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IoT-Based Motorbike Ambulance: Secure and Efficient Transportation

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Abstract: The predilection for 5G telemedicine networks has piqued the interest of industry researchers and academics. The most significant barrier to global telemedicine adoption is to achieve a secure and efficient transport of patients, which has two critical responsibilities. The first is to get the patient to the nearest hospital as quickly as possible, and the second is to keep the connection secure while traveling to the hospital. As a result, a new network scheme has been suggested to expand the medical delivery system, which is an agile network scheme to securely redirect ambulance motorbikes to the nearest hospital in emergency cases. This research provides a secured and efficient telemedicine transport strategy compatible with the vehicle social network (VSN). The proposed telemedicine method should find the best ambulance motorbike route for getting patients to the hospital as quickly as possible. This approach also enables the secure exchange of information between ambulance motorbikes and hospitals. Ant colony optimization (ACO) is utilized as a SWARM technique to expand the capabilities of 5G-wireless mesh networks to determine the best path. To secure communication, the secure socket layer (SSL), which is boosted once by the advanced encryption standard (AES), has achieved a new suggested scheme as a cybersecurity approach. According to the performance evaluation, this approach will determine the optimal route for motorbike ambulances. Additionally, this technique establishes a secure connection between ambulance motorbikes and the hospital. The study enhances telemedicine transportation.

Keywords: VSN; telemedicine; 5G-WMN; SWARM; AES-cybersecurity; motorbikes ambulance

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1. Introduction

The scenario of a telemedicine scheme is a comprehensive initiative platform to connect patients with doctors. The telemedicine platform allows patients to schedule appointments via portable applications [1]. There is a strong tendency for social networks to devote more time to developing telemedicine applications. It is important to note that there are many scenarios about patients losing their lives due to the late response time, or situations involving the leaking of patient details. Due to this, an active connection is necessary for each patient, especially during the navigation time of ambulance vehicles or motorbikes. Besides, the connections must also be secure. The efficient connection of the patient throughout the trip is important to achieve their safety. The latest vision of telemedicine models is how to utilize VSN technology to track ambulances to the closest hospital under a secure session. This is accomplished through the development of trusted telemedicine networks under the Internet of Things (IoT) umbrella with 5G network applications. Hence, the medical transportation system uses VSN to connect the ambulance with the hospital via a 5G-wireless mesh network [2] to aid in treating the patient in an emergency. However, two essential facets of VSN need to be discussed. The first is the problem of security, and the second is how to navigate a fast-track route to the closest hospital.

There are a variety of prior studies that have contributed to solving problems about data acquisition, transfer, analysis, and real-time intervention to enhance the various facets of life, and to evolving applications of car and health information systems. The telemedicine project developed by EPI-MEDICS is a creative tool for telemedicine researchers. It is easy to use, inexpensive, compact, and has an intelligent PEM for early-stage arrhythmia detection. The project can capture and attach each ECG with its reference using advanced neural network techniques and then submit the Personal Electronic Health Record to the patient. This study did not focus on improving patient contact during emergency cases, such as the patient time to transfer to the hospital [3]. The STARPAHC is a well-known telehealth project located on the Papago the Indian reservation near Tucson, Arizona, USA, and funded as a research case project by NASA and Indian medical services. A MHU represented a STARPAHC initiative to offer medical treatment through distance. The study did not develop an urgent plan and only went to a follow-up system [4]. The UTMB and TTHSC are both helping a healthcare agency to provide health services to Texas Department of Criminal Justice convicts. Telehealth addresses some of the issues posed to healthcare. For example, the prison distribution model is used to demonstrate the vision of telemedicine [5]. The EU-funded Telematics Management Project for Insulin Diabetes Mellitus also has been designed as a telemedicine framework for insulin-dependent diabetic patient management. The system depends on two interconnected units, the PU and the MU, which can connect through the Internet. Patients could immediately import their tracking data and upload it to the hospital database. This research presented reliable and secure patient data but was not interested in the details of rapid access [6]. Other research solutions have shown that the use of wireless BASN in telemedicine projects is necessary for the rehabilitation of global health and addressing patient safety issues [7,8]. Many solutions looked at how telemedicine technologies can be mobilized and combined with clinical medicine [9]. From a safety standpoint, some reports have proposed the idea of fine-grained access control for stable telemedicine connections. One study suggested that information extraction and convergence protection technologies could connect indoor medical information to the outdoor area [10]. Another study suggested to boost telehealth through developing a flexible wireless network based on IoT/sensor and cloud computing [11]. The Tavarua platform system is an open-source network project developed to build a high-quality telemedicine application [12]. Some other studies depend on packet traffic analysis to suggest a cyber approach. Utilizing this approach has resulted in a substantial improvement in efficiency [13]. The 5G-wireless networks have a swift involution of network traffic. Such traffic eliminates numerous core concerns related to QoS, routing and scheduling, resource control, power enhancement, latency, security management, and transport across processes such as software-defined networking and millimeter wave technologies [14]. The IoT fields are required to process large amounts of data in real-time. Thus, the data architecture spreads the parallel processing framework based on the Hadoop approach [15]. Wireless sensor networks have been attractive for medical applications, where the WSN network architecture is proposed to exploit sensor capacity to increase network efficiency [16]. The safety and medical aspects of driverless vehicles survey based on AVs focused on improved safety conditions, less environmental emissions, and an effective IoT infrastructure network [17]. Integrating LP-WAN communications into vehicle communications, which have expanded the long-range distance and enhanced vehicle network efficiency [18], was suggested. The rapid growth of mobile health in daily clinical practice led to implementing a diagnostic-based system to address the associated challenges in telemedicine [19]. Remote anesthetic treatment through telemedicine was handled for experimental purposes, as was a fruitful collaboration for several hospitals [20]. Live broadcasts of laparoscopic surgery will play a key role in surgical education by offering instant information to the surgical resident system [21]. Some authors proposed protocols to ensure information protection between doctors and patients in rural locations. These protocols used symmetric-key schemes to enhance the security of patient records, shared identification, the privacy of patients, honesty of data, freshness of contact, and mobility [22]. There is still a lack of longitudinal research, although some studies have shown that they can substitute for geographic differences in the supply of advanced services. Some of the suppliers provide tele-pharmacy services as an extension of telemedicine services, particularly for hospitals that do not have the experience of critical care pharmacists. Additionally, tele-stroke centers have effectiveness in the detection of strokes, the perception of pictures, and recognizing patients over time. Tele-emergency services have improved circulatory accidents, respiratory arrests, toxicological incidents, and trauma in remote hospitals [23]. One of the latest pieces of literature paid attention to the guarantee of patient credentials of telemedicine by using watermark images as one of the solutions for long-distance security problems to avoid a faulty diagnosis. The LZW algorithm was proposed in this work [24]. Some researchers focused on the NOMA approach to improve the QoS [25,26], and others focused on improving crowds by utilizing V2X [27]. On the other hand, some studies apply methods to reduce the traffic engaged and apply green transportation by using backscatter communication [28,29].

