

# ENCRYPTED BALANCED - AODV ROUTING PROTOCOL ALGORITHM IN WIRELESS MESH NETWORK

<sup>1</sup>Sukhwinder Singh, <sup>2</sup>Rajeev Sharma, <sup>3</sup>Pardeep Singh Tiwana  
<sup>1</sup>M.tech (Research Scholar), <sup>2</sup>Assistant Professor, <sup>3</sup>Assistant Professor  
<sup>1</sup>Department of Computer Science,  
<sup>1</sup>Chandigarh Engineering College Landran, Mohali (Pb.), India

**Abstract:** In Ad Hoc networks there is no requirement of constant infrastructure. All the nodes are associated to other nodes with the use of radio signals and wireless links. Wireless mesh networks are most preferable networks that come under the category of Ad Hoc. WMNs are communicating devices that consist of radio or mobile modes (nodes) to extract and sent data from source node to destination. It involves a distributed structure of interconnected nodes that make a huge topology later known as mesh networks. The architecture anchored at client hosts, wireless links and gateways. Moreover, it is divided into infrastructure WMNs, Client WMNS and Hybrid WMNs. The common areas of wireless mesh networks are security, education, medical, personal networking and natural disaster management. In any wireless networks, security is the main concern and routing protocols are utilized to expand the network services, security management and creating routes for transmission of data among various nodes. In this proposed work a new routing algorithm is invented which is called encrypted Balanced AODV routing protocol with the use other wormhole free routing. B-AODV is balanced ad hoc on demand vector which utilized in reactive protocols. It is only being applicable when there is need of initialization of routing. Wormhole free routing associated to choose a shortest path without any occurrence of worm hole attack and any other kind of attacks while transmitting data form source to destination. The common issues are related to fixed routers and load of multiple nodes, various attacks that degrades security of system and so on. We have used the MATLAB 2016a simulation tool with SCRIPT Language. We calculated the performance parameters, i.e. energy, packet delivery rate, probability distribution vs. time and delay vs. Frame error rate [ms].

**IndexTerms -** WMNs (Wireless Mesh Networks), Hybrid method, Encryption B-AODV routing protocol and MATLAB Simulation.

## I. INTRODUCTION

WMN is the full form of "WIRELESS MESH NETWORK". WMN is an encouraging technology that might be good alternative for WLAN to expand the coverage area of public WA (Wireless Access), due to its self-organizing, self-configuration, robustness and least expenses[1].IEEE 802.11 is a still draft, but wireless mesh networks are analyzed and have been now a famous topic of research. One of the main challenging tasks in WMNs is the routing, as it has to deal with complex radio atmosphere and often altering network topology to give effective communication. Wireless Mesh Networks are nearly related to adhoc networks. These are two technologies share the similar normal ideas:-

- (i) Nodes communicate over various wireless hops on a meshed network graph. Moreover recently, there has been a differentiation among them presented in various research consequences.
- (ii) Difference measures mainly mobility of mesh nodes. Wireless Mesh Networks are depending on a wireless back-bone formed by mesh routers with no-power restraints.

The mobility is very less or equal to zero, because in MANETs every nodes might be highly mobile. In wireless mesh networks the main mobility characterizes mesh clients. The WMNs characteristics are as follows :- (i) *Multi-hop Wireless Mesh Network:-* A wireless Mesh Network is one to connectors among the end users without direct line of sight association. Mesh Style Multi-hopping is fundamental which carry out high throughput in shorter distance and less interference of the nodes. [8] (ii) *Self-Forming and self-healing Network:-*Wireless Mesh Networks strengthen the network performance because of the tensile network architecture, easy distribution and configuration. Mesh Routers usually have minimal mobility and mesh clients can mobile nodes.

