Evaluation of Routing Protocols on Ad Hoc Network Modelling from Medical Data using OpNet Simulation

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Abstract

It is widely known that the communication of nodes via Ad Hoc wireless network have to face the impacts of radio communication, such as connection problems, sound, interloping and disappearing, etc. Those problems reduce the productivity and of course upsurge time postponement for the information movement. Besides that, there are other problems which are associated with connections such as less bandwidth than a wired network, each node in the wireless network node occupations as both a host. In addition the router and the control of the network is disseminated between the nodes. Therefore, the objective of this paper is to study the approaches of conveying actual time information from a quantity of active nodes in hospital settings in space area 1500m2 and develop a practical orientation that offers direction and suggested practices on unloading operational information. The best results of our comparison were based on the results the best of protocols was Optimized Link State Routing Protocol (OLSR) which has the lowest average end to end delay and the highest value of average throughput.

Keywords: Evaluation, Routing, Protocols, AD HOC Netowrks Wireless, Health Data, OpNet.

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محاكاة تقييم بروتوكولات التوجيه على شبكة نقل البيانات الطبية

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الخلاصة

من المعروف على نطاق واسع من الاتصالات نقطة العقد عن طريق شبكات آدهوك اللاسلكية تواجه تأثيرات عدة منها مشاكل الاتصال الراديوية والصوت والتطفل وتختفي، إلي آخره. وبالطبع فإن هذه المشاكل تقلل من الإنتاجية وتساعد علي التأخير في نقل المعلومات. وبالاضافة الى ذلك، توجد هناك مشاكل أخرى والتي ترتبط مع اتصالات مثل انخفاض عرض النطاق الترددي في الشبكات اللاسلكية مقانة بالشبكات السلكية، كل عقدة اتصال في عقد الشبكات اللاسلكية تشغل كلهما كمضيف. وأيضا جهاز التوجيه والسيطرة في الشبكات اللاسلكية ينشر بين العقد الاتصال. ولذلك، فإن الهدف من هذه البحث هو تقويم أداء الشبكات اللاسلكية من خلال الوقت الفعلي لنقل المعلومات من العقد النشط في المستشفيات في مجال الفضاء (1500m2) وتطوير المنهجية العملية التي تقدم التوجيه والاقتراحات العملية في عدم تحميل المعلومات التشغيلية. وكانت نتائج المقارنة بين كل من البروتوكولات التالية (AODV, OLSR and TORA protocols) وفقا لنتائج أفضل البروتوكولات هو (OLSR) Optimized Link State Routing Protocol كان لديه أدنى متوسط وقت تأخير في نقل المعلومات وأعلى قيمة متوسط انتاجية .

الكلمات المفتاحية : التقويم، التوجيه، بروتوكولات ، شبكات ad-hoc اللاسلكية ، البيانات الصحية، OPNET

Introduction

Widely, Wireless networks play a significant role in technology communication within the countries or globally. Currently, the use of wireless networks dominated human life and needs such as health care requests, emergency management, and industrial applications, even family and personal applications. The advantages of wireless which make it unique service compared to wired networks is its easily and friendly used in communication technology ([1]). Ad Hoc wireless network is known as self-configuring that does not need pre exiting infrastructure ([2]). However, the collection of mobile nodes communication still suffer of growing, thus, it is recommended to develop schemes to offer protocols that are more appropriate for serving the

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applications ([3]). The nodes in Ad Hoc wireless network is free while the system is a decentralized autonomous wireless with a self-configurable. The mobile or static nodes, a router with wireless communication devices and multiple hosts ([4]). There are several features of wireless communication devices that boost their popularity which are smart antennas with transmitters, receivers' services. These antennas can be set-up in mobile and fixed in any nodes. The word of node defined as points that are not stable and has free movements and arbitrarily in every direction which can be laptop, a mobile phone, personal computer, personal digital assistance and others. In this study, extensive review about technology communication network is provided. The framework for the study is developed based on the literature findings and it extends the previous literature that relates to this study. Finally, this section introduces the elementary notion of construction of Ad Hoc wireless network.

