



ORIGINAL ARTICLE

FRAMEWORKS FOR DATA TRANSMISSION IN SMART SYSTEMS: INTEGRATING WBAN, VANET, AND IOT FOR SEAMLESS COMMUNICATION IN HEALTHCARE AND VEHICULAR NETWORK

^{1*}Prianka RR, ²E U Iniyan

¹ Senior Assistant professor, Department of AIML, New Horizon College of Engineering, Bangalore, India

² Assistant Professor, Department of Electronics and Communication Engineering, Tiruvallur, India

Corresponding Author Email: priankabibin@gmail.com

(Received 08 May 2025; revised 20 August 2025; accepted 02 December 2025)

Abstract

The integration of the Wireless Body Area Networks (WBAN), Vehicular Ad Hoc Networks (VANET), and the Internet of Things (IoT) can be described as a possible way of ensuring the uninterrupted communication between the medical and vehicle networks. This structure is aimed at facilitating successful communication of information through the application of the specific features of each type of network. WBANs are used to monitor physiological conditions and vital signs through constant health surveillance based on information acquired by wearable sensors. VANETs enhance the navigating, security, Report Word and congestion control because they facilitate dynamic and rapid communication between structures and vehicles. IoT allows various smart objects to interact and create one ecosystem in which they exchange information and make decisions. The recommended paradigm addresses the following concerns: privacy of information, network overloading, and environmental conservation through focus on connectivity, security and the transmission of minimum latency. The integration of these approaches has seen the structure hope to enable improved medical programs, better traffic flow, better safety on the roads, and better real time monitoring all of which shall lead to better intelligence, and receptive and networked systems.

Keywords: *Wireless Body Area Network; Vehicular Ad-Hoc Network; Internet of Things; Smart Healthcare Systems; Vehicle-to-Infrastructure Communication*

1. Introduction

Due to recent technological advancements, WSN are now widely used in real-world situations. It is frequently called a Wireless Sensor and Actuator Network (WSAN) which is a collection of information at a single location to record and monitor key environmental or organizational conditions. Essentially, it makes it easier to communicate between an online and the real-world environment [1]. WSN measures different variables of the organization or surroundings through the perception of different variables like sound, relative humidity, temperature, contamination levels, direction of the wind and velocity, stress among many other customers, corporate or industrial setting. A WSN is comprised of a few thousand sensor nodes [2]. The sensor node is made up of a number of components such as an antenna, a microprocessor, transmitter and receiver unit and a power battery. The sensor nodes are minute and miniature. There are many advanced WSN including VANET and WBAN which need very small equipment [3]. VANET and WBAN are specialized wireless sensor networks that have mobility assistance. Unlike the WSN, WBAN and VANET possess some peculiarities, features, and limitations. WBAN, VANET, and WSN share many features such as node density, node mobility, multi-hop interpersonal interaction, cost-effectiveness and reliability [4]. Although there are certain similarities among these three challenges, there are as well differences in various aspects which include size, node characteristics, environment of operation, limitations to resource nomadism, and background information. The latest technology of WBANs has been assigned by IEEE as IEEE802.15.6 have become increasingly used by the recent developments in the Micro-Electro-Mechanical Environment (MEMS) [5]. WBAN is a collection of a small,

light, and low-power wireless sensor nodes, which are used in health surveillance. WBAN technologies have been initially driven by the need to have more effective and real-time surveillance of health due to an aging population and the soaring healthcare costs [6]. WBAN has provided a number of imaginative and interesting usages including omnipresent medical care, participatory gaming, military, and entertainment among others with the hope of being affordable and inconspicuous yet allowing continual surveillance. Wearable and ambulatory individual vital characteristics tracking is supported by real time, upgraded medical data to affordability of medical services through IoT connected systems. As indicated in Figure 1, remote body status monitoring has become increasingly essential to sportspeople, first responders, and military hospitals and centers [7].

The basic design of WBAN is the same as that of WSNs. The typical architecture of a sensor node is depicted in figure 2. One of these sensor node elements is the source of electricity, or sensor batteries, which are small with much less power consumption compared with the WSN, then there is the processor also known as the sensor node brain. The entire computing load of the sensor node is handled by it. It runs at 8 MHz or 15 MHz on the 16-bit microcontroller platforms. There are several types of storage used in this case; the MSP430 has 0.5KB-512 Flash to 128B-64 KB RAM. A transmission device is another component in cases of communications between or inside the node [8]. An Operating System (OS) has been introduced that sets interface between hardware system and its components. The operating system that is used is TinyOS which is an open-source software with the BSD license. Vital signals are collected and transmitted by WBAN sensor devices. The information studied in WBAN is sent to the doctor to obtain an insight into the health of the individual. The nodes of WBAN vary in pounds, size, resources, power usage, sampling rates, and many others [9].



Figure 1: Applications of WBAN

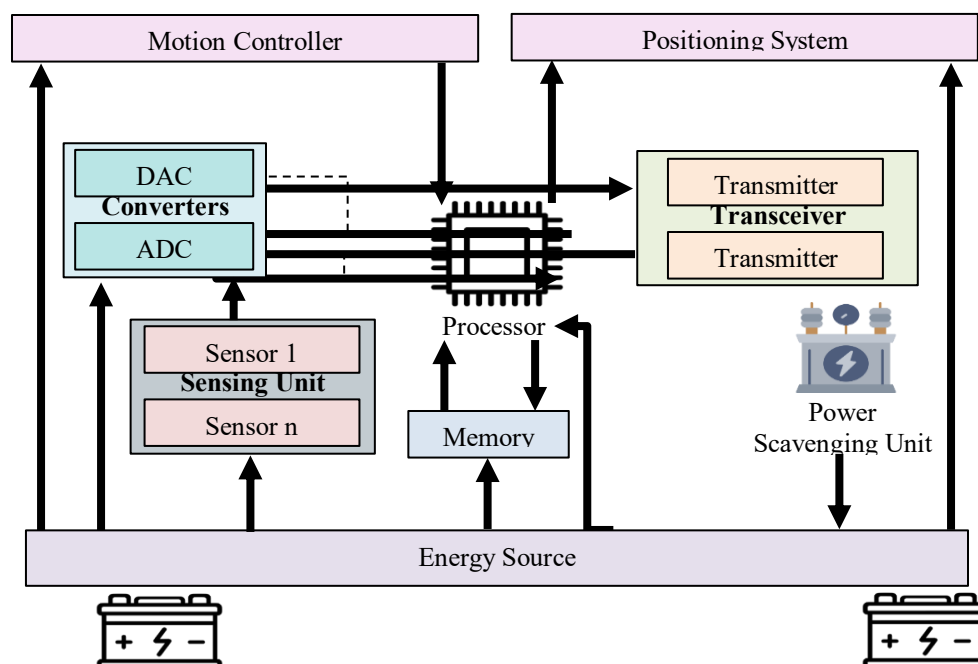
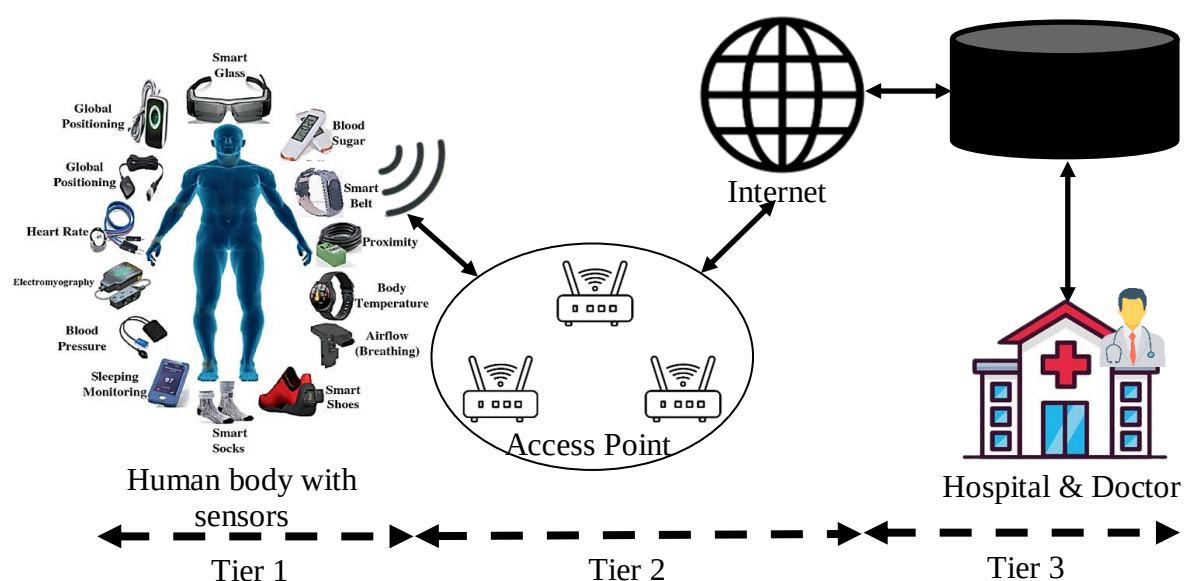