The contribution of this paper is to suggest a secure and efficient scheme for telemedicine transition services. The suggested telemedicine approach should determine the optimum ambulance motorbike route to transport patients to the hospital as soon as possible. This method allows for the secure exchange of information between ambulance motorcycles and hospitals. This scheme depends on solving the bottleneck problems of slow networks that emerge from the gap in speed between these networks and the cybersecurity problem for these networks. A middleware of 5G-wireless mesh networks suggested overcoming the efficiency problem by incorporating high-speed Ad-Hoc networks with wide coverage area networks, which the method achieves through three stages:

- The first step includes a 5G-wireless mesh network and splits it into VLANs, and each VLAN represents an independent wireless sub-network.
- The second step is writing a middleware application that handles the network and determines the closest end-to-end convenient access point using an appropriate algorithm to ensure that the patient is transported urgently to the nearest hospital.
- Third, the middleware transmits information to the network and monitors emergency motorbike information in the protected sockets layer to ensure the maximum degree of secure communication using the cryptography method. The ant colony hypothesis, one of the SWARM optimization methods recently used to solve short-tracking path problems, is proposed for quick access to the closest medical center.

In terms of security, employing Rijndael encryption to reassemble sequence fragments in the network layer was built as a challenge for the authentication part.

The remainder of this paper is structured as follows. The suggested method is outlined in Section 2, and the scheme is laid out in Sections 3 and 4. The performance analysis is illustrated in Section 5. The paper is concluded in Section 6. Table 1 illustrates and describes the abbreviations used in the study.

Table 1. Table of abbreviations.

Abbreviations	Describes
VSN	Vehicle social network
ACO	Ant colony optimization
SSL	Secure socket layer
AES	Advanced encryption standard
IoT	Internet of Things
PEM	Personal ECG monitor

Table 1. *Cont.*

Abbreviations	Describes
ECGs	Electrocardiogram
MHU	Mobile health unit
UTMB	University of Texas Medical Branch
TTHSC	Texas Tech Health Science Centre
MU	Medical unit
PU	Patient unit
BASN	Body area sensor networks
QoS	Quality of service
AVs	Autonomous vehicles
LP-WAN	Low power–wide area network
LZW	Lempel-Ziv-Welch
NOMA	Non-orthogonal multi-access
V2X	Vehicular-to-everything
VLANs	Virtual local area networks
IoV	Internal-of-vehicle
SN	Social Network
WMNs	Wireless mesh networks
WLAN	Wireless local area network
APs	Access points
AC	Access controller
TLS	Transport layer security
TL	Transport layer
GUI	Graphical user interface
NDF	Network diagnostics file
STA	Station
RTS	Request test signal
CTS	Conform test signal
MP	Mesh point
MPP	Mesh portal point
MSS	Maximum segment size

2. Preliminaries

2.1. 5G-Wireless Networks and IoT

In 1990, Japan was the leader in 3G, opening the door to the Internet on handheld computers. The United States dominated 4G with the use of live-streams. For 5G, China leads the networking and promises a modern cellular system with a speed up to 100 times higher than 4G [30]. Billions of computers and applications can connect to the 5G network. Furthermore, 5G is the launching point for the IoT, smart cities, and telemedicine applications. Since September 2018, the Fangshan government and the Chinese Telecom operator have been using a 10 km 5G-wireless path connecting vehicles and their surroundings. China Mobile and China Telecom have built 5G in the "Xiong'an" (129 km southwest of Beijing) smart city in China. Today, China's municipal authorities urge developers to use the 5G-wireless network for telemedicine and urban infrastructure applications.

2.2. Vehicle Social Networks

VSNs are the integration of the IoV and SN. VSNs encourage drivers to exchange information on social networks. Utilizing the 5G-wireless network on the Ambulances for the medical center chains has drawn interest in society recently. Besides, using the VSNs in telemedicine in urgent cases to bring together doctors and patients in medical decision-making is also significant [31].

2.3. Telemedicine Services Based on WMNs

WMNs have emerged as a 5G generation VSN technology due to their ability to provide high bandwidth at a low cost. WMNs combines WLAN and Ad-Hoc network capabilities to produce wireless networks for large regions. These features are attractive for telemedicine due to the ability to offer long-distance services, e.g., Emergency Room Connect in Tucson, Arizona. As a result, WMNs are very desirable in terms of expense, reliability, and efficiency [32]. As seen in Figure 1, WMNs are a series of wireless access routers and computers. According to the IEEE 802.11 network protocol, the network relies on wireless connectivity between the nodes [33]. WMNs consist of multiple internal APs managed concurrently by the AC. WMNs are the central expertise to developing Ad-Hoc networks where driver sharing with platform services can be accomplished [34].