Wireless Mesh Network is often used in healthcare applications, for transmission of the signal at the shortest distance. In medical applications the doctors can use the patient information and the test results. Wireless Mesh Networks provides connectivity in huge warehouses with least efforts. Institutions, universities, colleges are mainly using wireless mesh networks as WSN give a coverage of broadband and high bandwidth which enables the students to use the large files in minimum time[2].Wireless Mesh Networks provide advantages in metropolitan areas to send data at high-speed compared to cellular networks. Wireless Mesh Networks(WMN) had high impact on networking commonly used in television, personal computers for the connectivity of the

broadband. And the device connects in a single gateway. In situations where immediate connectivity is needed wireless mesh networks are used for rescue operations, mesh routers and disaster management, so people can communicate with each other through mobile phones in case of difficult situations in least time [9].

In Wireless Mesh Networks, Routing protocols provide functions for detecting and responding to changes in network topology and services which maximize the delivery of the packets and minimize the end delay. In Wireless Mesh Network classified into two types:-

**Proactive Routing Mesh Protocol:** The proactive routing mesh protocol determines the data to be sent to receiver, based on continuous information obtained from routing table. In routing table, that update information are to be maintained, which provide the route selection in more efficient way[10,11].

**Distance Sequenced Vector Routing:-** This type of routing based on communication method which uses the data packets to be sent over the Internet Protocol. DSR needs the routing hardware to report the distance of various nodes within the network or IP Topology in order to determine the efficient routes for data packets.

The types of distance vector routing protocols are :-

**i. Optimised Link State Reactive Routing Protocol:-** In this routing protocol, the protocol search the route which is to be send until the final route is obtained [12].

**ii. Optimised Hybrid Routing Protocol:-** In this protocol, proactive and reactive protocols are combined based on environment conditions to provide the path on demand based on up to date information.

**iii. Control Flooding Based Routing Protocol:-** This protocol based on ad hoc based protocol which are proactive, reactive and hybrid. This type of protocol based on control flooding techniques to send data to destination.

**iv. Traffic Aware Routing Protocol:-** In this type of protocol, the performance is evaluated based on link of the traffic.

Table 1. Various Routing Protocol [13]

Protocol	uses	Limitation	Parameters
Heterogenous Routing Protocol	Different network address in different transmission technologies .	Requires a routing table in order to forward data packets.	Throughput and performance
Proactive routing protocol	Reduce latency in high network,	Create high overhead due to flooding in network	Performance, packet delivery

Encrypted-BAODV Protocol solutions with several metrics for this type of networks have been also proposed. In this research paper gives an overview of available solutions depend on the detailed simulation study. This rest of the research paper is organized in the following path. Section 2: given a brief overview of the examined routing protocols in WMNs. Section 3: presents the proposed work and simulation situations in detail. In section 4: the result and discussions are presented and discussed. The last explanations are defined in section 5: where, we give some references for the encryption-BAODV method usage and further work (Future Work).

## II. RELATED WORK

**Shinji Sakamoto et al., 2015[3]** proposed a research on simulation system based on Particle Swarm Optimization (PSO). The size of giant component and number of covered mesh clients was used as metrics of Optimization. In this paper, it was found that all mesh routers are connected and all mesh clients in the area covered. Mainly it was considered that mesh router nodes placement problem in wireless mesh network routers and number wireless mesh client nodes of fixed positions in grid area. The objective was to find a location assignment for the mesh routers to the cells of the grid area that maximizes the network connectivity and client coverage. In this paper, they deal with connectivity and coverage in Wireless Mesh Networks. However problem was called NP-Hard, so they proposed and implement a Particle Swarm Optimization (PSO) based system for node placement problem in Wireless Mesh Network, called WMN-PSO. **Tetsuya Oda et al., 2015[4]** proposed a research on testbed for Wireless Mesh Networks, the performance of Optimized Link State routing protocol (OLSR) protocol was analysed in an order scenario considering mobile mesh node and evaluated using packet delivery ratio, throughput, delay and hop count. Wireless Mesh Networks (WMNs) attracting a lot of attention from wireless network researchers, because of their potential use in several fields such as collaborative computing and communications. Considering mobility of the terminals, routing is a key process for operation of WMNs, so routing protocol was analysed to result. In this paper, they implement a WMN testbed and investigate the performance of OLSR in an indoor environment considering mobile mesh node scenario. For evaluation, they considered throughput, Packet Delivery Ratio (PDR), hop count, delay and jitter metrics. **G. Akilarasu et al., 2016[5]** proposed a research on a proposed monitoring technique was used to increase the packet delivery ratio by reducing the packet drop. They used a technique for warm hole free routing and DOS attack. Initially, in finite state model was applied where the node had information about sender and neighborhood receiver. Then warm hole secure routing was implemented to find the wormhole free routes in the network. In the final description priority mechanism was applied where data packet was transmitted based on priority. Wormhole