Figure 2: WBAN sensor node component

WBAN can be implemented to continuously observe people in order to gather the necessary data to be diagnosed and recommendations made. These are on-body and in-body. On-body applications are commonly used in the form of mesh, tree, and star structures that have many configurations in the video game applications or the media. The connection of the body on the body also depicts how some parts of the human body slide around other parts. Regardless of the type of vital signs that should be detected, the nodes get installed on the different body parts such as the head, the chest, arms and legs [10]. The coordinating devices process information that was collected on the nodes of wearables that are linked wirelessly. There is no support of audio and video communication in a narrowband WMTS (15 MHz) thus 2.4 GHz ISM is used. It is used by guard bands to avoid interference of adjacent channels [11]. The above bands have different topologies used such as Bluetooth, Wi-Fi, and Zigbee. Point-to-point transmission is possible with the bandwidth of a licensed MICS (402-405 MHz). Figure 3 represents the fundamental design of WBAN [12].

**Figure 3:** Basic architecture of WBAN

VANET is very demanded in terms of technological innovation that enhance outdoor settings including roadside settings. VANET, which is one of the components of MANET is the primary concern of the academic community. Although MANET and VANET are similar in many ways, they are also different to a considerable extent. The cars of Intelligent Transport System (ITS) are routers where they receive and send information [13]. The data is dispatched to other vehicles in an attempt to improve security and reduce congestion. The cars communicate and share information with each other, considering that every vehicle has a specific direction and speed; they also issue warnings in order to avoid the imminent disasters [14]. A web connection is to be administered and supplied to the network, and another component named Road Side Unit(s) (RSU) is used. These units are attached on the sides of the roads and are connected to the backbone of the main network. The two topologies that are vehicle-based infrastructure are Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I), hence generated by the entire smart assistance system. One of the primary issues of VANET is signal attenuation to transfer signals to the target because of structures and other roadblocks [15]. IoT medicine is crucial because it leads to reducing the cost of patient care. The IoT detector may easily be used to track the doctor and the patient in their location. It will be provided with all the information they need on the patient and his current situation. To bring the sick person back to the hospital take away an ambulance [16]. Treatment needs such as medicine and operating room in case of medical emergency are present when an individual reports in the medical facility in the ambulance. The doctors can tell the current situation of the individual since they have access to all medical information regarding the person. This is a great waste of time and labor and it also leads to openness of the treatment process. The smart medical system will enable people to lead an easier life by properly utilizing assets and save time [17].

2. Related Works

A cluster is the development of a set of interconnected nodes. Moreover, the head of the cluster is known as cluster children leadership. Once the Top-Disc topology discovery is done, the sensor network is subdivided into n clusters, each cluster may be represented by a cluster head, which is one node. The cluster head can communicate with them instantly since all the sensor nodes in the cluster fall within its transmission range [18]. The tolerance of the network can be increased by implementing the grouping and head of cluster principles. The energy-aware clustering technique has four components. These involve the establishment of the group head, the cluster, establishment of the gateway and retransmission of the cluster [19]. The configuration of the cluster Head Generation system defines the dynamics of the formation of the cluster head. The cluster head requests the neighboring nodes to form another cluster. The gateway is useful in this case with regard to communication between clusters. By this incessant action, the cluster head consumes its energy, thereby causing delays and wastage of power. To address this issue, a procedure named cluster head retransmission has been included in the energy-aware clustering process [20]. Among the most significant issues within the WSN is the reduction of energy-consumption in order to extend the lifetime of the mobile sensor network that is applied in commercial and environmental surveillance. In order to solve these problems, the Energy Aware Re-Clustering Heterogeneous Routing (EARCHR) protocol was developed. This approach has four key steps that include sink relocation, information collection, grouping and re-clustering through swapping method [21]. The EARCHR protocol enhances the energy consumption and reduces the use of electricity, based on theoretical and experimental evaluation. Various new uses such as border security, intrusion detection are driving the rapid evolution of Device-Free Passive (DFP) localization systems. Implementation of EARCHR protocol enhances savings of energy and reduces the use of electricity [22]. The paper suggests the use of Honey Bee Method to pick a cluster head among a group of nodes in a Wireless Sensor Network (WSN). The way of selection takes into account various factors which include the energy level, direction of motion and the connectivity of each node [23]. Cluster managers play an important role in every group in regulating the interaction between the nodes and the base transmitter. The cluster-based networks utilize several methods of optimization, such as fuzzy logic principles in the artificial neural networks, optimization approaches to ant colonies methods, evolutionary algorithms, and mimetic algorithms [24]. In the current study, the Honey Bee Clustering Algorithm was utilized in order to improve the procedure of selecting cluster leaders in WSN. Some of the measurement measures of cluster leadership include its tenure, cluster count, number of control messages exchanged, and the rate of information packets being reintroduced in clusters. The Honey Bee Clustering Algorithm has got two steps in its procedure [25]. First, it uses appropriate power, the presence of a good number of connected nodes and traveling at the same speed as other nodes as part of the factors on which a cluster head is determined. Optimal node clusters are then identified by a greedy method and a cluster head is picked randomly. This process will make sure that the heads of clusters are selected in a manner that enhances and simplifies the work of the WSNs.