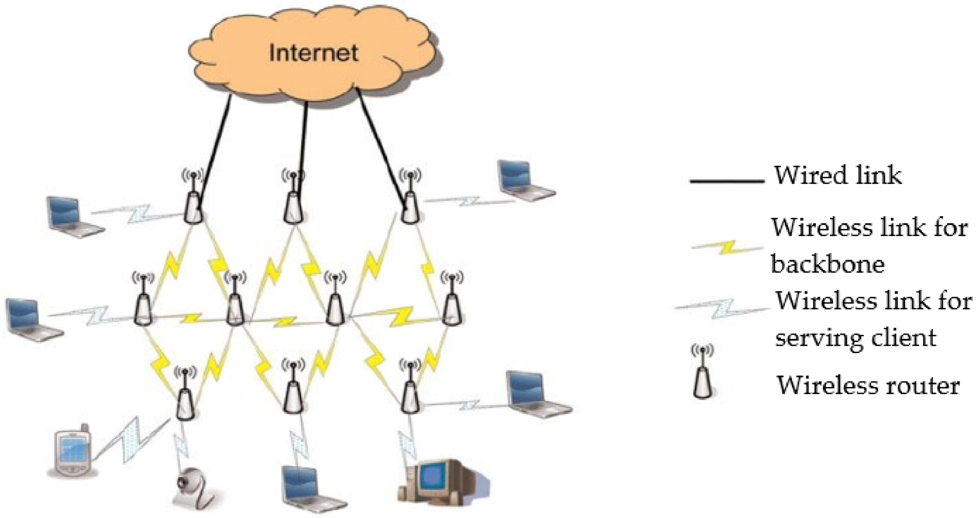


Figure 1. Architecture of wireless mesh networks.

2.4. *Intelligent Ant Colony Optimization (ACO)*

SWARM is a technique that aims to influence the behavior of a specific system by exploiting the behavior of a colony of animals [35,36]. The ant colony, for instance, is one of many colonies used by intelligent SWARM in the field of networks. The approach summarizes the technique of the ants to access food in terms of time. As a result, the network that adopts this strategy can supply information as quickly as possible. The ant colony approach is convenient for flexible networks since such networks do not have an infrastructure or centralized management. Therefore, Ad-Hoc networks are ideal for this temporary network connectivity [37]. The incentive to use a SWARM to boost the telemedicine system is to use the highest and nearest throughput to achieve high streaming efficiency.

2.5. *Transport Layer Security (TLS)*

The re-fragmentation process is an encapsulated procedure in the protected TL used to secure data access within a given network. The security mechanism depends on the sequence of the standard fragments formed by the transport layer. This method is a successful tactic against threats and prohibits intruders from receiving the correct information [38]. The re-fragmentation between transport layers to network layers of the TCP/IP protocol is called an end-to-end access point on the network. The technique provides controls and policies to permit operators with a correct sequence of fragments but prohibits malicious actors from accessing the data [39]. Additionally, to deter possible intruders from entering the network, each terminal computer must have an ID number and block the non-compliant ID [40]. It is necessary to remember that wireless networks are not as reliable as wired networks [41]. Re-fragmentation is one of the powerful security techniques for the defense of wireless networks [42].

2.6. *OMNeT++*

The case network simulator "OMNeT++" is one of the SDN frameworks. OMNeT++ uses C++ as an optimized programming environment to send and receive network messages based on the event approach. GUI is used to virtualize nodes in the network. The simulator creates an extended CC file for server and client submodules. OMNeT++ simulates network flow by setting up a network summary file called NDF. Figure 2 displays three servers representing hospitals and one client representing the STA. The STA sends a request signal called a RTS to request a test signal and receive a CTS from all hospitals in the near region. Once the CTS is obtained, a specified module within the STA will find the round-trip time for all via the SimTime () feature. The ambulance motorbike can then find and connect with the closest hospital [43].

Figure 2. OMNeT++ simulation for telemedicine system.

3. The Proposed System

As seen in Figure 3, the telemedicine scheme consists of three networks. An intelligent ambulance motorbike network, a hospital mesh network, and a 5G infrastructure network capable of delivering cloud computing and connectivity facilities for ambulance motorbikes.

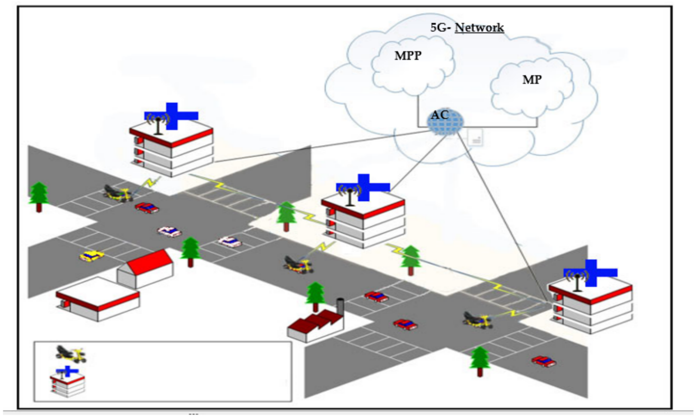


Figure 3. The scheme of the telemedicine network, features, and challenges.

Relations follow the protocol of the VSN enabled by the 5G network, and the telemedicine middleware under the VSN umbrella has additional features, as follows:

- The motorbike's SWARM computing algorithm is programmed to find the best way.
- Middleware is more reliable than any other Ad-Hoc middleware network because of the proposed encryption approach added to the TCP/IP network layer.

The proposed system aims to provide a strong connection and reliable access to the nearest hospital by utilizing the advantage of the 5G-wireless mesh network. The structure layout was divided into two medical centers, as shown in Figure 4. The STAs are fitted with middleware and are an emergency motorbike, which sends a test packet to the two nearby medical centers to compare the throughput. The middleware then selects a decent broadband to support the patient. This technique is the same as SWARM to increase the network performance. The middleware sends the patient's private information, which is re-sequenced by the AES encryption re-fragmentation process to ensure confidentiality between the STA and the medical center. Fragments send as a bi-directional approach between the treatment center and the recipient, which varies from the original series. Thus, the patient can find a better care facility without revealing their name.

