Estimation and Improvement of Routing Protocol Mobile Ad-Hoc Network Using Fuzzy Neural Network

Dr. Tarik Zeyad Ismaeel
professor
College of engineering-University of Baghdad
Email: tarikismaeel@yahoo.com

Dhurgham Razaq Mohsen
Instructor
College of engineering-University of Baghdad
Email: dego_977@yahoo.com

ABSTRACT

Ad-Hoc Networks are a generation of networks that are truly wireless, and can be easily constructed without any operator. There are protocols for management of these networks, in which the effectiveness and the important elements in these networks are the Quality of Service (QoS). In this work the evaluation of QoS performance of MANETs is done by comparing the results of using AODV, DSR, OLSR and TORA routing protocols using the Op-Net Modeler, then conduct an extensive set of performance experiments for these protocols with a wide variety of settings. The results show that the best protocol depends on QoS using two types of applications (+ve and –ve QoS in the FIS evaluation). QoS of the protocol varies from one protocol to another depending on the applications used in the network. The network design is done using the program (Op-Net V14.5 modular) with core i7 computer for multiple nodes deployed randomly in several area (100 * 100, 200 * 200, 400 * 400, 800 * 800, 1000 * 1000)m^2 accomplished by changing the number of nodes in the network (10, 20, 40 and 80). There are three programs designed using (MATLAB 2012A programming language). The first one evaluates the (QoS) using the organizational structure of the mysterious system (HFS), which relied on the standard applications that should be provided by the protocols to make the applications accepted by the nodes requirements. After the evaluation the QoS for all cases, we design Neural Network to assist in estimation of the best protocol for any network through QoS for all protocols (AODV, DSR, OLSR and TORA). Neural network has four entrances (area, number of nodes, real time application ratio and non-real time application ratio). The results show that the QoS estimated is (0.5401) of (OLSR) which has been improved to (0.6421) by reducing to mobility speed and making some nodes fixed and using more than one protocol in the network to provide the best QoS .

Keywords: Estimation, protocol, QoS, Simulator

اقتراح وتحسين بروتوكولات توجيه الشبكة المخصصة
باستخدام جودة الخدمة بواسطة الشبكات العصبية الغامضة

أ.د. طارق زياد إسماعيل
الباحث الأول
جامعة بغداد – كلية الهندسة

ضرغام رزاق محسن
الباحث الثاني
جامعة بغداد – كلية الهندسة

الخلاصة

شبكات (Ad-Hoc) جيل من الشبكات التي لا تحتوي على أي اتصال سلكي بالإضافة إلى انه يمكن بناؤها بسهولة ولا تحتاج إلى اي مشغل .وهناك بروتوكولات لإدارة هذه الشبكات ومن أهم العناصر التي تحدد فعالية هذه البروتوكولات هي جودة الخدمة للبروتوكول (QoS) (تم استخدام الـQos الموجبة والسالبة في تقييم الـFIS) .تختلف (QoS) من بروتوكول لأخر اعتماداً على تطبيقات المستخدمة في تلك الشبكة. تم تصميم شبكة بأستخدام برنامج (Op-Net 14.5 modular) لعدة مستخدمين تم نشرهم بشكل عشوائي في عدة مساحات متغيرة (100*100,200*200 ، 400*400 ، 800*800 ، 1000*1000) وتم تغيير عدد المستخدمين للشبكة من (10 ،20 ، 40 ،80) .وقد تم تصميم ثلاثة برامج باستخدام (MATLAB 2012A programming language) الأول وقد تم احتساب جودة الخدمة باستخدام نظام الهيكل التنظيمي الغامض (HFS) والذي اعتمد على متطلبات التطبيقات القياسية التي ينبغي أن يقدمها البروتوكول لجعل التطبيق مقبول من قبل المستخدمين النهائيين. والثاني لتوقع البروتوكول الأفضل وذلك من خلال إعطاء جودة الخدمة لكل بروتوكول (AODV ,DSR, OLSR,TORA) للشبكة المطلوبة وقد اعتمد البرنامج الثالث على تصميم شبكة عصبية لها أربعة مداخل وهي (المساحة و عدد المستخدمين و نسبة استخدامات تطبيقات الاتصالات المباشرة ونسبة تطبيقات الغير مباشرة). من أهم النتائج التي ظهرت لنا هي الاختبار الثالث حيث ان جودة الخدمة ظهرت لأفضل بروتوكول هي (0.5401) لل (OLSR) وقد تم تحسينها الى (0.6421) من خلال تقليل السرعة او جعل بعض المستخدمين ثابت او وضع مستخدمين فقط لتوفير الخدمة لباقي المشتركين واستخدام اكثر من بروتوكول بالشبكة لتوفير افضل جودة خدمة للشبكة .

مفاتيح الكلمات : اقتراح ،بروتوكولات ، جودة الخدمة ، محاكاة

1. INTRODUCTION

A mobile ad-hoc network (MANET) is a set of wireless mobile nodes that can communicate with each other without using any fixed infrastructure. It is also necessary for MANET devices to communicate in a seamless manner. There are multiple protocols that have been developed for MANETs. There is a need to support real time and non real time applications in MANETs as they gain popularity. MANETs require an efficient routing protocol and quality of service (QoS) mechanism in order to support multimedia applications such as voice and Email. Such applications have strict QoS requirements such as bandwidth, latency, PDR and jitter. Design and development of routing algorithms with QoS support is experiencing increased research interest. This paper evaluates the QoS performance of MANETs using fuzzy interface system for AODV, DSR,OLSR and TORA routing protocols. Through the OPNET Modeler program, we have conducted an extensive set of performance experiments for these protocols with a wide variety of settings. On-demand routing protocols are widely used because they use much lower routing overhead than proactive protocols, **Jasani, 2011.**