The sensor nodes of WBAN consume low transmit power due to the short-range interaction. Low power reduces heating of bodily tissues, power consumption and decreases chances of signal interference. The requirements of low power performance are challenging, however, especially with sensors not in the line of sight (NLOS) with the coordinator node. As an example, a node on the lower back on the individual can communicate with the coordinator node on the chest. In such situations, many relay based routing schemes have been proposed in order to improve the performance of WBAN. In relaying schemes, a middle node is employed between the source and the coordinator node to guarantee that specific delivery of messages with minimal transmit strength occurs, unlike direct ways of interaction between two nodes. The selection of relay nodes is one of the primary problems in the development of the relay-based intra-WBAN method of communication in the context of WBANs. A smart relay-choosing algorithm ensures reliable and power-saving communications in WBANs. In the example, inter-WBAN interference may take place in the overcrowded localities like clinics. Intra-WBAN communications are interfered by the interference signals of another network. Explore the stability of intra-WBAN relay-based telecommunications to non-cooperative inter-WBAN interference in the current work. Relay-based communication meets the data throughput needs, optimizes the lifespan, and reduces the bit error rate at the coordinator node in case of link failures, which in turn solves and helps enhance the QoS [30].

3. Materials and Methods

To ensure easy communication in healthcare and automotive network, there is a framework of information transmission in intelligent systems that are emerging to merge numerous networks such as VANET, WBAN and IoT. This integration is aimed at enhancing data availability, data reliability, and data availability through the creation of a coherent and smart infrastructure enabling instant data exchange at

a number of domains. The introduction of WBANs in healthcare allows sharing health data based on IoT architectures and studying vital signs of patients, which helps to manage wellness more effectively and timely make emergency interventions. The VANETs allow communication between vehicles and the combination of the IoT using structures can help in intelligent traffic control, avoiding accidents, and efficient route search. These systems should be flawlessly integrated to support such issues as safety information, delay, and energy efficiency which are all demanded by high-stakes applications in the medical and automotive industries. This organized system will enhance the resilience of smart systems by supporting cross-domain apps and encouraging growth in autonomous driving, remote medical services, and smart cities enhancement. The main objectives of the proposed system are reduced end-to-end latency, enhanced reliability, increased throughput, and efficient transfer of real-time physiological information to a healthcare facility or medical server to treat the patients immediately.

3.1 Scenario 1

The person under treatment as observed in Figure 4 is in an indoor environment like in a medical facility, meaning that it is either used in a medical facility or at home. Two communication types are applied in this case: two types of communication point-to-point and point-to-multipoint. The WBAN coordinator transmits important data directly to the next hop that is at the same location in point-to-point communications. On the other hand, in the second type the coordinator sends important information to the next hop which has numerous destinations. The communication through wireless technology allows transfer of information and communication between computers, smart devices, and other sensors within clinically assisted environments, including hospitals. In this case, the wireless communication networks under the IEEE 802.11 namely Wi-Fi are applied to connect WBAN to the local access point, which in its turn will be connected to the server accessed by the physician. The transfer of information regarding patients to a medical server is easy within an indoor environment

Algorithm 1. /* Patient is located at Indoor environment */

```

Connect (Coordinator, Network)
{
Collect Sensor data from different sensors;
Send data to the coordinator;
Send handshake signal (CTS, RTS);
Coordinator connect to the nearest network;
}
Patient_to_medical_server_Indoor
{
If (Patient is Indoor)
{
Check if patient is registered in hospital;
Connect (Coordinator, WLAN);
Send data to the Medical Server;
}
}

```

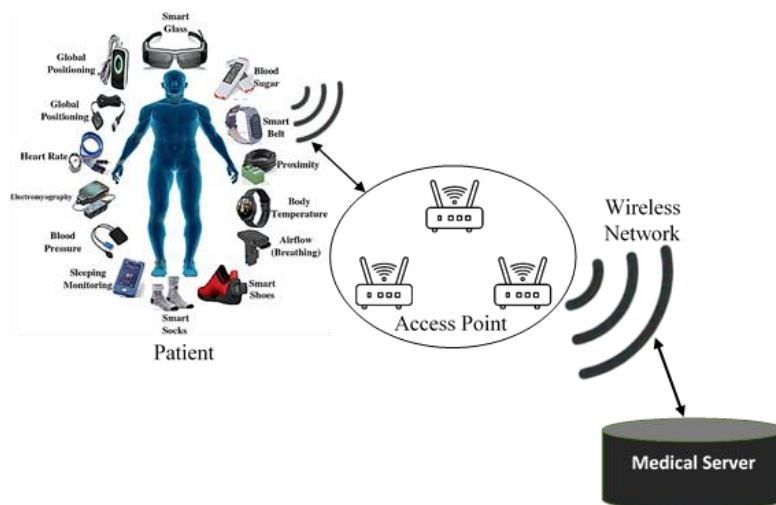


Figure 4: Indoor environment data transfer from Patient to Medical Server

3.2 Scenario 2

As it is observed in Figure 5, the needy person in the case is not indoors, i.e., inside the hospital or room context. Due to the external location, two types of interaction may be utilized to communicate physiological information of an individual to a health care system or the hospital environment. There is a connection to the internet that is used by the first one and the other one does not have the connection to the internet as long as it is offline as it happens in rural or isolated areas. With internet connectivity, the information of the patients is transmitted using the traditional WBAN architecture. In this case, the sensor collects the significant information on the human body and sends it to the body manager who is related to the internet and the server to provide medical attention. The vital information is then sent to medical server via the internet. The information is displayed on the display devices and specialists of the hospital or medical sphere propose therapy according to the state of a patient. In the other possible scenario, where the access to the information is not provided, the information may be instantly stored in a WBAN coordinator or sink, e.g. a smartphone and may be transmitted to the server through short-range connectivity when a WBAN customer is within close distance to his or her personal cloud. But in the other case, since the patient is in an emergency and has no access to the internet, a small signal, a small signal or an alert is sent via the VANET to the local hospital/healthcare server; the message can be V2V or V2I- so that the hospital can provide immediate assistance.