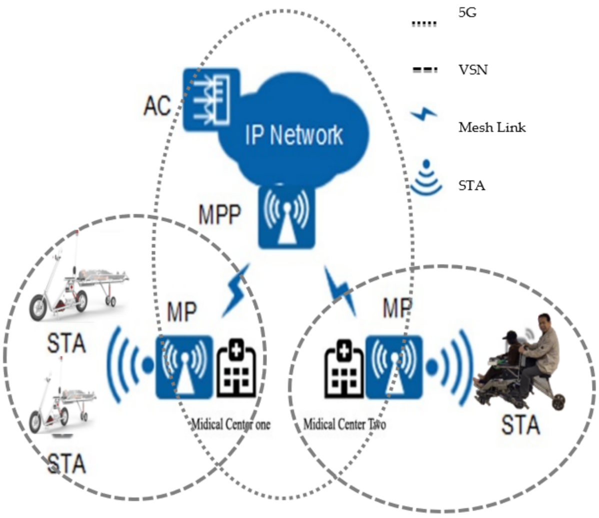


Figure 4. Overall proposed system architecture.

3.1. Network Architecture

Based on their characteristics, devices in WMN can be classified dependently into the following classes:

- MP is a wireless network internal connection point that can perform automatic path finding and packet forwarding.
- MPP is an external connection point that can join the WMN or other network types.
- AC is a controller configured to ensure continuous packet forwarding and high reliability.

For example, as seen in Figure 5, the WMN consists of two devices offering wireless access services for Medical Center 1 and Medical Center 2. MPP links the two medical centers to the Internet. AC provides a high broadband and a more secure Internet link for the device.

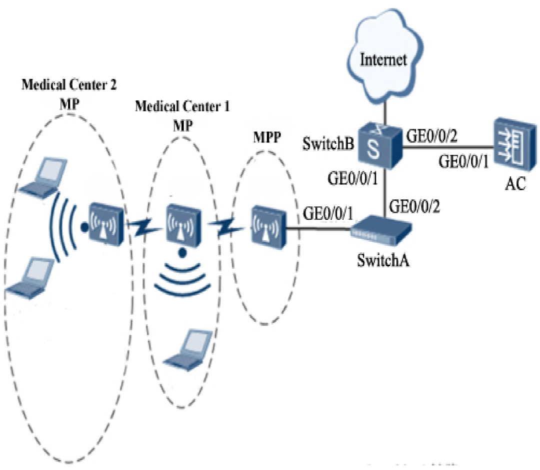


Figure 5. Suggested wireless mesh network.

3.2. The Proposed Delivery Algorithm

The SWARM algorithm is used to optimize network bottleneck problems. The suggested method follows the ant colony algorithm, one of the SWARM techniques. In nature, the ant colony is a colony that sends ants into roaming unexpectedly and they return to their nest after seeking food when laying down tracks. If other ants find such a short route, they are likely not to go to the random path but follow that short path and strengthen that path if they finally find food. Ants use unique chemical scents called pheromones to accomplish this goal. However, as time passes, the pheromone grows in the time it takes an ant to travel toward the road and back again. As the ant trip along the shortest path, the pheromone density stays elevated for a longer time. Driven by this theory, the proposed device uses throughput rather than pheromone as a gauge to find the optimal bandwidth in the network. ACO is a series of intelligent routers. ACO mimics the actions of ants to locate the nearest hospital using cooperation and adaptation mechanisms. The indicated algorithm is seen in Algorithm 1 [44].

Algorithm 1. Ant colony optimization

01. Input: sub-networks' throughput.
02. Output: Compute the best throughput for ambulance motorcycles, then the fast network path can follow to achieve efficiency.
03. Initialize the number of network nodes, n, and other parameters.
04. While (the end criterion is not met) do
05. t = t + 1;
06. For k = 1 to n
07. The ambulance motorbike is positioned on a starting node;
08. For m = 2 to hospital node number
09. Send test signals into hospitals according to the probabilistic transition rules;
10. Append return throughput that is calculated according to Equation (1);
11. End for
12. Compute $P_{ij}^{k}(t)$ for each hospital node according to Equation (2);
13. Compute the highest throughput according to Equation (3);
14. End for
15. Update the trail throughput for nodes concerning the time;
16. Compute and update the best solution;
17. End while.

- The problem has to be correctly defined, allowing the middleware to change the solutions incrementally by use of probabilistic transformation rules depending on the amount of throughput in the trail.
- Give a test signal in various directions and check the highest throughput. Based on the throughput, the device may recommend a link. The machine then redirects all data transfers to the maximum throughput connectivity with the respective hospitals.
- The description and measurement of the production are shown in Equation (1):

$$RT = \frac{(RWIN)}{(RTT)} \quad (1)$$

where:

RT, real throughput.
RTT, round-trip time.
RWIN, receive window size.

- Describe the heuristic function (η) that calculates the consistency of components that could be applied to the current partial solution to estimate the output.
- The rule set for the output is defined, which calculates how to change the output value (t).
- The probabilistic conversion rule is developed to concentrate on the heuristic function value (η) and the throughput used to create a fast-track assessment approach.
- The likelihood of paths is given in Equation (2):

$$P_{ij}^{k}(t) = \frac{\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}(t)\right]^{\beta}}{\sum_{\iota \in N_i^k}\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}(t)\right]^{\beta}}\ \iota \in N_i^k \quad (2)$$

where:

N_i^k, is the feasible neighborhood of the router that the telemedicine project has covered.
$\tau_{ij}(t)$, is the throughput value on the edge (i, j) at the time t.
$\eta_{ij}(t)$ is a priori available heuristic information on the edge (i, j) at the time t.
α is the weight of the throughput.
β is the weight of the heuristic information.

The two parameters α and β determine the relative influence of the throughput trail and heuristic information.

- The output value at the edge (i, j) at the time (t) is given by Equation (3):

$$\tau_{ij}(t) = \rho\tau_{ij}(t-1) + \sum_{k=1}^{n} \Delta\tau_{ij}^{k}(t)\ \forall(ij) \quad (3)$$

where:

$\tau_{ij}(t)$, is the throughput trail evaporation rate ($0 < t < 1$).
n is the number of servers.
$\Delta\tau_{ij}(t)$ is a constant for throughput updating.