Characteristics of WAN's such as lack of central coordination, mobility of hosts, dynamically varying network topology and limited availability of resources make QoS provisioning very challenging for all difficulties, **Reddy, 2006**. Some nodes may behave maliciously, resulting in degradation of the performance of the network or even disruption of its operation altogether. The results obtained show that the overall performance of the Ad-Hoc network is significantly improved, **Hallani, 2008.**

2. WIRELESS AD-HOC NETWORKS

A mobile Ad-Hoc network (MANET) is Unlike cellular wireless networks, no static or fixed infrastructure exists and no centralized control can be available. The network can be formed anywhere, **Lewis, 2007.** The mobile nodes can perform the roles of both hosts and routers. The presence of mobility makes a MANET challenging for designing and implementation in real life. It is a huge challenge to design topology control, routing, (QoS) and resources management, services discovery, network operations and management, security services, **Misra, et al. 2009.**

2.1 Mobility The mobility of nodes is the key function of mobile Ad-Hoc networks, and the performance of MANET needs to be studied in presence of mobility. It is known that the Real-life mobility patterns can be very complex depending on the mission objectives of mobile nodes that are part of the autonomous system, **Misra, et al. 2009.**

2.2 Routing. The routing in mobile Ad-Hoc networks is very challenging due to the frequent updates for changes in topologies, and active routes may be disconnected as mobile nodes move from one place to another, **Misra, et al. 2009.**

2.3 Transport Protocol: In mobile Ad-Hoc networks, the frequent changes of the network topology and the shared nature of the multi-hop wireless channel pose a significant challenge for the transport protocols that are used over the network protocol such as Internet protocol (IP), **Misra, et al. 2009.**

2.4 Application A mobile Ad-Hoc network consisting of mobile nodes is self-organized and decentralized and communicates among mobile nodes using multi-hop wireless links. Each mobile node is autonomous and can have random movement patterns, **Misra, et al. 2009.**

3. HIERARCHICAL FUZZY SYSTEMS

Since the upper layers of a hierarchical architecture generally deal with low-resolution, imprecise, and incomplete information, more intelligence (or knowledge-based action) would be needed in the associated decision-making process. Yet the performance of the overall system may be acceptable. The characteristic of an intelligent system are task description, knowledge representation, and consequently some intelligence will be needed for interpretation and processing of this information in order to make inferences (and control actions), **Sivanandam et al. 2007.**

3.1 Evaluation of QoS Using Hierarchal Fuzzy System (QoSHFS)

The evaluation of QoS for any protocol that depends on applications used, and these are divided into two type:

A. Evaluation of QoS Real time Application

To clarify the design process, there are two types of parameters effect, positive parameters (+ve) and negative parameters (-ve). According to this proportionality, QoS is a result of, **Valbonne 2007:**

1. +ve QoS: This calculation of QoS is affected only when parameters have a positive effect on the QoS, which are throughput and packet delivery ratio. When these two parameters decrease, the protocol QoS support will decrease too, **Zaghar and AL Wahab, 2013.**

2. -ve QoS: This calculation of QoS is affected by parameters that have negative effect on the protocol QoS. End-to-end delay (latency) and jitter will belong to this branch of QoS. Decreasing these two parameters will increase protocols QoS, **Zaghar and AL Wahab, 2013.**

In the network design, the increment of +ve QoS is done by increasing the throughput and PDR (Packet Delivery Ratio) and reduction of the –ve QoS is done by reducing the Latency and Jitter. **Fig. 1** illustrates the QoS calculation, **Zaghar and AL Wahab, 2013.**

B. Evaluation of QoS Non Real time Application

Each type of applications is very sensitive to a certain set of parameters. The most effect parameters in the QoS in the Email application are (throughput and latency) as shown in **Fig. 2.**

4. NEURAL NETWORKS

An Artificial Neural Network (ANN) is an information-processing paradigm that is inspired by the way of biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. An ANN are configure for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true for (ANNs) as well, **Karray and de Silva, 2004.**

4.1 Neural Network Architecture

Neural networks Architecture can be viewed as weighted directed graphs in which artificial neurons are nodes and direct edges (with weights) are connections between neuron inputs as shown in **Fig. 3.**

The following characteristics of neural networks emphasize their pattern recognition capabilities, making them particularly attractive for solving complex, and data rich problems, **Fakhreddine et al, 2004**:

1. They can be learned from examples and adapted to new situations.
2. They can be generalize from examples (i.e. can provide correct solutions from data similar to but not exactly like training data).
3. They can construct solution quickly with no reliance on domain knowledge.
4. They can approximate any complex multivariate function and form a classification decision from the recognition of the discriminating patterns.
5. They are computationally efficient (i.e. they have the speed to operate in real time).
6. They can implicitly account for the relative importance of input sources, **Karray and de Silva, 2004.**

4.2 Artificial Neuron Structure

The human nervous system, built from cells called neurons is of staggering complexity. An estimated (10^{11}) interconnections over transmission paths are there and that may range for a meter or more.

Each neuron shares any characteristics with the other cells in the body, but has unique capabilities to receive, process, and transmit electrochemical signals over neural pathways that comprise. The Biological neuron consists of three main components: cell body, dendrite and axon.

Dendrites extend from the cell body to other neurons where they receive signals at a connection point called a synapse. On the receiving side of the synapse, these inputs are conducted to the cell body, where they are summed up. Some inputs tend to excite the cell causing a reduction in the potential across the cell membrane.

The artificial neuron was designed to mimic the first order characteristics of the biological neuron. In essence, a set of inputs is applied, each representing the output of another neuron. Each input is multiplied by a corresponding weight, analogous to a synaptic strength, and all of the weighted inputs are then summed to determine the activation level of the neuron. If this activation exceeds a certain threshold, the unit produces an output response.