1. Ad Hoc Wireless Network

Ad hoc wireless networking is a system to provision strong and effective process in mobile wireless networks through integrating routing functionality into mobile hosts ([5]), automatically and regardless geographically locations ([6]). There are two main characteristics of Ad Hoc wireless network namely bandwidth of throughput and low delay in high density nodes. One of the central goal of the protocol of the Ad Hoc Network Routing is to establish right and competent route between a pair of nodes where the messages can be delivered in time responsiveness ([7]; [8]). The Ad Hoc routing protocol is used to determine the speedy alterations of the topology in such a way where middle nodes could perform as routers to advancing boxes instead of communicating pair ([9]). To obtain an efficient service route structure ought to be performed with a minimum cost of bandwidth and overhead ([10]). The optimal Ad Hoc routing protocols emphasize the importance of reducing the number of messages that need to be directed to adopt routes and minimizing the number of route requests. Route protection approaches are required to have the ability to detect the path when it is among the target and the source. It is undesirable if the link in the path is broken.

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1.1.Reasons for Ad Hoc Wireless Network Applications

The Ad Hoc networks too are wireless networks where nodes connect with each other through using multi-hop contacts. There is no fixed structure or base position for contact. Each node itself deeds as a router for advancing and receipt packs to/from other nodes ([11]). The task of routing in Ad Hoc networks has been continue challenging ever after the wireless networks originated into presence ([12]; [13]). The main motive for this is the continuous alteration in network topology due to the extraordinary grade of node movement ([14]). Basically, the Ad Hoc wireless network contains users with a number of parts, several types of equipment, several requests, a trickle of devices, and some mutual resources. In order to avoid the obvious difficulty out of the user services is to designate all these basics as services which can be joint and retrieved repeatedly although of their position and possession. Ad Hoc wireless networks are multi-hop wireless structure with animatedly altering network communicatively outstanding to movement ([15]). The protocol corresponding set comprises a set of routing protocols definitely well-thought-out for Ad Hoc routing. Route detection is a complex algorithm that needs messages to broadcast over the network, which is costs affordable, resources available in circumstances of battery power and wireless bandwidth ([16]).

1.2.Ad Hoc Wireless Network Related Mechanisms

The focuses of this study on the optimal routing protocols used in the Ad Hoc wireless network. Despite, the past literature paid attention on the routing protocols used Ad Hoc wireless networks, it has been narrowed the focus on various assumptions such as node density or topology. However, this study extends the past literature through targeting three Ad Hoc routing protocols which have widely suggested by other researchers. These protocols are Optimized Link State Routing Protocol (OLSR), Ad Hoc on Demand Distance Vector (AODV), and Temporally-Ordered Routing Algorithm (TORA). This study also discusses and explains the comparison between those three types according to specific criteria namely delay to transfer and throughput and altercation diverse types of data in hospital area via OpNet 14.0 simulation. Hsu et al. ([17]) explore the performance of mobile ad hoc networking routing protocols namely OLSR, AODV DSR and ZRP. In addition, the indicators of performance packet delivery ratio,

model realistic scenarios, jitter and latency of data packets were used to evaluate the performance. The outcome of the study emphases that AODV is complete well than others. Another study by Samba (2004) compared four Wireless Ad hoc Routing Protocols namely DSR, TORA, DSDV and AODV. The overhead of the parameter of random nodes movement, performance delay, and control over time, route acquirement, and throughput are all used in the comparison. The outcome of the study states that DSDV appropriate for small networks with partial topology; while in the other hand TORA is upright for greatly mobile and dense.

Manickam et al. ([18]) compare routing protocols between four namely AODV, TORA, DSR and DSDV. The study also used simulator Ns-2, CBR traffic source, movement model based on delay, Jitter and pause time. The outcome nominated DSDV as the optimal type in path optimality, DSDV and DSDV in jitter AODV in delay and DSR in load balancing.