3.3. The Proposed Authentication Scheme

In this study, the network layer fragmentation index in the TCP/IP protocol and the handshake sequence encryption utilizing the AES method were combined concurrently as one authentication method. The proposed encryption system is modern secure connectivity for VSN under 5G network computing. The specifications of the suggested authentication scheme have been shown in Figure 6. The emergency motorbike-to-ambulance as STA and hospital-to-hospital as MP links are encrypted. The ambulance motorbike-to-environment as MPP is also covered. In the first part of the scheme, the MSS is the maximum number of bits transmitted in a single segment and cannot be expanded during transmission, as noted in Equation (4). These segments are later re-assembled at the other end of the transmission process. Besides, each segment must be indexing by the ID number that has been selected between the send and receive ports. This process leads to the proper reorganization of the details. The section and its index number are considered fragments. The fragments are sent and received at the other end, which is called the fragmentation process, as observed in Figure 7. Thus, from the example, it must be known that there is a set of (index, frame) frames, each of which has an index, and the order of the indexes must be symmetrical in two pairs. The index series between the sender and receiver must be re-ordered using the AES encryption method, which is re-fragmented using the suggested strategy. To meet the required authentication, the AES must adjust the frame series to conform to the security specifications. Otherwise, the attacker will trace the ambulance motorbike. As seen in Figure 8, an authentication protocol was performed between the STA and MP as the ambulance motorbike traveled into the hospital's wireless contact range. STA performs the function of the key protected node with more authentication capacity than MP. During the authentication process, a protection process has been carried out from MPP to STA to enhance security efficiency. Each step of the proposed authentication protocol is illustrated in detail, as shown in Algorithm 2. The ID header variable indicates the number of frames measured in the first step of the algorithm. Thus, the algorithm starts with the initial vector, transmits the header IDs to the registry buffer, and then organizes these IDs depending on AES.

$$\text{MSS} = \text{MTU} - 40\ (\text{IP header}(20) + \text{TCP header}(20)) \tag{4}$$

Algorithm 2. Authentication

```
Input: the sequence of frames IDs from the network layer.
Output: the encrypted/decrypted sequence of frames IDs.
Import scapy and socket libraries.
Initialize port.
ec = 1 for encryption.
ec = 0 for decryption.
Define fragments array ().
For (I = 0; I <= The frame number; i++)
     If (ec == 0) // inverse the key
End for
For (I = 0; I <= The frame size: i++)
     Inv_Opt_keyexpansion(key,1);
End for
For (i = 0; i <= round; i ++)
     addroundkey;
     If (i ==10) break;
       Inv_Opt_keyexpansion(key,ec);
     End if
End for
If (ec == 1)
    Inv_Opt_subbytes(ec);
    Inv_Opt_shiftrows(ec);
End for
If (i < 9)
    Inv_Opt_mixcolumns(ec);
    ElseIf (i > 0)
     Inv_Opt_mixcolumns(ec);
     Inv_Opt_shiftrows(ec);
     Inv_Opt_subbytes(ec);
  End if
End if
append.PacketList()
       pkts.append(IP(flags = "MF", frag = 0)/(message [0])) #8
       pkts.append(IP(flags = "MF", frag = 2)/(message [1])) #8
       pkts.append(IP(flags = "MF", frag = 3)/(message [2])) #8
       pkts.append(IP(flags = "MF", frag = 1)/(message [3])) #8
       return pkts
s = socket(AF_INET, SOCK_STREAM)
s.bind((HOST, PORT))
s.listen(1)
conn, addr = s.accept()
data = conn.recv(1024)
conn.close()
```

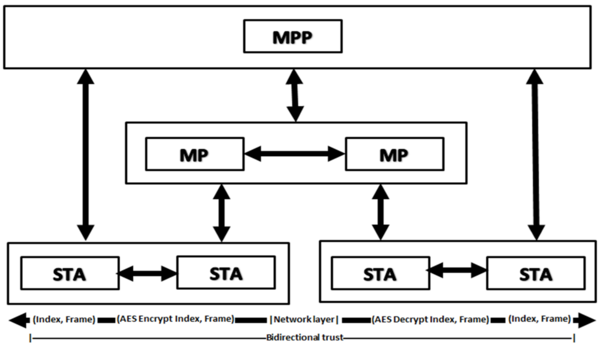


Figure 6. Proposed trust model.

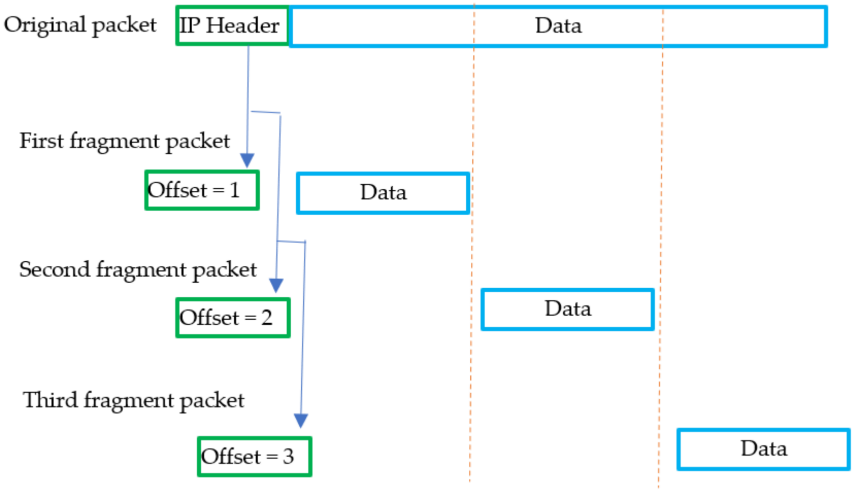


Figure 7. IP packet fragmentation in the network layer.