Algorithm 2: /*Patient is located at Outdoor Environment */

```

Connect (Coordinator, Network)
{
Collect Sensor data from different sensors;
Send data to the coordinator;
Send handshake signal (CTS, RTS);
Coordinator connect to the nearest network;
}
Patient_to_medical_server_outdoor
{
Initialize connectivity;
Initialize threshold value;
If (patient is at outdoor)
{
Check connectivity == Internet then goto 8 else connectivity == No internet goto
12;
connect (Coordinator, Internet)
Check authentication;
Connection established;
Send data to the Medical Server:
If (data <= threshold value)
{
Normal data
Connect (Coordinator, Smart phone)
Store data in the smart phone which act as temporary back up device;
Check hospital private cloud availability;
Connect to the private cloud
Send data to the medical server
}
Else
{
Emergency data;
Emergency and critical condition;
Send emergency signal to the nearest hospital;
Connect (Smart Phone, VANET)
Emergency alert goes to nearest hospital;
Hospital is ready for service;
Patient arrive hospital and send data to medical server;
}
}
}

```

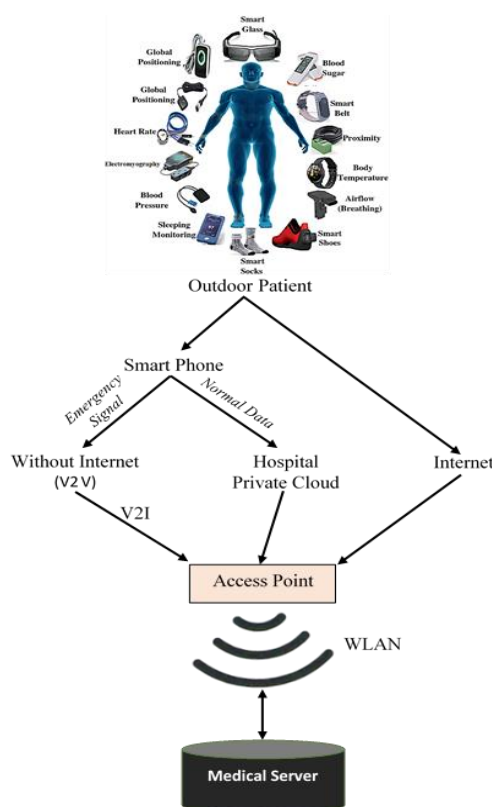


Figure 5: Outdoor Environment data transfer patient to medical Server

3.3 Scenario 3

In this instance, as observed in Figure 6, the needy person is either in an isolated area or rural. The Internet has become ubiquitous with the pace of technology that is creating them these days. The inability to transfer physiological information of an individual to a healthcare server through alternative means of interaction prompts the growth of internet connectivity, which is very important in remote areas. In this case, the information transmission is performed according to the regular structure of ZK-BAN with three levels. The WBAN sensor collects the crucial information about the consumer and sends it either to the Sink or smartphone using satellite connection or via the internet in a remote or in a rural area. After passing the information to the medical server or health care facility, medical staff act accordingly.

Algorithm 3 /*Patient is located at Remote area */

```

Connect (Coordinator, Network)
{
  Collect Sensor data from different sensors;
  Send data to the coordinator;
  Send handshake signal (CTS, RTS);
  Coordinator connect to the nearest network;
}
Patient_to_medical_server_remoteara
{
  Initialize connectivity;
  If (patient is in remote area)
  {
    Check connectivity == Internet then goto 7;
  }
  Else
  {
    Check connectivity == No internet then goto 11;
    Check authentication;
    Check if patient is registered;
    Connect (Coordinator, Internet)
    Send data to the Medical Server;
  }
}

```

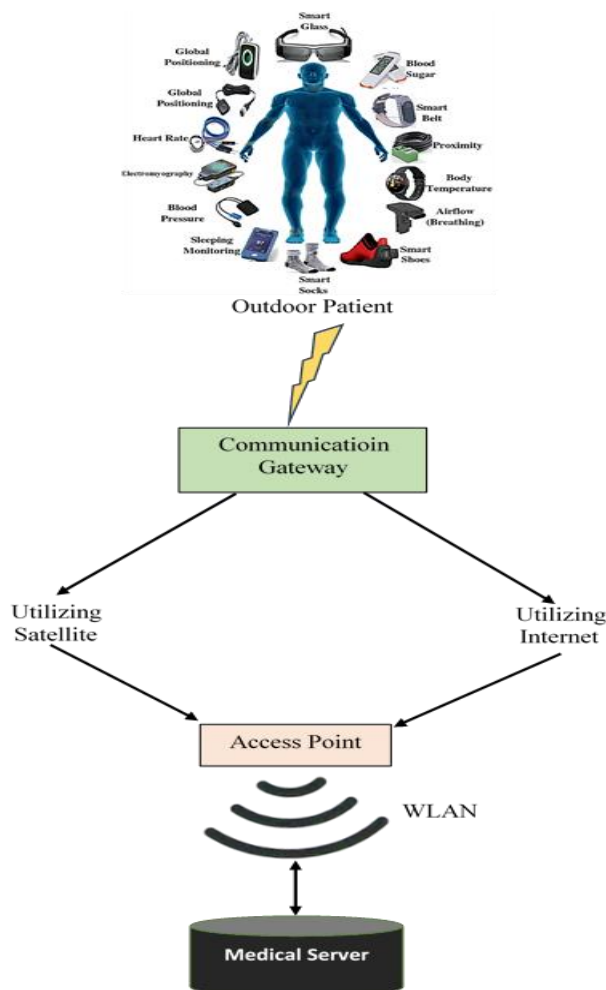


Figure 6: In remote environment data transfer from patient to medical server

4. Results and Discussions

In this section, we give numerical findings to the three suggested situations. It is employed in drawing the throughput and the number of communication connections nested in the different scenarios, as in Figures 7-12. Transmission of patient sensor information to the medical server is provided by a separate nested communication connection, it is shown that the throughput decreases radically as the nesting connection providing the communication lengthens. The poor routing paths, which occur as a result of end-to-end packet loss, queuing delays, and delays of packet delivery, lead to reduced throughput. End-to-end packet loss probability of wireless interaction are three; 0.1, 0.01, and 0.001. The above size of the packet of 50 KB is relied on to compute throughput in all situations, but in the case of VANET, the packet size is 0.5 KB. Among them, it is worth noting that at the above cases as represented in Figures 7-12, total throughput is maximized when the end-to-end percentage loss of packets is minimized. Three hierarchical layers are considered to transfer patients to the medical server or interior setting as illustrated in Figure 7 that represents the throughput of the indoor setting. Increased throughput is observed when the probability of packet loss of 0.1, 0.01 and 0.001 are considered but decreased throughput when the nested degree is increased. In Figure 8, the external medical environment is represented when essential data of clients is sent to the healthcare server through the internet. In the case, it is believed that patient-to-medical server flow of information needs four-point communications connection. Throughput increases with the decrease of the risk of packet loss to 0.1 to 0.01 to 0.001, and decreases with the increment of the nest level. Figure 9 depicts differences in throughput vs the number of point-point lines of communication. Data is temporarily stored on the mobile phone of the patient and could be transferred to the server using IEEE 802.15.1 or Bluetooth even when the user is out of area.

