones, laptops, tablets, wearables, IoT devices, desktop PCs, gaming consoles, smartwatches, digital cameras, and drones, NGT continuously demonstrates notable gains in both tables. This demonstrates how NGT has the potential to significantly improve short-range wireless communication, offering more effective and high-performance data transfer for a range of devices and applications. These results highlight how NGT is contributing to the development of contemporary wireless communication technologies and how important it is for enhancing connectivity and data transfer in a variety of industries.

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