This functionality is captured in the artificial neuron known as the threshold logic unit. Here a set of input labeled X_0, X_1, ...,X_n is applied from the input space to artificial neuron .These inputs, collectively referred as the input vector “X”, correspond to the signal into the synapses of biological neuron. Each signal is multiplied by an associated weight W_0, W_1,……., W_n, before it is applied to the summation block .The activation function is given by **Equation 1**, **Karray and de Silva, 2004.**

$$a = W_0X_0 + W_1X_1 + \ldots W_n X_n + \theta \qquad \ldots 1$$

This may be represented more compactly as

$$a = \sum_{i=0}^{n} \mathrm{XiWi} + \theta \quad ...2$$

Where θ the base of the weight

The output y is then given by y = f (a),

where f is an activation function used and defined as

$$y = \begin{cases} 1 & if\, a \geq \beta \\ 0 & if\, a < \beta \end{cases} \quad ...3$$

The threshold S will often be zero. The activation function is sometimes called a step-function. Some more non-linear activation functions where also tried by the researchers like sigmoid, Gaussian, etc. and the neuron responses for different activation functions with the MATLAB program, **Liua, et al. 2007.**

The number of input layers have four neurons (area, number of nodes, ratio of RTA and ratio of NRTA) and there are three hidden layers.

5. DESIGN AND EVALUATION

The network are designed using Op-Net Modular V14.5 under specification given in **Table 1**, and the area is changed as following values (100*100, 200*200, 400*400, 800*800 and 1000*1000) m^2. Different numbers of nodes are taken in all scenarios, after all scenarios are done we calculate the QoS for all protocols and used it to leaned Neural network to estimate the Best protocol as shown in **Fig. 4.**

5.1 Evaluation and Analysis of QoSHFS

During the evaluation of FIS from the QoSHFS, the first calculations of voice QoS are between the throughput and PDR under the first level of +ve QoS part. The second calculations of voice QoS are between jitter and latency under the same level but in -ve QoS part. The result from the two parts will be used in the calculation of the final QoS and will be multiplied by the ratio of real time application (depending on the requirements).

Another evaluation of fuzzy is QoS of E-Mail calculated between throughput and latency parameters, which are multiplied by the ratio of non-real time application.

Finally adding the results from the fuzzy voice to results of E-mail under constrain environment, which will be the results of QoS, **Zaghar and AL Wahab, 2013.**

5.2 Neural Network.

1. There are 180 simulations designed using Op-Net modular 14.5 by (AODV, DSR, OLSR and TORA) protocols and evaluated the QoS for it using fuzzy interface system.
2. Through **Equation 4**, **Xia, et al. 2012**, and trial and error we concluded the number of hidden layers which is 4 as shown in **Fig. 5.**

$$n \leq 4\sqrt{m(k+1)} \qquad ...4$$

where

(m) is input layer nodes, (K) the output layer nodes

3. The 180 QoS evaluated from **step 1** in the **Table 2-A,2-B,2-C,2-D,2-E,** will be used to learn neural till 5000 iteration and the best validation 12331 as shown in **Fig. 6** and **Fig. 7**.
4. The input are four elements (area, number of nodes, ratio of R.T.A and ratio of N.R.T.A), the second layer is hidden layer and it contains 20 neurons and the third layer contains 10 neurons and fourth is contains 20 neurons and last
5. Training the network depends on the results from the simulation (QoS) and making the error ratio (10^{-7}). This will learn the neural network to get high accuracy digit to estimate the best protocol of the area. This topic describes

two different styles of training. The incremental training in which the weights and biases of the network are updated each time an input is presented to the network. The second style is the batch training in which the weights and biases are only updated after all the inputs are presented. The batch training methods are generally more efficient in the MATLAB 2012A environment, and they are emphasized in the Neural Network Toolbox software, but there are some applications where incremental training can be useful, so that paradigm is implemented as well.

6. Validation the network. Now the network is ready to be used.

After neural network design, one can be sure from accuracy of the results through the input data approximation of data learning.

Test No.	**1**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
15000 m^2	50	0.5	0.5	0.9963	0.9945	0.9994	0.9934

From **test 1** the area 15000 m^2 is (122*122) which is close to the area (100*100) and result matches the learning data. The best protocol is OLSR.

Test No.	**2**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
25000 m^2	45	0.5	05	0.9993	0.9947	0.9925	0.9905

Test No.	**3**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
50000 m^2	60	0.5	0.5	0.3311	0.1383	0.5401	0.0158

From **test 2**, increasing the area and decreasing the number of nodes the QoS remains constant and the best of routing protocol for this specification is (AODV).

Test No.	**4**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
750000 m^2	40	0.7	0.3	0.7585	0.7200	0.8586	0.4922

In **test 3**, the best protocol is OLSR but it needs to be improved; by adding node server to serve other nodes as shown in **Fig. 8** and making some of nodes static (to reduce the update of table driven in reactive protocol) or increasing the ratio of real time application to improve the QoS.

After adding 6 nodes server and making 25 nodes static the QoS will be improved to (0. 6421).

Test No.	**5**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
300000 m^2	60	0.5	0.5	0.9968	0.9991	0.9939	0.9902

Test No.	**6**			**Results**			
Area	**No. Of Nodes**	**Ratio Of Real Time Application**	**Ratio of Non-Real Time Application**	**AODV**	**DSR**	**OLSR**	**TORA**
500000 m^2	48	0.3	0.7	0.9911	0.4838	0.2472	0.1561

Through previous tests and the results showed it was possible to expect the best protocol for any region and the number of nodes application used, which in turn will determine the best protocol, which helps to achieve the best QoS to the network. There are some of rules to improve QoS through mixing between the two protocols (AODV & DSR) as compared with reference **Bandyopadhyay, 2006**, or distribute some of nodes server to help other nodes by flooding.