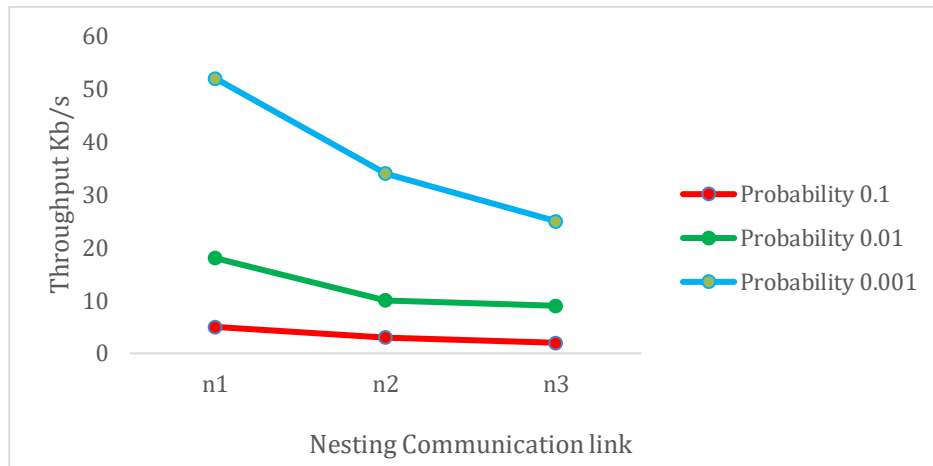


Figure 7: Throughput for scenario 1

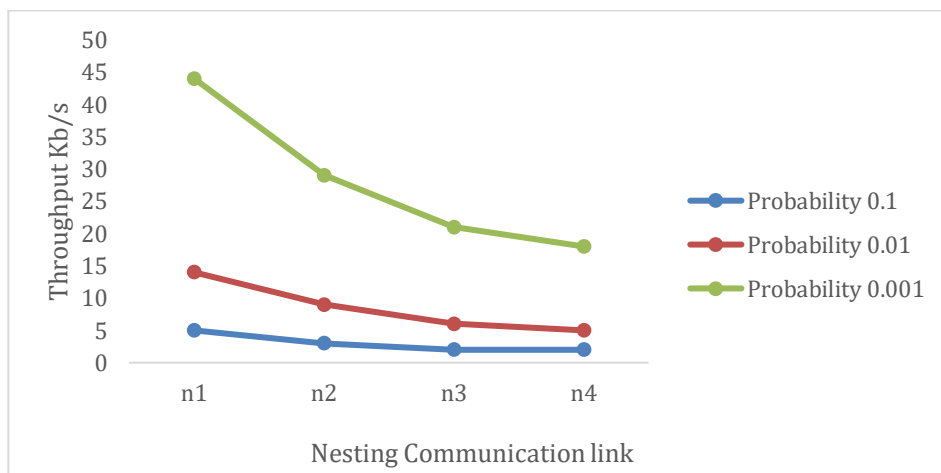


Figure 8: Throughput for scenario 2

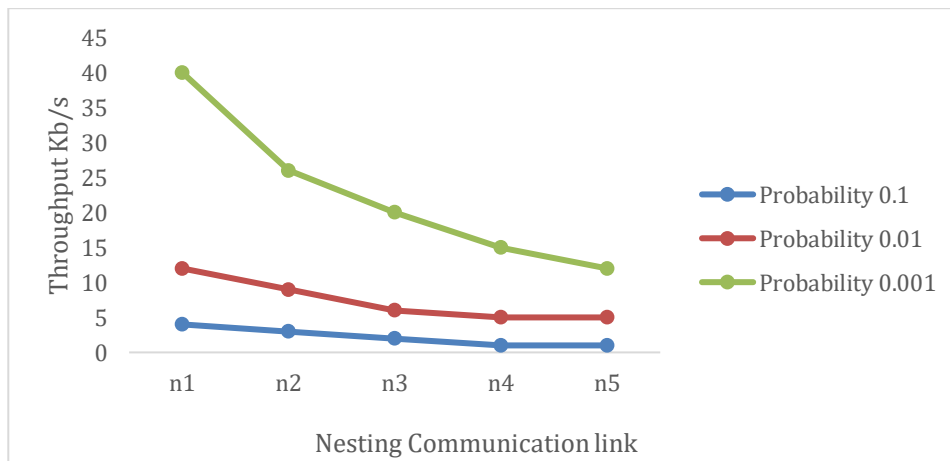


Figure 9: Throughput for Scenario 2 (Cloud)

Figures 10 and 11 depict throughput vs. Connection speed. In case a person happens to be offline outside the internet but an emergency happens, a beacon communication is passed to the medical server through VANET. In case of three VANET nodes considered in Figure 10 and four in Figure 11, respectively, seven and eight point-to-point connections occur to communicate in Figures 10 and 11. It has been discovered that the throughput is increased as the frequency of the packet loss is reduced i.e. to 0.1, 0.01 and 0.001, and it decreases as the direct communication connection increases. Figure 10 displays the throughput versus communications connection.

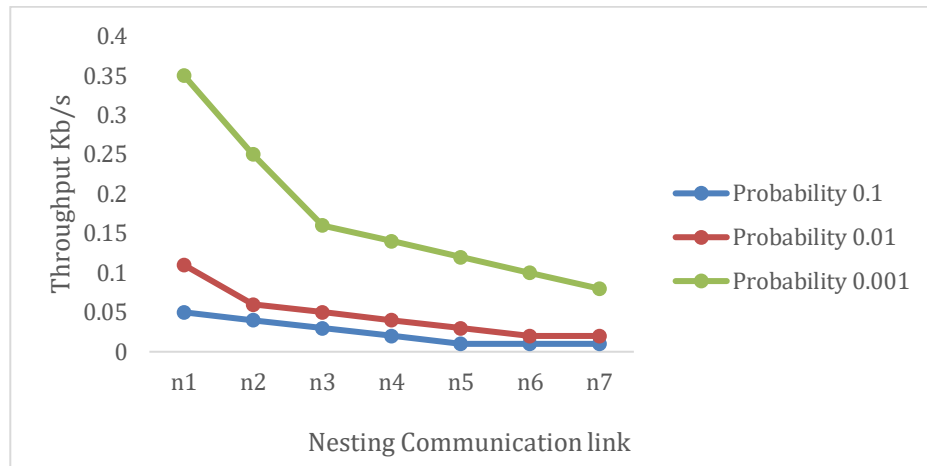


Figure 10: Throughput for Scenario 2 (VANET node 3)

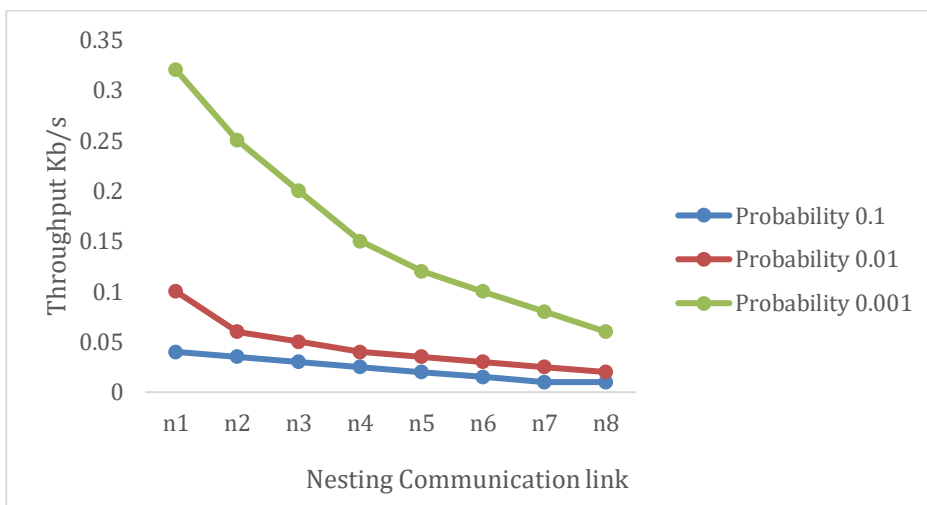


Figure 11: Throughput scenario 2 (VANET node 4)