2.   The Concept of Routing Protocols

Ad Hoc wireless networks are networks where physical connections are absent. The networks are working in a free space without specific topology because the mobility of nodes, intervention, multipath proliferation and path loss. Also, Routing is an action or function that attaches a call from source to purpose in telecommunication networks and also plays essential part in construction, design and set-up of networks . Therefore, active routing protocol is required for these networks to deliver their tasks appropriately. Yet, the nodes might be accomplished of connections straight with each other, for instance, during they are inside wireless communication range of each other. Thus, Ad Hoc wireless networks need also to uphold the connection between nodes that are merely circuitously connected with a series of wireless hops over extra nodes ([19]). Several Routing protocols have been advanced for completing this task.

2.1.The Techniques of Ad Hoc Routing

Despite, that the node must send data to additional target node shorn of knowing how to direct the data over the network, it must perform route detection. The source node has to transmit analytical messages to catch a path to the target node. Upon survey the inquiry, the target directs response by a message back to the supply. The basics identify the answer message and know

how to transfer messages to the target. In this study, an effort is made to assess three of Ad Hoc routing protocols Temporally-Ordered Routing Algorithm (TORA), Optimized Link State Routing Protocol (OLSR) and Ad Hoc On-Demand Distance Vector (AODV). Ad Hoc wireless network is designed for the simulation study taking network units and their configuration conferring to the submissions classes that have selected. Furthermore, we then simulate three diverse routing protocols, and each one has altered the amount of requests with 30 wireless mobile workplaces where each one is located in an area of 1500 m2 field. The illustration of an Ad Hoc network in our plan is displayed in the subsequent Figure 1, illustrate how the information interchange between the nodes in this network as when the server needs to send a file to one of the workstations in the network. After that the folder can take two ways, the first is that the terminus device is located within the broadcast range of the server where the server can send the folder directly to the destination. Next, if the target outdoor the space of broadcast of the server, then the server will send a transmission to all nearby and inside the space of transmission accordance to the use of the protocol and the mechanism of its own in the search for the best route to reach the target indoors the network, over the pass the message which is intermediate workstations in multichip of the link between the server and the target. We constructed the network by selecting the substances wanted from object palette and distribute them as our des igned; we want to Application Configuration, Profile Configuration, Wireless LAN server mobile node and 30 Wireless LAN Workstations mobile nodes as Figure 1.

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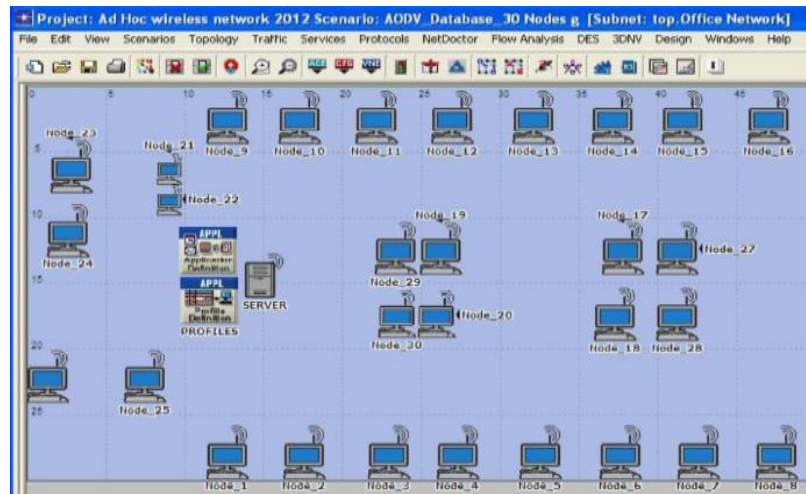### Haitham A.Ali , Qusay Kanaan Kadhim   and Hamid Sadeq Mahdi

Figure1: The Structure of the Network

Methodology

This methodology is used in order to isolate the impact on network performance. The general objective of this study is to provide with practical approaches to build models and running network simulations so that we can obtain meaningful results. The results provided by OPTEN'S stimulations are a function of the models that we have worked with and the data that we enter for parameters of the models.