attack was one of the major security threats, which can disturb majority of routing communications, even when placed strategically and on the basis of finite state model and priority mechanism, the malicious and wormhole nodes were removed. **Jamal N. Al-Karaki et al., 2017[6]** proposed a research on routing protocols with the emphasis on their routing premises, operation and design considerations. In this paper the extensive summaries and comparisons among different categories of protocols had been designed. The main issues that affect the design of both protocols and routing metrics was also highlighted. In this paper, this paper, a comprehensive survey of the current state-of-art routing protocols in Wireless Mesh Networks were presented. The routing protocols were classified based on the protocol design, protocol operation, and the WMNs' nodes design. Also, the main issues that affect the protocols and metrics design were introduced to give a deeper insight of the main requirements of WMNs. In general, WMNs are promising new technology with increasingly important role in the future generations of wireless mobile networks. These networks was characterised by dynamic self-organization, self-configuration, and self-healing to enable quick deployment, easy maintenance, low cost, high scalability, and reliable services. **Ahmed Al-Saadi et al 2016[7]** proposed a research on a heterogeneous metropolitan area network architecture that combines an IEEE 802.11 wireless mesh network with a long-term evolution (LTE) network. Moreover, a new heterogeneous routing protocol and a routing algorithm based on reinforcement learning called Cognitive Heterogeneous Routing (CHR). The Cognitive Heterogeneous Routing was proposed to select the appropriate transmission technology based on parameters from each network. The proposed heterogeneous network overcomes the problems of sending packets over long paths, island nodes and interference in wireless mesh network and increases the overall capacity of the combined network by utilizing unlicensed frequency bands instead of buying more license frequency bands for LTE. In this paper it was validated through extensive simulations that indicate that the proposed heterogeneous wireless mesh network outperforms the LTE and Wi-Fi networks when used individually. The simulation results show that the proposed network achieves an increase of up to 200% increase in throughput compared with Wi-Fi-only networks or LTE-only network.

### III. RESEARCH PROPOSAL DESIGN AND IMPLEMENTATION

In this section described that the main research work of the Wireless Mesh Network as follows: (i) Study of a variety of routing protocols based safety algorithms and their pros and cons. (ii) Implementation of the secure optimized routing algorithm using Encrypted-BAODV Protocol. (iii) For prevention and detection the Worm Hole Attack using proposed approach in mesh network. (iv) Performance evaluation in terms of Packet delivery ratio (PDR) and End to End delay.