6.CONCLUSION

This paper presented a research work on QoS technologies for multimedia applications in next generation networks. We used Fuzzy Neural technique to implement this work. The Fuzzy technique evaluated QoS for all protocols by identifying different number of nodes using several areas. The most important parameters in the QoS are: throughput, PDR, Latency, and Jitter. The values of the QoS evaluation were compared with the results of implementing other protocols for the same design. The Neural technique was implemented and tested to identify the best protocol. The Ad-hoc network had used two types of applications: Real time and Non real time applications in the MANET. Finally, the neural technique used all QoS results obtained by Fuzzy technique to learn ANN. The results showed that the proposed approach enhanced performance and it was the best protocol depending on the QoS factor of the medium radio.

REFERENCES:

- Bandyopadhyay S., Roy S. and Ueda T., 2006, “*Enhancing the Performance of Ad Hoc Wireless Networks with Smart Antennas*”, Published in 2006 by, Auerbach Publications, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742.

- Hallani H. and Shahrestani S. A., 2008, “*Fuzzy Trust Approach for Wireless Ad-hoc Networks*”, Communications of the IBIMA, vol.1, pp.212–218,
- Jasani H., 2011, “*Quality of Service Evaluations of On Demand Mobile Ad-Hoc Routing Protocols*”, Department of Computer Science, Northern Kentucky

University, Highland Heights, KY, USA, 41099, jasanih1@nku.edu, 978-0-7695-4496-0/11 © 2011 IEEE, DOI 10.1109/NGMAST.31

- Karray F. O. and de Silva C., 2004, "*Soft Computing and Intelligent Systems Design*", Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England.

- Lewis F. L., 2007, "*Wireless Ad Hoc and Sensor Networks*", A Thesis in Applied Control Engineering, University of Texas at Arlington, Fort Worth, Texas.

- Liua B., Zhangb X., Xiea S., and Maa H., 2011, "*Variable Weights Decision-Making and Its Fuzzy Inference Implementation*", School of information science and technology, Tsinghua University, Beijing, China, 100084,b. School of electronics and information engineering, Beijing University of Aeronautics and, Astronautics, Beijing, China, 100084,liu-b03@mails.tsinghua.edu.cn.

- Misra S., 2009, "*Guide to Wireless Ad-Hoc Networks*", School of Information Technology, Indian Institute of Technology, Kharagpur, India.

- Odom W., 2010, "*CCIE Routing and Switching Exam Certification Guide*", Third Edition, , CCIE No. 1624, Rus Healy, CCIE No. 15025, Contributing author: Naren Mehta, CCIE No. 9797.

- OPNETWORK 2002, "*Introduction to Using OPNET Modeler*".

- Reddy T. B., Karthigeyan I., Manoj B. S., Murthy C. S. R., 2004, "*Quality of service provisioning in ad hoc wireless networks a survey of issues and solutions*", Department of Computer Science and Engineering, Indian Institute of Technology, Madras 600036, India, Received 15 February; accepted 14 April 2004, Available online 5 June.

- Roy R. R., 2011, "*Handbook of Mobile Ad-Hoc Networks for Mobility Models,*" United States Army Research, Development and Engineering Command, (RDECOM),Myer Center 2700, Fort Monmouth, NJ 07703, USA, rroy3@optonline.net.

- Shen C., and Rajagopalan S., 2007, "*Protocol-independent multicast packet delivery improvement service for mobile Ad hoc networks*", Science Direct, Ad Hoc Networks, vol.5, pp.210–227.

- Sivanandam S. N., 2010, "*Introduction to Fuzzy Logic using MATLAB*", Dr. Professor and Head, Department of Computer, Science and Engineering, PSG College of Technology, Coimbatore 641 004, Tamil Nadu, India, E-mail: snsivanandam@yahoo.co.in.

- Valbonne S. A, , "*3GPP support office address*", 650 Route des Lucioles -– FRANCE, Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16, Internet, http://www.3gpp.org.

- Xia C., Yang Z. and Li H., 2012, "*Electric Load Forecasting Using Virtual Instrument Based on Dynamic Recurrent Elman Neural Network* ", College of Electrical Engineering and Renewable Energy, China Three Gorges, University Yichang, Hubei 443002 China

- Zaghar D. R. and AL Wahab T. A., 2013, "*Simplified the QoS Factor for the Ad-Hoc Network Using Fuzzy Technique*", Computer & Software Engineering Department, College of Engineering, Almostansyriya University, Baghdad,Iraq,Email:DRZ_RAW@yahoo.com,Thoalfqar_almashaikhy@yahoo.com

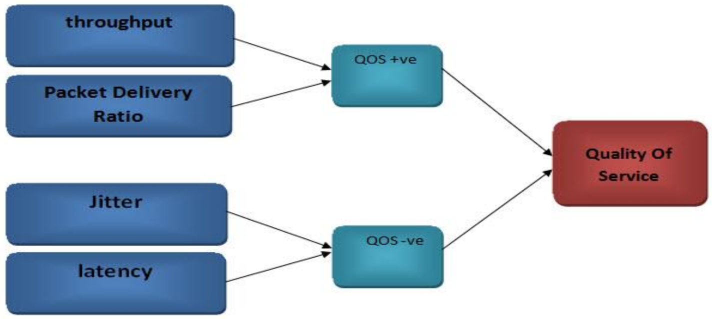

Figure 1. Evaluating the QoS of Real Time application.

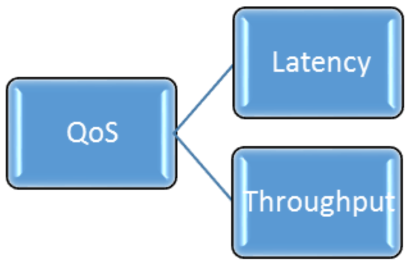

Figure 2. Evaluating the QoS of Non-Real Time application.