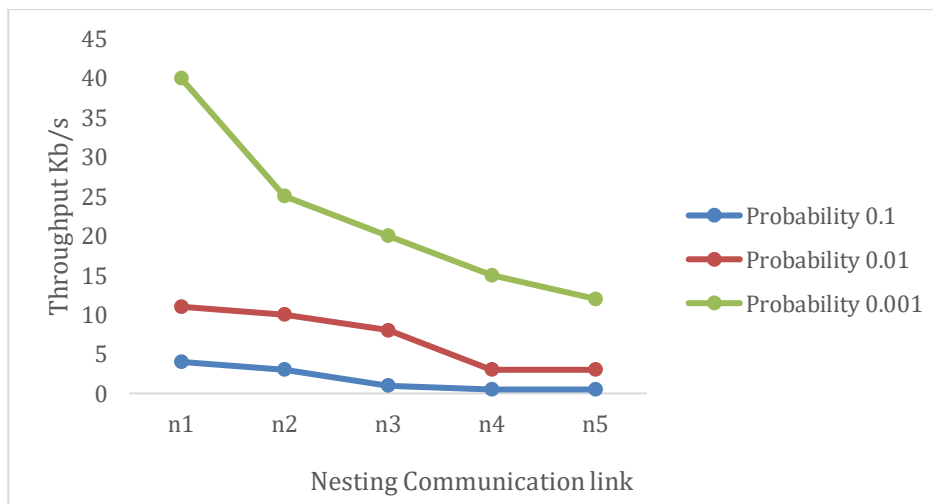


Figure 12: Throughput scenario 3

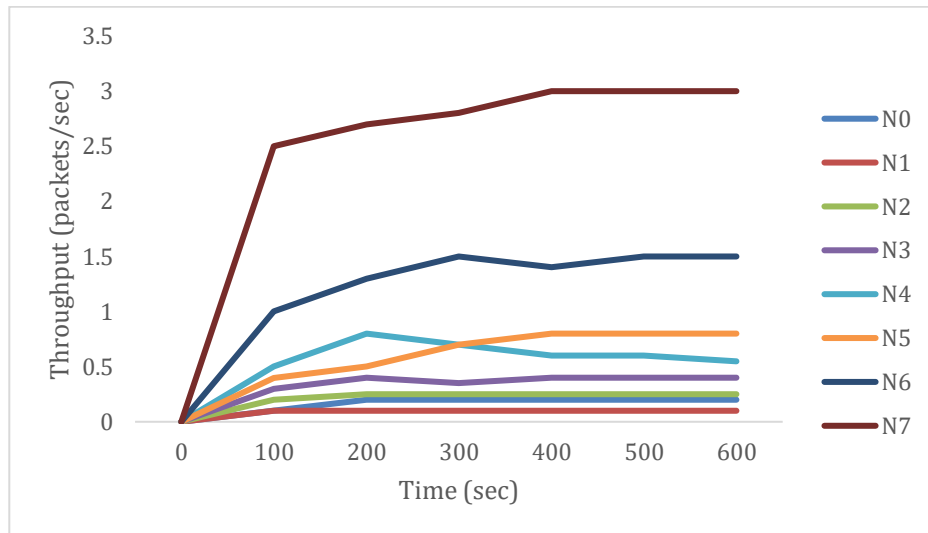


Figure 13: The throughput results

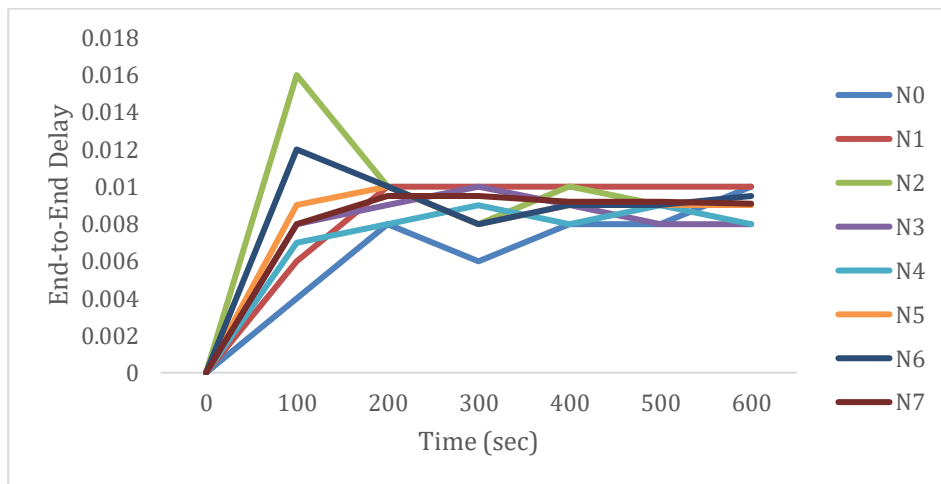


Figure 14: The end-to-end delay results.

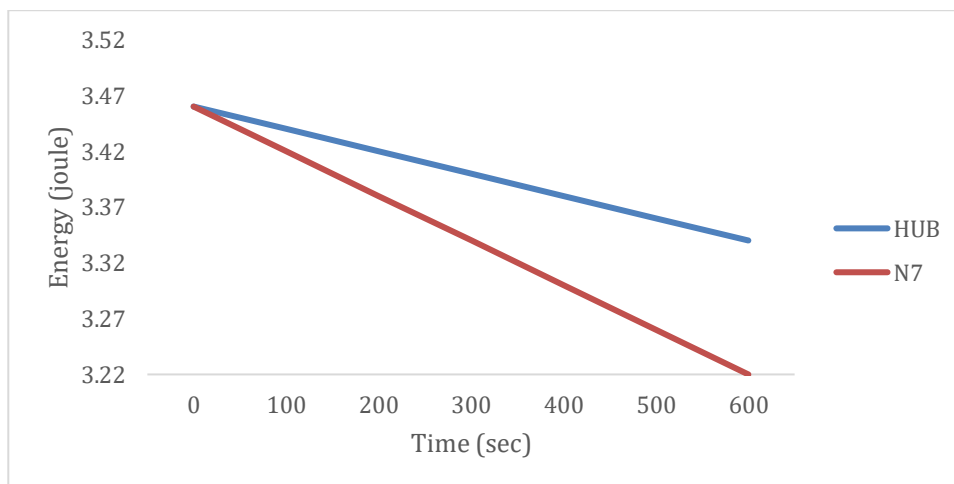


Figure 15: The energy consumption results.