Initial, we create the wireless mesh network, which connects one mesh node to another mesh node. To communicate the information in connecting form, this is linked together. Next, we search the source and destination node in this network. We plot the Main Head node name is base station. In 'Main Head' normal id's and unique id's as created in the wireless mesh networks to travel on position to another position in the mesh networks. The unique id generate, the purpose is Main Head communicates a secure message and send the trusted node, which is defined by the base station administration. Base Station administrator provides authentication by means of the registration process. Limit decided at the 20 - 50 Unmanned Aerial Vehicles. If any other user who crosses the limit, then message will be displayed by Base Station. We implement the routing protocol (EBAODV) to provide the security and manage packet according to the rules in the mesh networks. E-BAODV protocol performs well with mobile knobs it incurs high above with an increase in network size. E-BAODV is an on-Demand routing protocol. The route is calculated on demand, via route discovery process. That is why it is called a reactive protocol. E-BAODV maintains a routing table where it preserves one entry per endpoint E-BAODV provides loop gratis routes while repair link breakages, but it doesn't require global periodic routing advertisements. We calculate the performance parameters based on the Wormhole resistant Routing Protocol with Encryption Techniques (Distance Probability, Throughput, packet delivery rate and frame error rate based on delay (0%, 10% and 20%). We implement the proposed approach named as an Encryption Balanced On demand Distance Vector Routing Protocol algorithm. This is resolving the network issues and transmits the data securely and calculates the performance parameters, i.e throughput, delay and delivery rate etc. Comparison between the existing and proposed approach and proved that proposed work is better than previous one.

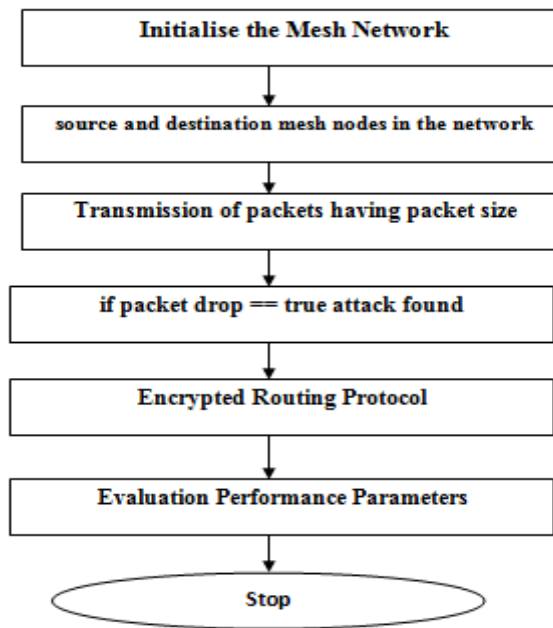


Fig 1. Research Proposal Flow Chart

**IV. RESULT DISCUSSIONS**

In this paper, the encryption protocol B-AODV and the routing protocol to compared with the wormhole resistance model. WMN design a novel network, firstly user selection enter the number of mesh nodes and length define 1000\*1000 (length =1000, width =100). WMN network with linked mesh networks for the signal broadcast of data packets from initial node to the destination node is plotted in color wise (Red and Green) all other nodes with their verification id. After that base station plotting in the network. Base station means is the KDC (key Distribution Center) that is main head to handle all the packet information in the WMNs. Then plot the initial node and sink node in the network. In source node means continue the packer travel sink node means end the transmission node in the WMNs. All registration process completed by KDC and MNs are authorized with Main Head or Base Station. The coverage set developed according to the mesh nodes. It evaluates distance and range accordingly to network area of the WMNs. Messagebox defined that the packet has been delivering or transferring from the mesh nodes.