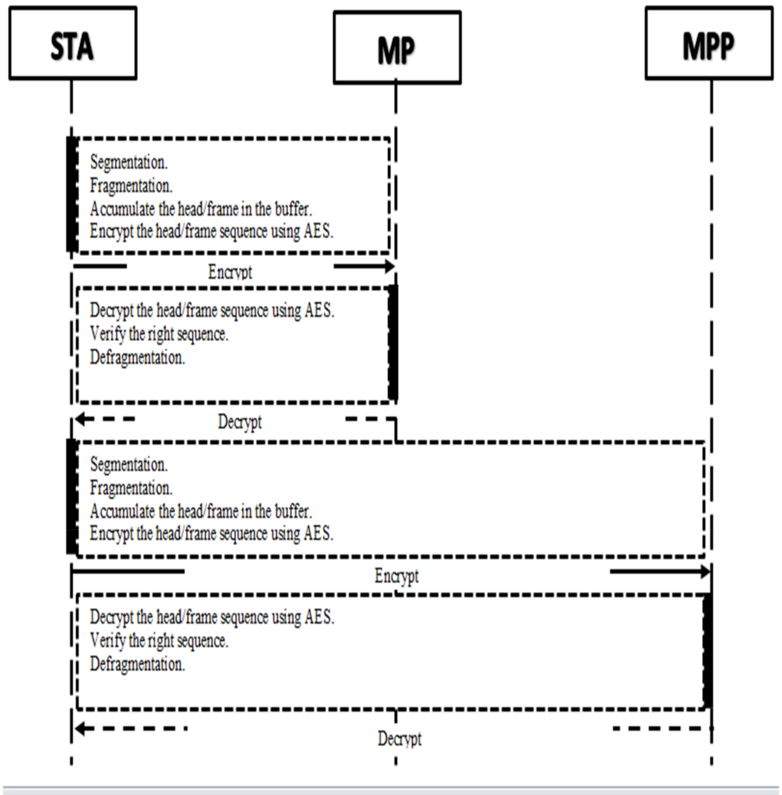


Figure 8. Authentication protocol.

4. System Implementation

The system consists of one access controller (Huawei AC6605), one wireless router (Huawei AP6010DN-AGN) configured as an MPP, and two wireless routers (Huawei AP6010DN-AGN) configured as MPs, as seen in Figure 9. The middleware was developed by a programming environment called Python. This middleware consists of two interconnected parts: the Client-Middleware and the Server-Middleware, for each medical center. WMN wireless router tables update after 30 s. MPP (Center 1) binds to WMN and sends VLAN network control messages from the access controller. MP1 (Center 2) and MP2 (Center 3) offer access facilitation to WMN terminals. Finally, Center 2 and Center 3 become inside the medical center coverage region within the Ad-Hoc network. Access controllers and access points (APs) configure using CTL [45], as shown in Table 2.

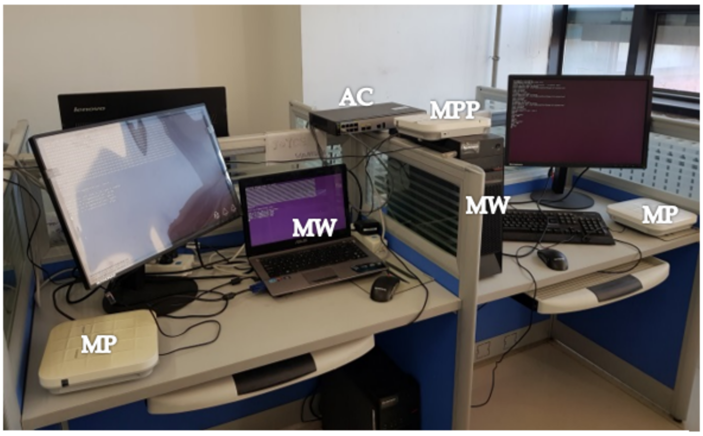


Figure 9. Components and configuration of the system. MP: mesh point, MPP: mesh portal point, MW: middleware, and AC: access controller.

Table 2. Configuration of the mesh network.

Device	Type	My Net	Radio	Configuration
AP1	AP6010DN	192.168.1.1/24	Center1	Channel 40 MHz-plus 157
AP2	AP6010DN	192.168.2.1/24	Center2	Ap-region 102, 102, 103
AP3	AP6010DN	192.168.3.1/24	Center3	Forward mode
AC	AC6605	VLAN 100	mesh1	p/w: 12345678

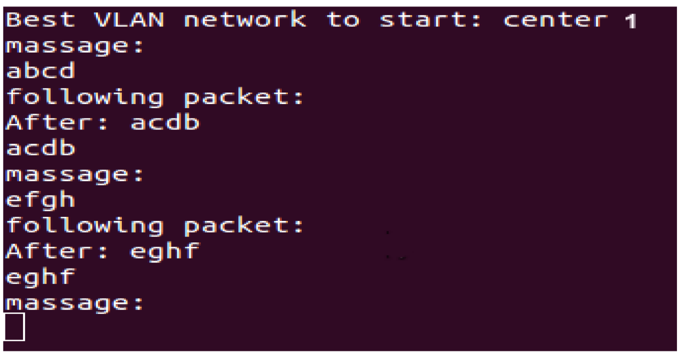
The middleware was initially designed for a link session (soft port number and IP) using socket () library commands (socket(AF INET, SOCK STREAM), conn.listen (), conn.bind (), conn.send () and conn.recv ()). The middleware then sends an initial packet to both Center 2 and Center 3 networks. Finally, for each network, the output is determined by the OS (), SYS (), and Time () libraries. The speed of signal transmission is used as one of the viable alternatives to determine how close the ambulance is to the hospital. Furthermore, achieving a speedy transfer allows the motorcycle ambulance to have a quick and secure session to enquire about the patient's details. The use of throughput is not the ideal method for ensuring the patient's proximity to the nearest hospital, but it is one of the alternatives given to assist the patient. Based on the best throughput, the middleware tests which network is appropriate for connectivity and which medical center is closest to the user. The findings are presented in Figure 10. Round-trip latency is the time to reach the terminal at a measured distance. The packet window size for the test signal was 64 KB. The three hospitals in Table 3 indicate various motorbike emergency sites with different suggestions for the highest throughput to connect. The three scenarios in Table 3 demonstrate the network mesh approach. In the first example, Hospital 1 is a better recommendation, with a throughput of 17.4 Mbps. In the second example, Hospital 3 is recommended, with a 30 Mbps throughput. In the third case, Hospital 2, with 52 Mbps.