Through the throughput figures, the information has been passed on to the gateway successfully. The production of the aforementioned information is carried out by N0 and N7 body nodes within HUB 0 intra wbana. The node with the highest priority and the shortest inter-arrival time of packets (N7) has the highest throughput as observed in Figure 13. The production of the aforementioned information is carried out by N0 and N7 body nodes within HUB 0 intra wbana. The node with the best throughput is the one with the highest priority, and the least inter-arrival time between packets such as N7 as depicted in

Figure 14. This objective has been achieved through the use of high-performance CSMA/CA based IEEE 802.15.6 and geographical routing protocols with priorities. The results indicate that the above technological capabilities are quite appropriate in an eHealth monitoring system. The end-to-end delay (EED) is the delay between the time a packet is received at its destination and the time it is created at the point of origin. The EED data in percentage is represented in figure 14. The data on the findings in the usage of energy is presented in Figure 15. The utilization of energy by the nodes is determined using the transmitting, acquiring, idle, and sleep modes. Each source gives one node and one HUB result as the output. The nodes also send the information to the hub and construct the packets and identify the channel. Nodes send information to hubs followed by identification of the medium, implementation of the methodology of routing and transmission of information to the neighboring node.

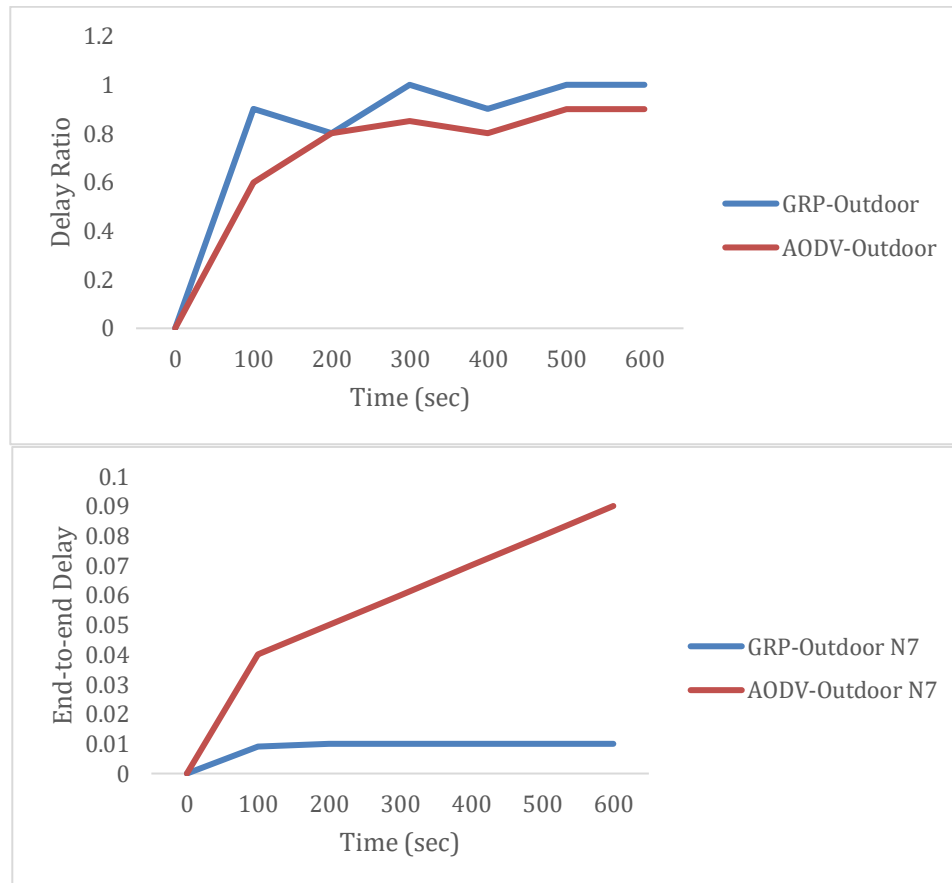
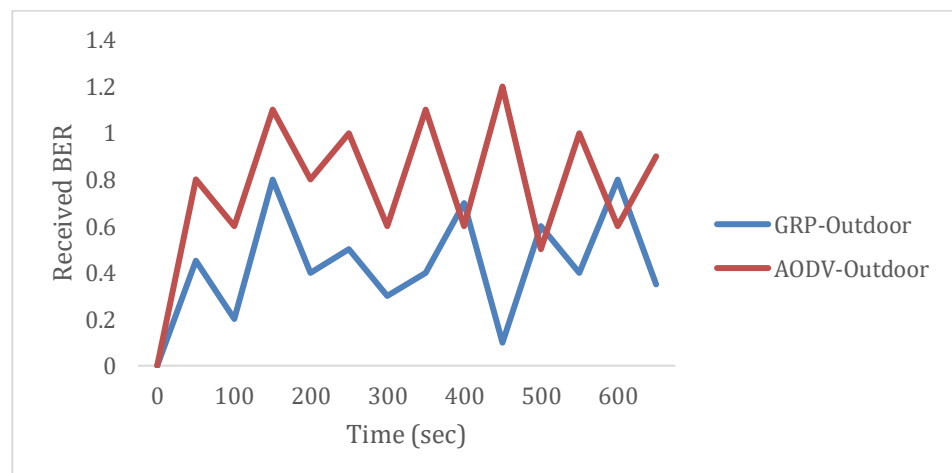


Figure 16: a) The end-to-end delivery ratio and b) delay of N7 for GRP and AODV.



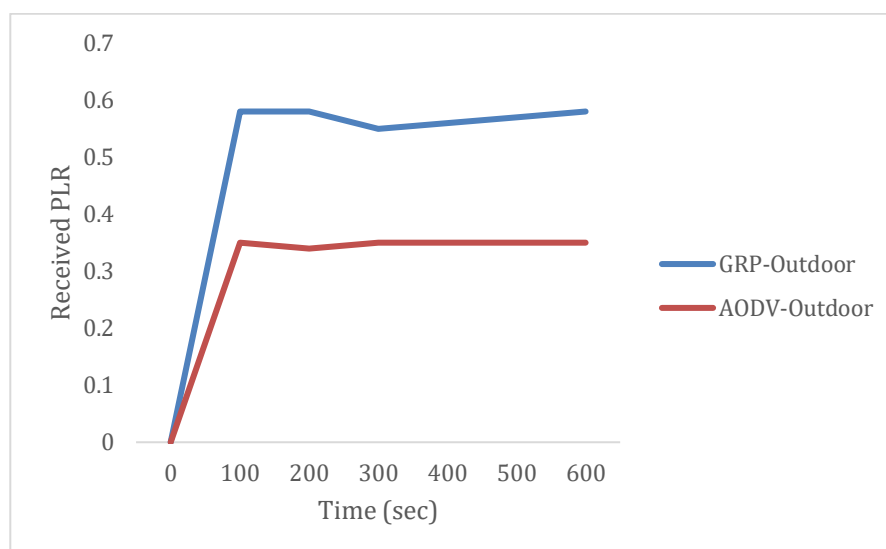


Figure 17: a) Bit error rate and b) Packet loss ratio for GRP and AODV.