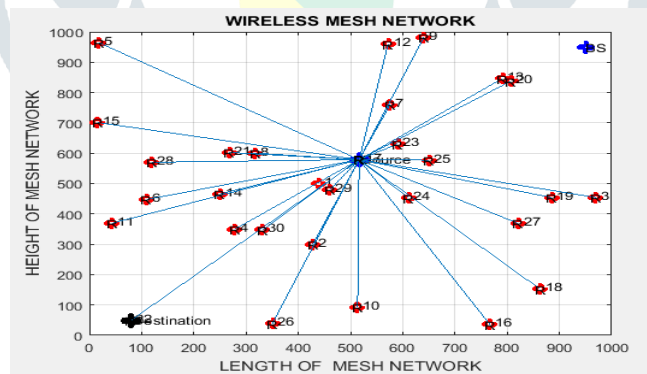


Fig 2. Encryption with B-AODV Protocol

Fig 3 defines that the routing protocol designed using B-AODV initialization the source MNs sent the request to the other mesh vehicle nodes. The route vehicle nodes in the WMNs. In this route Vehicle nodes evaluate the reply nodes in the network and Balanced Shortest distance calculation. Attacked mesh nodes is two from the route to which attacker attacks in the network or will deviates all the packets from the route. Trusted nodes which is 10 in the network is in rest mesh nodes are the trusted vehicles in the red color.

Trusted mesh node means secure data transmission node plotted in wireless mesh network. Implement a network to data transmission in the rules based data request sent, received and route error occur in case any attack has come in the WMN.

Table 2. Proposed Performance Parameters

Performance Parameters	Values
Delay 0%	40 ms
Delay 10%	4.4 ms
Delay 20%	8.00 ms
Energy	0.9 Joules
Packet Delivery rate	97%

Table 2, 3 and 4. described that the performance parameters like as delay, packet delivery rate and Energy Consumption in Encryption Balanced On demand Distance vector Routing Scheme.

Packet delivery rate for the successful transmission of packets from source to the destination through trusted vehicles which shows that 97% throughput with E-BAODV routing scheme are transmitted using secure transmission. Energy for the successful transmission of packets from source to the destination through trusted vehicles which shows that 0.9 (joules) energy with E-BAODV routing schemes are transmitted using secure transmission. With E-BAODV algorithm to optimize the energy based on encrypted balanced on demand distance vector approach in the wireless mesh network. Routing delay to transfer the packets from the basis to the destination having Frame Error Rate which is edge error rate in Encrypted –BAODV scheme. These are showing the delay in between the transfer of the packets when the FER with E-BAODV is 0%, FER with E-BAODV is 10% or FER with E-BAODV is 20%. Little delay results in the high Packet Delivery rates.

Table 3. Comparison E-BAODV and Wormhole-Resistant Secure Routing (Delay-ms)

Attackers	E-BAODV Proposed Work	Wormhole Resistant Secure Routing (Existing Work)
1	3	12
2	3.8	12.7
3	4	17
4	5.9	19
5	8.0	20

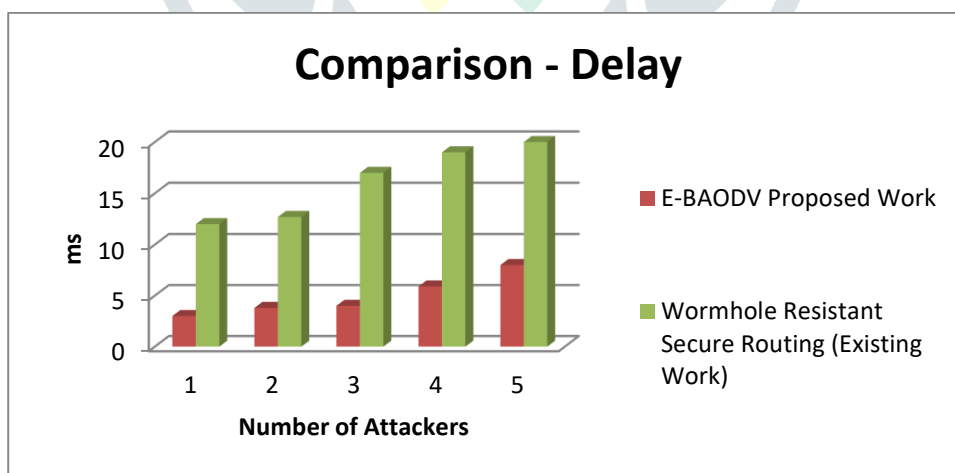


Fig 3. Comparison – Delay

The above figure 4 shows that the delay in E-BAODV Routing Scheme and Wormhole Resistant Secure Routing algorithm. We reduce the delay in the wireless mesh network level.