1. Measurements

Six main scenarios were implemented at three times each of them comprises a protocol from one of three Ad Hoc routing protocols used, each scenario will run during 30 minutes and compared all by the performances.

2. End to End Delay

The end-to-end delay of data packets is the interval between the data pack generation time and the time when the last bit reaches at the target. In a system topology wireless Ad Hoc network, nodes cooperate to construct a network shorn of applying of any structure for example admission points or base positions.

3. Throughput

It is the whole number of bits (in bits/Sec) advanced from wireless LAN layers to advanced layers in all WLAN nodes of the network which was calculated according to the subsequent scenarios:

Megabits =1,048,576 bits

Megabits =131, 072 bytes

Megabits =1024 kilobits

Megabits=128 kilobytes

Megabits =0.125 megabytes

Then we can say Megabits = y (bits) /1048576, where y is value by bits of amount throughput in *Y* axis.

4. Criteria

The outcome components that obtainable in each scenario of this project are shown as the following:

Min means the smallest value of average end-to-end delay or average throughput of the whole network as Global Statistics.

Max represents the supreme value of average end-to-end delay or middling throughput of full network as Global Statistics.

Initial Value represents the primary value with simulation starting of average initial values from average end-to-end delay or average throughput of the whole network as
Global Statistics.

Final Value denotes to the last value at simulation end of average last values from average end-to-end delay or average throughput of the whole network as Global
Statistics.

The sample mean is the regular value of a sample, which is a limited sequence of dimensions, used to estimate the population mean. The sample mean, denoted is calculated with the formula:-

$$\mu = \frac{\sum_{i=1}^{n} x_i}{n} \quad : \text{i=1, 2,..., n where as n the number of values} \tag{1}$$

Expected value is an expected value for assuming investment. In statistics and probability analysis, anticipated value is calculated by multiplying each of the possible results by the likelihood that each result will happen, and summing all of those values. At this point, for the reason that expected values will be equivalent to the sample mean.

For the **variance** is a measure of dispersion. It tells us something about the scatter of scores around the mean. It is defined as the mean squared deviation from the sample mean by calculating the variance, we first find the errors of all the measurements, that is, the difference between each measurement and the sample mean. Further, we then square each value and add them all together, then divide by the number of samples, minus 1 with the formula:-

$$\sigma^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \mu)^2 \quad : \text{i=1,2,...,n} \tag{2}$$

And **standard deviation**, it is how much each individual measurement diverges from the sample mean, and it is the square root of the variance.

$$S = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \mu)^2} \quad : i = 1,2,...,n \tag{3}$$

Result and Discussion

1. Scenarios for FTP Services

In this scenario, we will start building our scenario by configure all applications in the Server and All Values for Wireless Mobile Workstations used in the network designed by using File Transfer Protocol (FTP), and this FTP service estimator by High Load as (50000 byte). Then, we will apply one of AODV, OLSR or TORA protocol for Wireless Mobile Workstations and server by selecting all, then choose edit attributes, next select AODV, OLSR or TORA Value for Attribute Ad Hoc Routing Protocol from Ad Hoc Routing Parameters.

2. End-to-End Delay

The average end-to-end delay for AODV, OLSR and TORA protocols as shown in Table 1 and Figure1. The simulation results reveal that OLSR has the lowest average end-to-end delay and reaches to 6.89182635455E-005Sec; also, it starts with initial and maximum values 0.000201495121568Sec and decreases in the first minute of the simulation then stapling around 7.41434075537E-005Sec and reaches to the minimum value at the end of the simulation by 6.89182635455E-005Sec. Then the AODV has an average end-to-end delay value 8.05685327842E-005Sec, which starts also with the initial and maximum values 0.00020176279817Sec and decreases sharply with the beginning of simulation in the first minute, and then it decreases slightly to end simulation. In last, TORA has the largest average end-to-end delay which starts with 0.00864707870592Sec and increases sharply till reaches to 0.0138350422381Sec then, also decreases sharply in the first five minutes, after that decreases slightly to reach to 0.00454306821456Sec in the final at end of simulation.