Figure 10. The system sends and receives test signals to choose a suitable network.

Table 3. Throughput theoretical calculation for the long distance of the WMN.

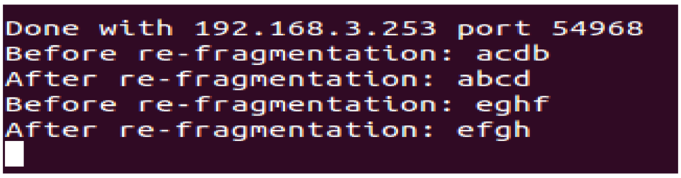
Scenario	Hospitals	Window Size (KB)	Round-Trip Latency (S)	Throughput (Mbps)
Near From Hospital 1	Hospital 1	64	0.03	17.47626667
	Hospital 2	64	0.09	5.825422222
	Hospital 3	64	0.05	10.48576
Near From Hospital 3	Hospital 1	64	0.02	26.2144
	Hospital 2	64	0.2	2.62144
	Hospital 3	64	0.017	30.84047059
Near From Hospital 2	Hospital 1	64	0.07	7.489828571
	Hospital 2	64	0.01	52.4288
	Hospital 3	64	0.44	1.191563636

In the proposed method, the re-fragmentation has been carried out in conjunction with the AES between the Server-Middleware and the Client-Middleware to protect the patient's identity using the Scapy () library. The findings are clearly illustrated in Figure 11.



(**a**)

Figure 11. *Cont.*



(**b**)

Figure 11. Re-fragmentation results between medical centers. (**a**) Sender. (**b**) Receiver.

5. Performance Analysis

The telemedicine device has demonstrated vulnerabilities to malware threats and sluggish transport operations. Previous research has employed a variety of hypotheses to promote telemedicine. Among the most notable is the EPI-MEDI project, which was designed as a unique telemedicine tool for PEM monitoring [3]. The MHU was used for the first time in India to implement the STARPAHC telehealth project [4]. Telehealth services are available at the Texas Criminal Justice Institute [5], and within the Diabetics Telematics Management Project, sponsored by the EU [6]. BASN use is seen in some telemedicine initiatives [7,8]. The mobility of medical and other data has been analyzed using the optimization technique [13]. New approaches for the distribution of trust and the enhancement of QoS can be applied by incorporating the principle of trusted collaboration and SWARM strategies. This paper acknowledges the basic safety and quality criteria of the telemedicine project. In comparison, the simulation efficiency review indicated a substantial change. This system is scalable as the number of nodes increases and works well even with a fraction of the time delay.

In case a stronger signal (higher throughput) is received from a hospital that is physically inaccessible or full and cannot accept any more patients, the proposed model allows the ambulance motorbike to communicate with the hospital via a secure session and inform the driver to redirect the connection to another hospital. After implementing SWARM technology, ambulance motorbikes first transmit a small block window as a test signal to all surrounding hospitals within the coverage area. Second, the best throughput is decided as an indicator of the nearest hospital, then the emergency motorbike is connected to this hospital. Sending a test signal to check the shortest path is more effective than sending the information arbitrarily. Besides, the question of patient privacy is critical when it involves life or death. Figure 12 shows the example of timing diagrams before and after the SWARM technique. After applying the SWARM technique, the emergency motorbike first sends a small window as a test signal to the nearby hospitals, then selects the required throughput, and then connects to the closest hospital.

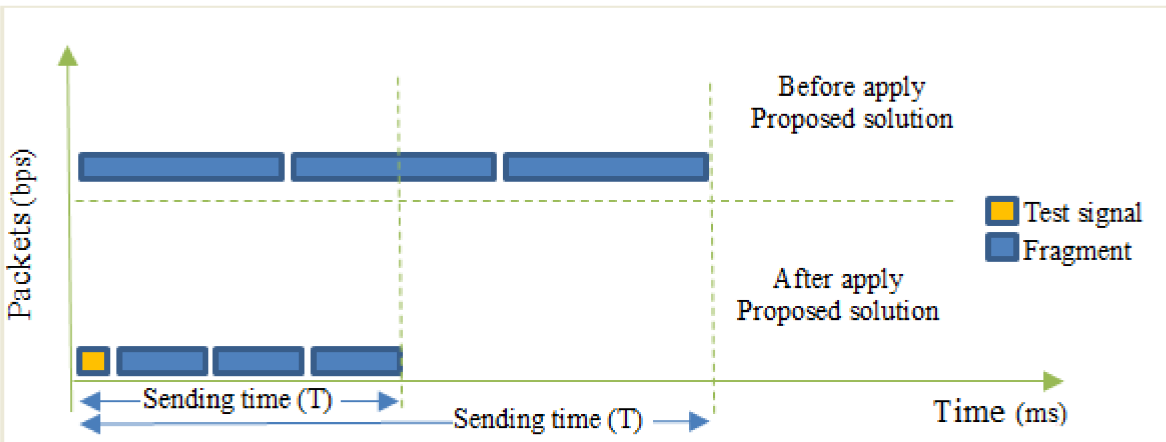


Figure 12. Proposed system timing diagram.

5.1. Throughput Analysis

The ambulance motorbike monitors the throughput three times, as shown in Figure 13. At each point, the location of the ambulance motorbike changed according to the various hospitals. The considerable throughput smoothing effect is determined based on round-trip latency and set packet window duration. The findings suggest that the high throughput increase means that the hospital is close as the round-trip time is short. In the initial deployment, it is unclear how many joint hospitals would concurrently transmit a signal that could lead to interference through networks, whether a wireless channel or a broadband flow. Hence, the interaction with external signals has contributed to a decrease in aggregate throughput, but it can estimate from the study that the mesh network has sufficient coverage.