Table 4. Comparison E-BAODV and Wormhole-Resistant Secure Routing (Packet Delivery Rate (%))

Attackers	E-BAODV Proposed Work	Wormhole Resistant Secure Routing (Existing Work)

1	25	22
2	40	24
3	60	14
4	70	10
5	97	5

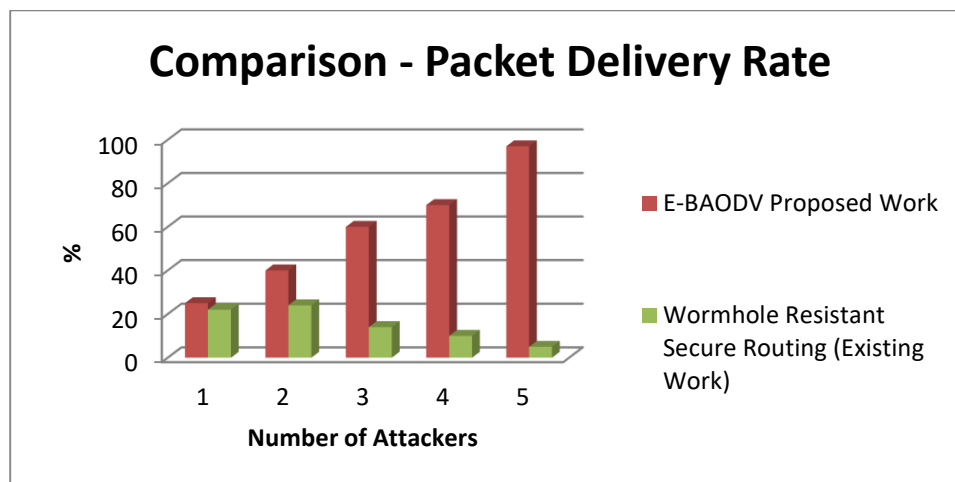


Fig 5 Comparison – Delivery Rate (%)

The figure 5 represents that the comparison based on E-BAODV and Wormhole Resistant Secure Routing algorithm in the PDR (%). We improve the packet delivery with E-BAODV and Wormhole Resistant Secure Routing algorithm. We implement the proposed approach to enhance the performance of the information transmission.

## V. CONCLUSION & FUTURE SCOPE

Wireless mesh networks jumped from the planning phases into the real world. Various new businesses are seeking after the innovation and utilization to fulfill the necessities of various applications particularly to give access to broadband Internet, home networking and so on. In every field confidentiality of data is mostly required things and while designing a network it is the essential concern that needs to be more efficient and authenticated. WMNs are acquiring wide popularity due to their propensity to integrate several networks with alone network. Having various routing protocols, and meta-heuristic algorithm utilized, it proliferate reliability and enhanced performance over conventional wireless LANs. Attributable to routing protocols, nodes automatically establish and maintain network connectivity. Furthermore the precedence of meta-heuristic algorithms is that they provide low up-front cost, are robust, facile network configuration and tranquil upkeep, consistent network coverage etc. WMNs are the efficacious technology that provides internet access in rural areas in a cost effective way with the modus operandi. This security becomes paramount and a critical parameter for wireless mesh network because of its vulnerability to various attacks and requirement of intensive care for impregnability and un-assailability. We have conversed about the attacks and their genre herein. Distinguished routing protocols, and meta-heuristic algorithm schemes could be implemented to protect the network. There are assorted techniques which are hypothesized in this paper on the essence of distinct parameters. While data or private information is transferred from one place to other on the internet, several kinds of attacks are occurred that manipulated data as per their needs and misuse it. For enhancing mesh networks, an encrypted B-AODV routing algorithm is discovered that based on the encryption to hide the private data in a secure manner. Moreover, Wormhole Free Routing initiated to take a control over the wormhole attack. The results are evaluated with the simulation tool as MATLAB. The parameters that incline the output are Packet Delivery Ratio and Energy which also origins to make a continuous decrease in End to End delay.