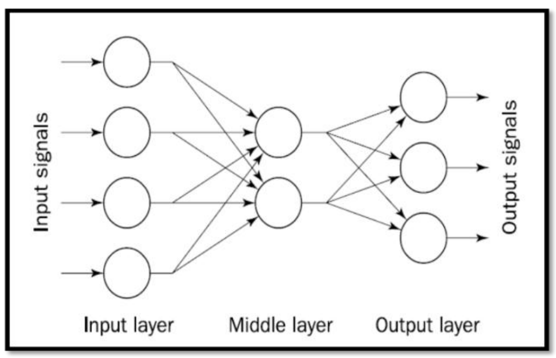

Figure 3. Artificial neuron structure (perceptron model).

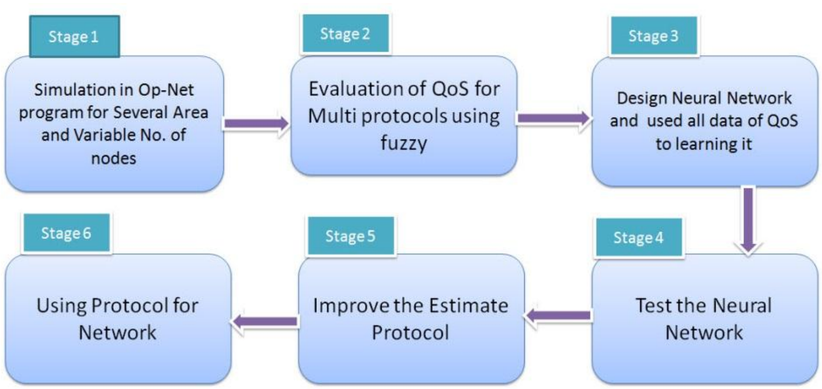

Figure 4. System design.

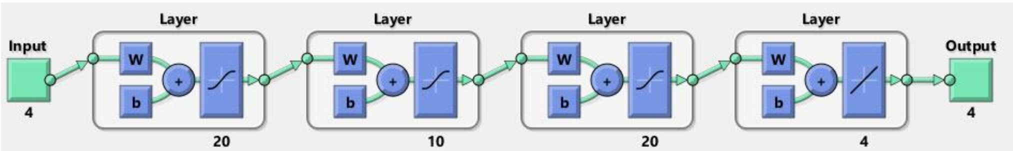

Figure 5. Neural network.

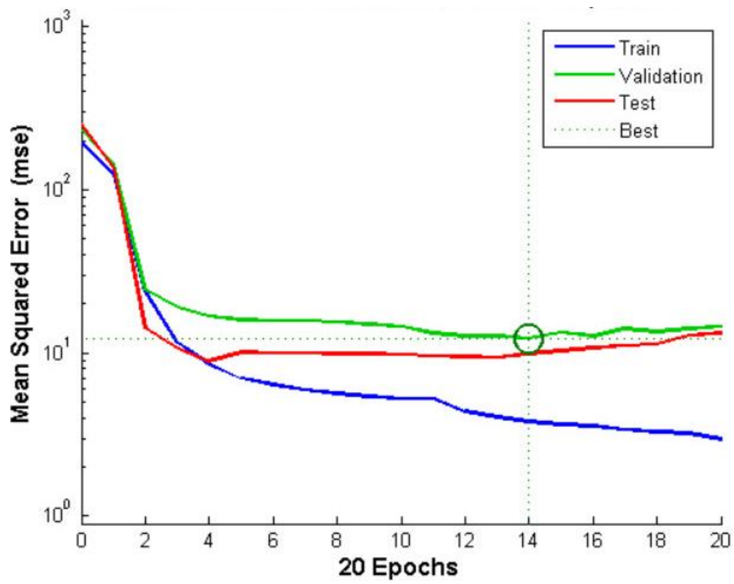

Figure 6. Best Validation is 12331 at epoch 14.

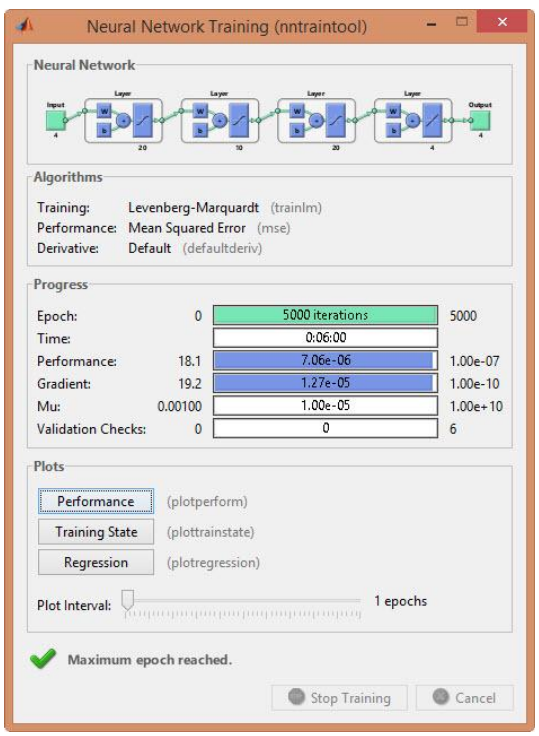

Figure 7. Training Neural network after training.