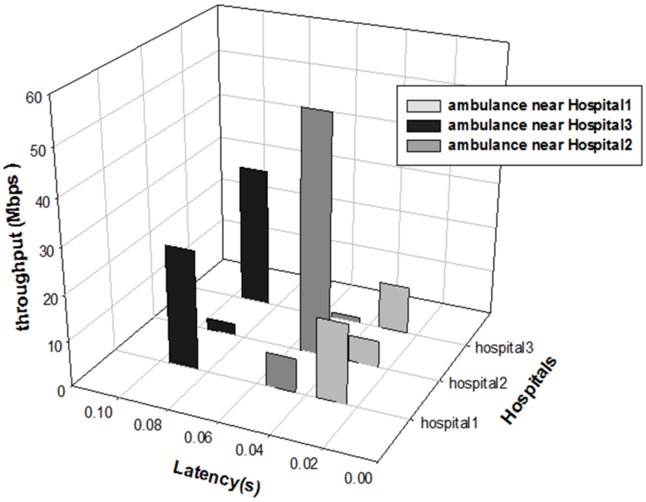


Figure 13. Throughput across round-trip distance latency.

5.2. Simulation

The OMNeT++ simulator presented the signal traffic, as in Figure 14. Here, the signal obeys the handshaking technique of UDP synchronization, where the request and response signals are shared. This simulator explores the three medical networks and the ambulance motorbike. The ambulance sends messages to all hospitals from the signal traffic scheme. Besides, the ambulance chooses to connect to Hospital 1. Not to mention, the middleware re-configures fragmentation standardization in the embedded layer of the network, which is not easy to break.

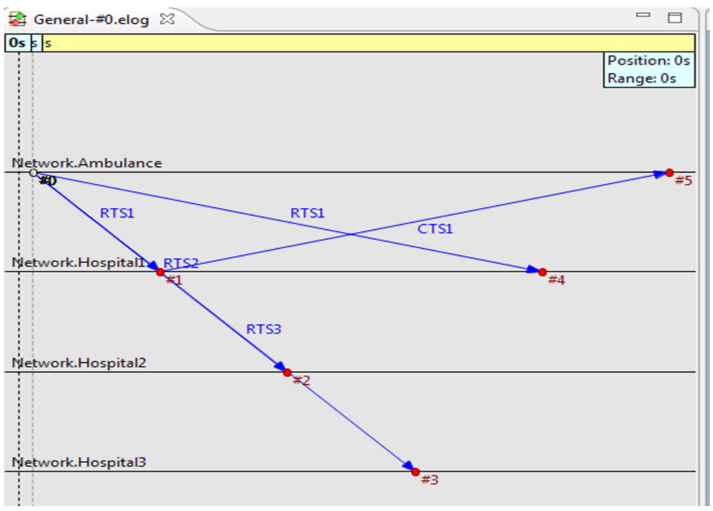


Figure 14. Signal diagram under the OMNeT++ simulator.

The findings show that the ant colony system strengthened the network relative to the usual Ad-Hoc network. Authenticated patients are remembered in the telemedicine platform and responded to more quickly than unknown patients.

5.3. Security Analysis

Both telemedicine sides (ambulance and hospital) must have the same fragmentation index during the network encapsulation procedure. The research focused on information technology and cybersecurity resources. The experiment used two distinct authentication strategies for cyber-secure network middleware in the transport and network layers of the TCP/IP protocol. The medical information packet of the patient was divided into several segments. Each segment was fragmented and encapsulated with a unique ID. The fragment ID sequence re-fragmented on the send side depends on the suggested authentication method and is then recovered on the receive side link with the same sequence based on the protected public key. Without this TCP handshaking chain, it will be hard to get the right message. Users frequently make little errors all the time that help the hackers to infiltrate the system. Most of the time, these gaffes are inconsequential. The proposed middleware solves this dilemma using hardware suggestions. The packet sends directly to the segmentation portion for segmenting into fixed-size segments. Each segment requires an identity ID, called a fragment ID. At this stage, the middleware can modify the original index sequence using the AES encryption method to ensure that no one can obtain the correct message without the right index, that depends on the public key. Figure 15 demonstrates the security lifecycle that indicates the improved security of the telemedicine device.

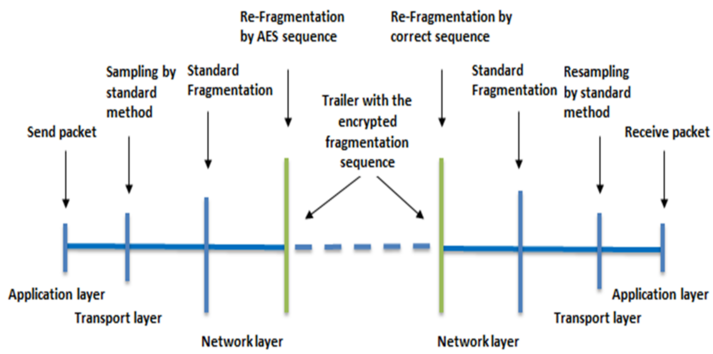


Figure 15. The security process lifecycle.

6. Conclusions and Outlook

To achieve a stable and accessible telemedicine infrastructure, this paper indicated that efficiency and security issues are critical and have a direct impact on patients. Both broadband selection and network layer security frameworks propose to satisfy these criteria. SWARM is an approach that allows packets' forwarding toward a fast-tracking path, and re-fragmentation with AES secures the network session between medical centers. This paper contributed to achieving improvement through four stages:

- The first stage includes a 5G-wireless mesh network and split it into VLANs, where each VLAN represents an independent wireless sub-network.
- The second stage is writing a middleware application that handles the network and determines the closest end-to-end convenient access point using an appropriate algorithm to ensure that the patient is transported urgently to the nearest hospital.
- The third stage is the middleware transmits information to the network and monitors emergency motorbike information in the protected sockets layer to ensure that the maximum degree of secure communication is achieved using the cryptography method. The ant colony hypothesis, one of the SWARM optimization methods recently used to solve short-tracking path problems, was proposed for quick access to the closest medical center.

- The fourth stage is security employing the Rijndael encryption to reassemble sequence fragments in the network layer, which was built as a challenge for the authentication part.

Performance analysis showed that the proposed system is stable and efficient. Further research is also required to determine the long-term effect of the proposed network on a wide range of telemedicine applications before drawing a general conclusion.

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