Table 1: stimulation results

	AODV	OLSR	TORA
Min	7.07195075783E-005	6.89182635455E-005	0.00454306821456
Max	0.00020176279817	0.000201495121568	0.0138350422381
initial value	0.00020176279817	0.000201495121568	0.00864707870592
final value	7.07195075783E-005	6.89182635455E-005	5 0.00454306821456
expected value	8.05685327842E-005	7.41434075537E-005	0.00572620298256
sample mean	8.05685327842E-005	7.41434075537E-005	0.00572620298256
variance	2.82675633103E-010	2.33816609309E-010	3.12644161674E-006
Standard deviation	1.68129602718E-005	1.52910630536E-005	0.00176817465674

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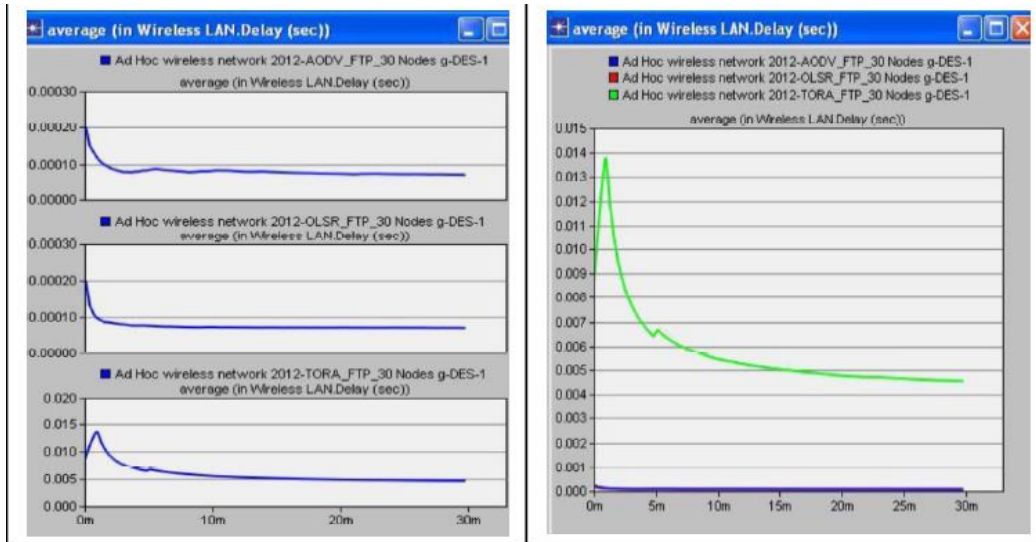
Figure 2. The average end-to-end delay for AODV, OLSR and TORA protocols

All average end-to-end delay of FTP service shown in Table 1. However, we can extract the rank of workstations in order by highest or lowest average delay from the simulation, so we will show the five objects that have the lowest average end-to-end delay and the average delay of the server for each selected protocol as shown in Table 2 and 3:

Table 2: Lowest five objects and server report for OLSR: Wireless LAN, average delay (Sec)

Rank	Object Name	Minimum	Average	Maximum	Std Dev
1	Node_27	0.00024880	0.00044619	0.0013996	0.00026063
2	Node_8	0.00024882	0.00045537	0.0014032	0.00025393
3	Node_28	0.00024880	0.00046389	0.0016674	0.00028313
4	Node_13	0.00024879	0.00046397	0.0018711	0.00028974
5	Node_5	0.00024880	0.00046421	0.0014319	0.00027621
	SERVER	0.00024879	0.00048366	0.0014296	0.00028665

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Table 3: Lowest five objects and server report for OLSR: Wireless LAN, average delay (Sec)

Rank	Object Name	Minimum	Average	Maximum	Std Dev
1	Node_17	0.00022842	0.009713	0.092033	0.017248
2	Node_9	0.00022843	0.009736	0.092705	0.017301
3	Node_13	0.00022843	0.009859	0.088087	0.017221
4	Node_24	0.00022844	0.009873	0.088122	0.016612
5	Node_15	0.00022843	0.009906	0.098507	0.017684
	SERVER	0.00022842	0.010418	0.089466	0.016806