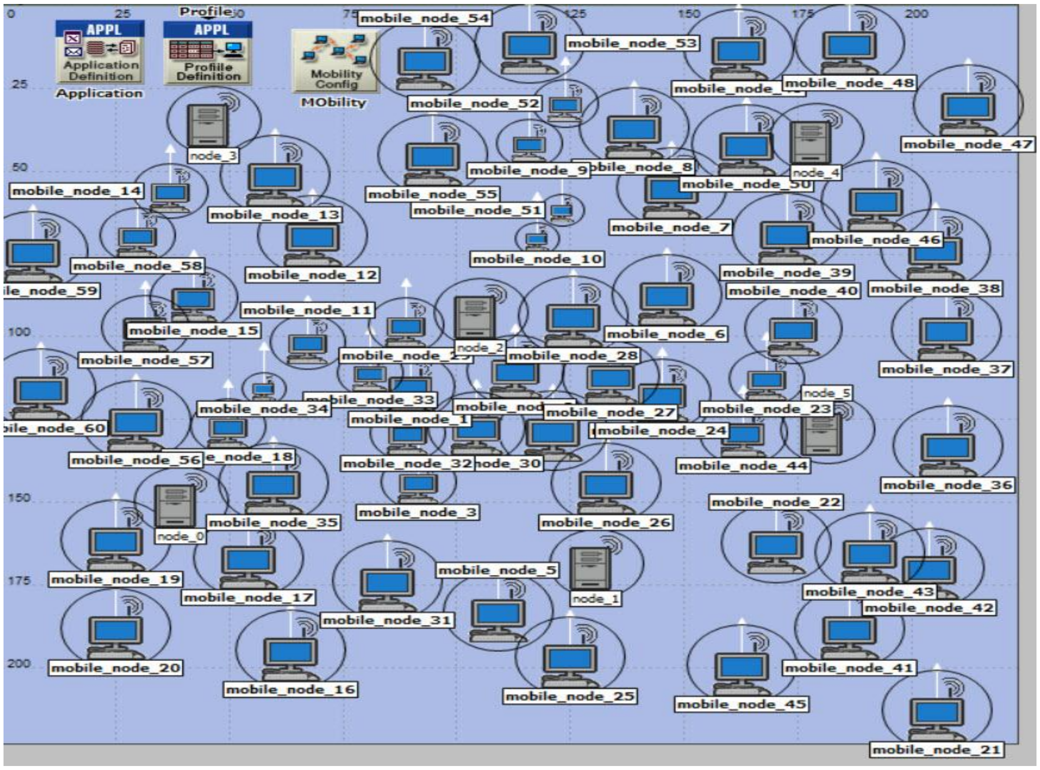

Figure 8. Improve the routing protocol OLSR.

Table 1. Specification of Design

Simulation Specification	Value
Mobility Model	**Random Way Point (RWP)**
Node Speed	**2.7 m/sec**
Areas	**100*100 - 200*200 - 400*400 - 800*800 - 1000*1000**
Number of Nodes	**10,20,40 and 80**
Simulation time	**1100 sec**
Packet Reception Power Threshold	**-85 dB**
Transmission Power	**0.006w or 7.781 dBm**
Mac Layer Type	**802.11g (12MB)**

Table 2-A. QoS of simulation on area (100*100) m^2.

Area	No. of nodes	Ratio of voice used	QoS of protocols			
			AODV	DSR	OLSR	TORA
100*100	10	0.1	0.84391	0.84391	0.84391	0.84391
100*100	10	0.2	0.85421	0.85422	0.85422	0.85422
100*100	10	0.3	0.86453	0.86453	0.86453	0.86453
100*100	10	0.4	0.8748	0.87484	0.87484	0.87484
100*100	10	0.5	0.8852	0.88515	0.88515	0.88515
100*100	10	0.6	0.8955	0.89546	0.89546	0.89546
100*100	10	0.7	0.9058	0.90577	0.90577	0.90577
100*100	10	0.8	0.9161	0.91608	0.91608	0.91608
100*100	10	0.9	0.9264	0.92639	0.90639	0.92639
100*100	20	0.1	0.8692273	0.84391	0.84391	0.84391
100*100	20	0.2	0.8798466	0.85422	0.85422	0.85422
100*100	20	0.3	0.8904659	0.86453	0.86453	0.86453
100*100	20	0.4	0.9010852	0.87484	0.87484	0.87484
100*100	20	0.5	0.9117045	0.88515	0.88515	0.88515
100*100	20	0.6	0.9223238	0.89546	0.89546	0.89546
100*100	20	0.7	0.9329431	0.90577	0.90577	0.90577
100*100	20	0.8	0.9435624	0.91608	0.91608	0.91608
100*100	20	0.9	0.9541817	0.92639	0.92639	0.92639
100*100	40	0.1	0.7795	0.78024	0.17427	0.48
100*100	40	0.2	0.7262	0.72688	0.18824	0.46
100*100	40	0.3	0.673	0.62016	0.20221	0.44
100*100	40	0.4	0.6197	0.62016	0.21618	0.42
100*100	40	0.5	0.5664	0.5668	0.23015	0.4
100*100	40	0.6	0.5131	0.51344	0.24412	0.38
100*100	40	0.7	0.4598	0.46008	0.25809	0.36
100*100	40	0.8	0.4066	0.40672	0.27206	0.34
100*100	40	0.9	0.3533	0.35336	0.28603	0.32
100*100	80	0.1	0.7795	0.70155	0.350775	0.78006
100*100	80	0.2	0.7262	0.65358	0.32679	0.72672
100*100	80	0.3	0.673	0.6057	0.30285	0.67338
100*100	80	0.4	0.6197	0.55773	0.278865	0.62004
100*100	80	0.5	0.5664	0.50976	0.25488	0.5667
100*100	80	0.6	0.5131	0.46179	0.230895	0.51336
100*100	80	0.7	0.4598	0.41382	0.20691	0.46002
100*100	80	0.8	0.4066	0.36594	0.18297	0.40668
100*100	80	0.9	0.3533	0.31797	0.158985	0.35334

Table 2-B. QoS of simulation on area (200*200) m^2.