Most routing protocols use neighborhood tables of nodes in order to determine routing decisions. These databases are made by means of routing beacons (packets). All nodes within the targeted area receive these packets and are cast on a continuous basis. The main problem of beacon-based algorithmic routing is that neighborhood information is not always up-to-date. The other problem is that beacons consume more resources and bandwidth and create the quantity of network traffic. This is a major problem especially in networks which are energy limited as in the case of WBAN. Figure 16 (a) compares percentages of ad hoc On-Demand Distance Vector (AODV) and geographic routing protocol (GRP) completion percentage of outside area delivery. Figure 16 (b) has compared delay analysis to the outside area with the node with the highest priority. The results prove the excellence of the GRP routing technique. We can conclude that the geographical data is important in outdoor routing systems. This disparity is known to be insignificant within. Figure 17 (a) provides the packet loss ratio (PLR) and received bit error rate (BER) of GRP with AODV routing protocols in the outdoor region in Figure 17 (b). Geographic routing methods using small, cheap and low-power GPS to calculate sensor locations depending on the signal strength make an efficient approach to energy constrained WBANs.

5. Conclusion

The implementation of WBAN, VANET, and IoT within the data transmission infrastructure can transform the healthcare and automotive networks and will form the basis of smarter, more connected, and more automated networks. This connection provides real-time exchange of information that is cross-domain and enhances the speed of emergency-based medical response and amplifies safety in driving situations. Such structures can be used to meet vital demands of reliability, low latency, and information confidentiality, due to the unique benefit of each of the network types VANET interaction with mobility, WBAN information gathering individually, and IoT involvement with a high number of connections. Such structures form a significant leap towards strong, flexible, and user-friendly intelligent systems and are crucial to the creation of autonomous healthcare surveillance, the enhancement of highway security, and the creation of seamless and data-driven methods throughout intelligent urban infrastructure.

Competing Interests

Conflict of Interest Statement

There is no conflict of interest

Data Availability Statement

Data not available due to commercial restrictions

Funding

No funding

References

- [1]. Behura, Aradhana. "Significance of Vehicular Ad Hoc Networks (VANETs) in Smart Healthcare: Research Challenges and Case Studies." Healthcare Analytics and Advanced Computational Intelligence. CRC Press, 2024. 193-220.

- [2]. Arafat, Muhammad Yeasir, Sungbum Pan, and EunSang Bak. "An adaptive reinforcement learning-based mobility-aware routing for heterogeneous wireless body area networks." *IEEE Sensors Journal* (2024).
- [3]. Mukhopadhyay, Adwitiya, et al. "A QoS-Aware IoT Edge Network for Mobile Telemedicine Enabling In-Transit Monitoring of Emergency Patients." *Future Internet* 16.2 (2024): 52.
- [4]. Gouiza, Nissrine, Hakim Jebari, And Kamal Rekloui. "Integration Of Iot-Enabled Technologies and Artificial Intelligence in Diverse Domains: Recent Advancements and Future Trends." *Journal of Theoretical and Applied Information Technology* 102.5 (2024).
- [5]. Al Barazanchi, Israa Ibraheem, et al. "Secure Trust Node Acquisition and Access Control for Privacy-Preserving Expertise Trust in WBAN Networks." *International Conference on Forthcoming Networks and Sustainability in the AIoT Era*. Cham: Springer Nature Switzerland, 2024.
- [6]. Rejeb, Abderahman, et al. "Unleashing the power of internet of things and blockchain: A comprehensive analysis and future directions." *Internet of Things and Cyber-Physical Systems* 4 (2024): 1-18.
- [7]. Al Barazanchi, Israa Ibraheem, et al. "Check for updates." *Forthcoming Networks and Sustainability in the AIoT Era: Second International Conference FoNeS-AIoT 2024*. Vol. 2. Springer Nature, 2024.
- [8]. Haddaji, Achref, Samiha Ayed, and Lamia Chaari Fourati. "A novel and efficient framework for in-vehicle security enforcement." *Ad Hoc Networks* 158 (2024): 103481.
- [9]. Rachakonda, Lakshmi Priya, Madhuri Siddula, and Vanlin Sathya. "A comprehensive study on IoT privacy and security challenges with focus on spectrum sharing in Next-Generation networks (5G/6G/beyond)." *High-Confidence Computing* (2024): 100220.
- [10]. Behura, Aradhana. "Intelligent Ambulance Services Management: A Comprehensive Medical Service for Emergency Healthcare." *Healthcare Analytics and Advanced Computational Intelligence*. CRC Press, 2024. 104-123.
- [11]. Dhiman, Gaurav, and Norah Saleh Alghamdi. "Smose: Artificial intelligence-based smart city framework using multi-objective and iot approach for consumer electronics application." *IEEE Transactions on Consumer Electronics* (2024).
- [12]. Chu, Tran-Tuan, et al. "A self-manageable network infrastructure towards supporting Healthcare transport communication." *IEEE Transactions on Vehicular Technology* (2024).
- [13]. Singh, Pawan, et al., eds. *Wireless Ad-hoc and Sensor Networks: Architecture, Protocols, and Applications*. CRC Press, 2024.
- [14]. Bekri, Wiem, Rihab Jmal, and Lamia Chaari Fourati. "Secure and trustworthiness IoT systems: investigations and literature review." *Telecommunication Systems* 85.3 (2024): 503-538.
- [15]. Obuseh, Gloria Obiageli, Ikechukwu Innocent Umeh, and Ikechukwu Udoka Onwuegbuzie. "Design And Implementation of Security Framework to Enhance Internet of Things Environments Using Crypto Model." CRC Press, 2023. 108-123
- [16]. Mahdi, Mohammed Najah, et al. "Comprehensive Review and Future Research Directions on ICT Standardisation." *Information* 15.11 (2024): 691.
- [17]. Pati, Abhilash, et al. "Simulating Fog of Medical Things: Research Challenges and Opportunities." *IEEE Access* (2024).
- [18]. Tunwal, Bhawna, et al. "The diverse technology of flying ad hoc networks (FANETs)." *Wireless Ad-hoc and Sensor Networks: Architecture, Protocols, and Applications* (2024): 48.
- [19]. Kumar, Sachin, and Pawan Kumar Verma. "A comparative study of collision avoidance medium access control protocols in internet-of-things." *International Journal of Cloud Computing* 13.2 (2024): 139-164.
- [20]. Shafik, Wasswa. "An Overview of Computational Modeling and Simulations in Wireless Communication Systems." *Computational Modeling and Simulation of Advanced Wireless Communication Systems* (2024): 8-40.
- [21]. Baskar, Prabu, et al. "Quantum Computing Smart City: Fostering Sustainability and Green Infrastructure With Smart City." *Applications and Principles of Quantum Computing*. IGI Global, 2024. 162-213.
- [22]. Kokila, M., and Srinivasa Reddy. "Authentication, Access Control and Scalability models in Internet of Things Security-A Review." *Cyber Security and Applications* (2024): 100057.
- [23]. Ouaisa, Mariyam, et al., eds. *Low-Power Wide Area Network for Large Scale Internet of Things: Architectures, Communication Protocols and Recent Trends*. CRC Press, 2024.
- [24]. Abdullah, Ako Muhammad. "An efficient energy-aware and reliable routing protocol to enhance the performance of wireless body area networks." *The Journal of Supercomputing* 80.10 (2024): 14773-14798.
- [25]. Masood, Isma, et al. "A blockchain-based system for patient data privacy and security." *Multimedia Tools and Applications* 83.21 (2024): 60443-60467.