Throughput

The observation average throughput of the whole network for AODV, OLSR and TORA protocols as shown in Figure 3. The simulation results tell that OLSR has the largest average of throughput with sample mean value 726,968.320687527 bits/Sec; whereas that starts with initial and maximum values 1,351,168 bits/Sec, then decreases sharply in the first few seconds then staples to end simulation.
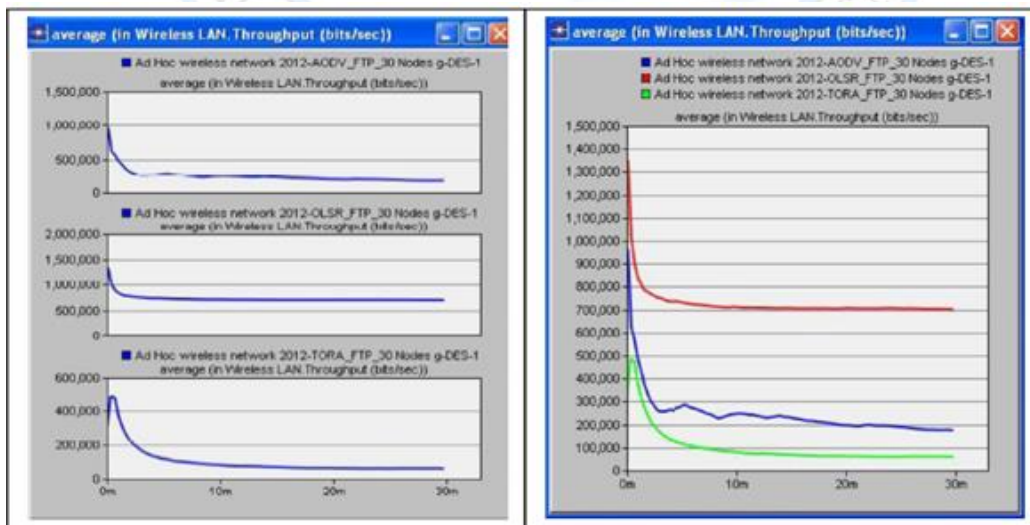

Figure: 3 LAN average throughput (bits/Sec) - FTP

The second is the AODV which has an average of throughput amount 243,434.127892567 bits/Sec, which starts also with initial and maximum values 962,885.333333333 bits/Sec and then decreases sharply in the first two minutes then decreases slightly at the end of the simulation. In last, TORA has the lowest average of throughput amount which has sample mean value 98,902.3237211bits/Sec, which started with initial value 307,534.222222222 bits/Sec and it increases sharply to reach at maximum value 484,376.888888889 bits/Sec, and then it decreases sharply before first five minutes after that decreases slightly to reach in the final of simulation to 59,570.4355556 bits/Sec. The LAN average Throughput of FTP service is shown in Table 4.

Table: 4 LAN average throughput (bits/Sec) - FTP

	AODV	OLSR	TORA
Min	174,541.76	701,507.235555555	59,570.4355556
Max	962,885.333333333	1,351,168	484,376.888888889
initial value	962,885.333333333	1,351,168	307,534.222222222
final value	174,541.76	701,507.235555555	59,570.4355556
expected value	243,434.127892567	726,968.320687527	98,902.3237211
sample mean	243,434.127892567	726,968.320687527	98,902.3237211
variance	10,382,486,378.4141	5,716,491,277.25476	6,394,246,953.60708
Standard deviation	101,894.486496641	75,607.4816222	79,964.035376

Conclusions

Wireless computer network plays key roles in all arenas of our live including daily work, especially with data exchange and communication. For the reason that the construction of an Ad Hoc network provides a good service to enhance data exchange especially in health data. There is no central controlling authority, the interconnection between the mobile nodes in this kind of networks are accomplished of changing on a repeated basis. In addition, the

movement of nodes is free and have the ability to change their seats into the topologies. They also can connect to each.