Area	No. of nodes	Ratio of voice used	QoS of protocols			
			AODV	**DSR**	**OLSR**	**TORA**
200*200	10	0.1	0.84391	0.84391	0.84391	0.84391
200*200	10	0.2	0.85422	0.85422	0.85422	0.85422
200*200	10	0.3	0.86453	0.86453	0.86453	0.86453
200*200	10	0.4	0.87484	0.87484	0.87484	0.87484
200*200	10	0.5	0.88515	0.88515	0.88515	0.88515
200*200	10	0.6	0.89546	0.89546	0.89546	0.89546
200*200	10	0.7	0.90577	0.90577	0.90577	0.90577
200*200	10	0.8	0.91608	0.91608	0.91608	0.91608
200*200	10	0.9	0.92639	0.92639	0.92639	0.92639
200*200	20	0.1	0.58048	0.78024	0.84391	0.19036
200*200	20	0.2	0.62006	0.72688	0.85422	0.22042
200*200	20	0.3	0.65964	0.67352	0.86453	0.25048
200*200	20	0.4	0.69922	0.62016	0.88515	0.28054
200*200	20	0.5	0.7388	0.5668	0.89546	0.3106
200*200	20	0.6	0.77838	0.51344	0.90577	0.34066
200*200	20	0.7	0.81796	0.46008	0.91608	0.37072
200*200	20	0.8	0.85754	0.40672	0.92639	0.40078
200*200	20	0.9	0.89712	0.35336	0.92639	0.43084
200*200	40	0.1	0.78024	0.78024	0.546168	0.17427
200*200	40	0.2	0.72688	0.72688	0.508816	0.18824
200*200	40	0.3	0.67352	0.67352	0.471464	0.20221
200*200	40	0.4	0.62016	0.62016	0.434112	0.21618
200*200	40	0.5	0.5668	0.5668	0.39676	0.23015
200*200	40	0.6	0.51344	0.51344	0.359408	0.24412
200*200	40	0.7	0.46008	0.46008	0.322056	0.25809
200*200	40	0.8	0.40672	0.40672	0.284704	0.27206
200*200	40	0.9	0.35336	0.35336	0.247352	0.28603
200*200	80	0.1	0.78024	0.7334256	0.468144	0.78024
200*200	80	0.2	0.72688	0.6832672	0.3052896	0.72688
200*200	80	0.3	0.67352	0.6331088	0.2828784	0.67352
200*200	80	0.4	0.62016	0.5829504	0.2604672	0.62016
200*200	80	0.5	0.5668	0.532792	0.238056	0.5668
200*200	80	0.6	0.51344	0.4826336	0.2156448	0.51344
200*200	80	0.7	0.46008	0.4324752	0.1932336	0.46008
200*200	80	0.8	0.40672	0.3823168	0.1708224	0.40672
200*200	80	0.9	0.35336	0.3321584	0.1484112	0.35336

Table 2-C. QoS of simulation on area (400*400) m^2.

Area	No. of nodes	Ratio of voice used	QoS of protocols			
			AODV	DSR	OLSR	TORA
400*400	10	0.1	0.83104	0.84391	0.84391	0.84391
400*400	10	0.2	0.84278	0.85422	0.85422	0.85422
400*400	10	0.3	0.85452	0.86453	0.86453	0.86453
400*400	10	0.4	0.86626	0.87484	0.87484	0.87484
400*400	10	0.5	0.878	0.88515	0.88515	0.88515
400*400	10	0.6	0.88974	0.89546	0.89546	0.89546
400*400	10	0.7	0.90148	0.90577	0.90577	0.90577
400*400	10	0.8	0.91322	0.91608	0.91608	0.91608
400*400	10	0.9	0.92496	0.92639	0.92639	0.92639
400*400	20	0.1	0.84391	0.82024	0.84391	0.80242
400*400	20	0.2	0.85422	0.80688	0.85422	0.79104
400*400	20	0.3	0.86453	0.79352	0.86453	0.77966
400*400	20	0.4	0.87484	0.78016	0.87484	0.76828
400*400	20	0.5	0.88515	0.7668	0.88515	0.7569
400*400	20	0.6	0.89546	0.75344	0.89546	0.74552
400*400	20	0.7	0.90577	0.74008	0.90577	0.73414
400*400	20	0.8	0.91608	0.72672	0.91608	0.72276
400*400	20	0.9	0.92639	0.71336	0.92639	0.71138
400*400	40	0.1	0.78024	0.78024	0.48	0.48
400*400	40	0.2	0.72688	0.72688	0.46	0.46
400*400	40	0.3	0.67352	0.67352	0.44	0.44
400*400	40	0.4	0.62016	0.62016	0.42	0.42
400*400	40	0.5	0.5668	0.5668	0.4	0.4
400*400	40	0.6	0.51344	0.51344	0.38	0.38
400*400	40	0.7	0.46008	0.46008	0.36	0.36
400*400	40	0.8	0.40672	0.40672	0.34	0.34
400*400	40	0.9	0.35336	0.35336	0.32	0.32
400*400	80	0.1	0.78024	0.75024	0.450144	0.78024
400*400	80	0.2	0.72688	0.73688	0.442128	0.72688
400*400	80	0.3	0.67352	0.70352	0.422112	0.67352
400*400	80	0.4	0.62016	0.68016	0.408096	0.62016
400*400	80	0.5	0.5668	0.6668	0.40008	0.5668
400*400	80	0.6	0.51344	0.63344	0.380064	0.51344
400*400	80	0.7	0.46008	0.61008	0.366048	0.46008
400*400	80	0.8	0.40672	0.59672	0.358032	0.40672
400*400	80	0.9	0.35336	0.57336	0.344016	0.35336

Table 2-D. QoS of simulation on area (800*800) m^2.