In this future work, wireless networking played out a necessity role in each field. In future there are enormous applications are designed that easily improves the previous wireless n\connectivity and make more control over malicious attacks. Additionally, it utilized for security systems as in Bas, Military border areas to share private information and in industrial sector for securing huge data sent to overseas and so on.

## REFERENCES

[1] Zakrzewska, Anna, Leszek Koszalka, and Iwona Pozniak-Koszalka. "Performance study of routing protocols for wireless mesh networks." In Systems Engineering, 2008. ICSENG'08. 19th International Conference on, pp. 331-336. IEEE, 2008.

- [2] Matus, F. J., Morales, L. E., & Arias, M. R. (2017, November). Performance analysis for a wireless mesh network test-bed using HWMP and BATMAN-Adv routing. In Central America and Panama Convention (CONCAPAN XXXVII), 2017 IEEE 37th (pp. 1-6). IEEE.
- [3] Sakamoto, Shinji, Tetsuya Oda, Makoto Ikeda, and Leonard Barolli. "Design and implementation of a simulation system based on particle swarm optimization for node placement problem in wireless mesh networks." In Intelligent Networking and Collaborative Systems (INCOS), 2015 International Conference on, pp. 164-168. IEEE, 2015.
- [4] Oda, Tetsuya, Keita Matsuo, Leonard Barolli, Makoto Ikeda, and Makoto Takizawa. "Performance Evaluation of a WMN Testbed in Indoor Environment Considering Mobile Mesh Node Scenario." In Network-Based Information Systems (NBIS), 2015 18th International Conference on, pp. 93-98. IEEE, 2015.
- [5] Akilarasu, G., & Shalinie, S. M. (2017). Wormhole-free routing and DoS attack defense in wireless mesh networks. *Wireless Networks*, 23(6), 1709-1718.
- [6] Al-Karaki, Jamal N., Ghada A. Al-Mashaqbeh, and Sameer Bataineh. "Routing protocols in wireless mesh networks: A survey." *International Journal of Information and Communication Technology* 11, no. 4 (2017): 445-495.
- [7] Al-Saadi, Ahmed, Rossitza Setchi, Yulia Hicks, and Stuart M. Allen. "Routing protocol for heterogeneous wireless mesh networks." *IEEE Transactions on Vehicular Technology* 65, no. 12 (2016): 9773-9786.
- [8] Karthika K. C, "Wireless mesh network: a survey," *International Conference on Wireless Communications, Signal Process and Networking (WiSPNET)*, 2016.
- [9] S. Trifunovic, S. Kouyoumdjieva, B. Distl, L. Pajevic, G. Karlsson and B. Plattner, "A decade of research in opportunistic network: challenges, relevance, and future directions," *IEEE Communications Magazine*, January 2017.
- [10] I. Armuelles-Voinov, J. Chung-Miranda and A. Chung-Cedeño, "Evaluation of QoS provisioning in nodes of wireless mesh networks based on IEEE 802.11s," *IEEE Central America And Panama Convention (CONCAPAN)*, 2014.
- [11] Dugaev and E. Siemens, "A wireless mesh network NS-3 simulation model: implementation and performance comparison with a real testbed," *International Conference on Applied Innovations in IT (ICAIIIT)*, March 2014.
- [12] Cerrano, L. Magalhaes, D. Muchaluat and C. Albuquerque, "IEEE 802.11s multihop MAC: a tutorial." *IEEE Communications Surveys and Tutorials* Volume 13, Number 1, 2011.
- [13] R. Iborra, M. Cano and J. Garcia, "Performance evaluation of BATMAN routing protocol for VoIP services: a QoE perspective," *IEEE Transactions on Wireless Communications*, December 2012.