References

1. Sr., D.J. & Sharma, Y., 2016. Cloud Computing with ERP - A Push Business Towards Higher Efficiency. *Social science research network*, 4, p.pp– 140–155.

2. Coyne, L. et al., 2016. Security and Security and Privacy Issues in Cloud Computing - arXi,

3. Amnai, M., Fakhri, Y. & Abouchabaka, J., 2011. QoS Routing and Performance Evaluation for Mobile Ad Hoc Networks using OLSR Protocol. 2008 The 4th International Conference on Mobile Adhoc and Sensor Networks, pp.89–94. Available at: http://arxiv.org/abs/1107.3656.

4. Qasim, N., Said, F. & Aghvami, H., 2009. Mobile ad hoc networking protocols' evaluation through simulation for quality of service. IAENG International Journal of Computer Science, 36(1).

5. Johnson, D.B. & Maltz, D. a, 2001. DSR : The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks. Computer Science Department, Carnegie Mellon University, Addison-Wesley, pp.139–172.

6. Cadger, F. et al., 2013. A Survey of Geographical Routing in Wireless Ad-Hoc Networks. IEEE Communications Surveys & Tutorials, 15(2), pp.621–653. Available at: http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6238283\nhttp://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6238283.

7. Li, P., Zhang, C. & Fang, Y., 2011. The capacity of wireless ad hoc networks using directional antennas. IEEE Transactions on Mobile Computing, 10(10), pp.1374–1387.

8. Heni, M. & Bouallegue, R., 2012. Power Control in Reactive Routing Protocol for Mobile Ad Hoc Network. International Journal of Wireless & Mobile Networks, 4(2), pp.53–68. Available at: http://airccse.org/journal/jwmn/0412wmn04.pdf.

9. Bekmezci, I., Sahingoz, O.K. & Temel, ??amil, 2013. Flying Ad-Hoc Networks (FANETs): A survey. Ad Hoc Networks, 11(3), pp.1254–1270.

10. Sehra, S.S., Singh, J. & Rai, H.S., 2015. Quality Assessment of Crowdsourced Data against Custom Recorded Map Data. Indian Journal of Science and Technology, 8(November), pp.1–5.

11. Sahingoz, O.K., 2013. Ad Hoc Networks Flying Ad-Hoc Networks (FANETs): A survey. ADHOC, (January).

12. Sari, A., 2015. A Review of Anomaly Detection Systems in Cloud Networks and Survey of Cloud Security Measures in Cloud Storage Applications. Journal of Information Security, p.PP. 142–154.

13. Syed Hamid Hussain Madni, M.S.A.L. & Yahaya Coulibaly, S.M.A., 2016. Resource scheduling for infrastructure as a service (IaaS) in cloud computing: Challenges and opportunities. Journal of Network and Computer Applications, 68, pp.173–200.

14. Liang, W. et al., 2014. Vehicular Ad Hoc Networks: Architectures, Research Issues, Challenges and Trends. International Journal of Distributed Sensor Networks, pp.102–113. Available at: http://link.springer.com/chapter/10.1007/978-3-319-07782-6_10.

15. Mokhtar, B. & Azab, M., 2015. Survey on Security Issues in Vehicular Ad Hoc Networks. Alexandria Engineering Journal, 54(4), pp.1115–1126.

16. Huang, X., Han, T. & Ansari, N., 2015. On Green-Energy-Powered Cognitive Radio Networks. IEEE Communications Surveys & Tutorials, 17(2), pp.827–842.

17. Hsu, J. et al., 2003. Performance of mobile ad hoc networking routing protocols in realistic scenarios. Ieee Milcom, pp.1268–1273.

18. Manickam, P. et al., 2011. Performance Comparisons of Routing Protocols in Mobile Ad Hoc Networks. International Journal of Wireless & Mobile Networks, 3(1), pp.98–106.

19. Moussaoui, A. & Boukeream, A., 2016. A survey of routing protocols based on link-stability in mobile ad hoc networks. Journal of Network and Computer Applications, 47, pp.1–10.