Area	No. of nodes	Ratio of voice used	QoS of protocols			
			AODV	DSR	OLSR	TORA
800*800	10	0.1	0.80074	0.23794	0.23794	0.20413
800*800	10	0.2	0.76788	0.31558	0.34558	0.24796
800*800	10	0.3	0.73502	0.39322	0.37322	0.29179
800*800	10	0.4	0.70216	0.47086	0.47086	0.33562
800*800	10	0.5	0.6693	0.5485	0.5485	0.37945
800*800	10	0.6	0.63644	0.62614	0.62614	0.42328
800*800	10	0.7	0.60358	0.70378	0.70378	0.46711
800*800	10	0.8	0.57072	0.78142	0.78142	0.51094
800*800	10	0.9	0.53786	0.85906	0.85906	0.55477
800*800	20	0.1	0.819252	0.78024	0.78266	0.76494
800*800	20	0.2	0.763224	0.72688	0.79502	0.71328
800*800	20	0.3	0.707196	0.67352	0.75738	0.66162
800*800	20	0.4	0.651168	0.62016	0.73974	0.60996
800*800	20	0.5	0.59514	0.5668	0.70721	0.5583
800*800	20	0.6	0.539112	0.51344	0.68446	0.50664
800*800	20	0.7	0.483084	0.46008	0.66682	0.45498
800*800	20	0.8	0.427056	0.40672	0.65918	0.40332
800*800	20	0.9	0.371028	0.35336	0.62154	0.35166
800*800	40	0.1	0.78024	0.78024	0.68024	0.17427
800*800	40	0.2	0.72688	0.72688	0.63688	0.18824
800*800	40	0.3	0.67352	0.67352	0.60352	0.20221
800*800	40	0.4	0.62016	0.62016	0.57016	0.21618
800*800	40	0.5	0.5668	0.5668	0.5668	0.23015
800*800	40	0.6	0.51344	0.51344	0.51344	0.24412
800*800	40	0.7	0.46008	0.46008	0.46008	0.25809
800*800	40	0.8	0.40672	0.40672	0.40672	0.27206
800*800	40	0.9	0.35336	0.35336	0.35336	0.28603
800*800	80	0.1	0.78006	0.77688	0.17427	0.24796
800*800	80	0.2	0.72672	0.75352	0.18824	0.29179
800*800	80	0.3	0.67338	0.73016	0.20221	0.33562
800*800	80	0.4	0.62004	0.6968	0.21618	0.37945
800*800	80	0.5	0.5667	0.67344	0.23015	0.36796
800*800	80	0.6	0.51336	0.56008	0.24412	0.34008
800*800	80	0.7	0.46002	0.55672	0.25809	0.33672
800*800	80	0.8	0.40668	0.52336	0.27206	0.32336
800*800	80	0.9	0.35334	0.50603	0.28603	0.30231

Table 2-E QoS of simulation on area (1000*1000) m^2.

Area	No. of nodes	Ratio of voice used	QoS of protocols			
			AODV	DSR	OLSR	TORA
1000*1000	10	0.1	0.71296	0.84391	0.84391	0.84391
1000*1000	10	0.2	0.73782	0.85422	0.85422	0.85422
1000*1000	10	0.3	0.73782	0.86453	0.86453	0.86453
1000*1000	10	0.4	0.78754	0.87484	0.87484	0.87484
1000*1000	10	0.5	0.8124	0.88515	0.88515	0.88515
1000*1000	10	0.6	0.83726	0.89546	0.89546	0.89546
1000*1000	10	0.7	0.86212	0.90577	0.90577	0.90577
1000*1000	10	0.8	0.88698	0.91608	0.92639	0.91608
1000*1000	10	0.9	0.91184	0.92639	0.92639	0.92639
1000*1000	20	0.1	0.40957	0.4341442	0.84391	0.19488
1000*1000	20	0.2	0.46814	0.4962284	0.85422	0.22946
1000*1000	20	0.3	0.52671	0.5583126	0.86453	0.26404
1000*1000	20	0.4	0.58528	0.6203968	0.87484	0.29862
1000*1000	20	0.5	0.64385	0.682481	0.88515	0.3332
1000*1000	20	0.6	0.70242	0.7445652	0.89546	0.40236
1000*1000	20	0.7	0.76099	0.8066494	0.90577	0.40236
1000*1000	20	0.8	0.81956	0.8687336	0.91608	0.43694
1000*1000	20	0.9	0.87813	0.9308178	0.92639	0.47152
1000*1000	40	0.1	0.78024	0.80074	0.17427	0.48
1000*1000	40	0.2	0.72688	0.76788	0.18824	0.46
1000*1000	40	0.3	0.67352	0.73502	0.20221	0.44
1000*1000	40	0.4	0.62016	0.70216	0.21618	0.42
1000*1000	40	0.5	0.5668	0.6693	0.23015	0.4
1000*1000	40	0.6	0.51344	0.63644	0.24412	0.38
1000*1000	40	0.7	0.46008	0.60358	0.25809	0.36
1000*1000	40	0.8	0.40672	0.57072	0.27206	0.34
1000*1000	40	0.9	0.35336	0.53786	0.28603	0.32
1000*1000	80	0.1	0.78006	0.702054	0.3159243	0.78006
1000*1000	80	0.2	0.72672	0.654048	0.2943216	0.72672
1000*1000	80	0.3	0.67338	0.606042	0.2727189	0.67338
1000*1000	80	0.4	0.62004	0.558036	0.2511162	0.62004
1000*1000	80	0.5	0.5667	0.51003	0.2295135	0.5667
1000*1000	80	0.6	0.51336	0.462024	0.2079108	0.51336
1000*1000	80	0.7	0.46002	0.414018	0.1863081	0.46002
1000*1000	80	0.8	0.40668	0.366012	0.1647054	0.40668
1000*1000	80	0.9	0.35334	0.318006	0.1431027	0.35334