ISSN 2249-6343
International Journal of Computer Technology and Electronics Engineering (IJCTEE)
Volume 2, Issue 1

Improving AODV Routing Protocol with Priority and Power Efficiency in Mobile Ad hoc WiMAX Network

Dr. Sanjay Sharma, Pushpinder Singh Patheja

Abstract:- These days' ad hoc networks have found many applications. Multiple ad hoc routing protocols have been proposed, of which on-demand routing protocols are very popular because they are easy to realize and have no power and priority concept for data communication in routing. In mobile ad hoc networks (MANETs), routing protocol plays the most important role. In the last decade, Ad hoc On-demand Distance Vector (AODV) routing protocol becomes the attention of focused research on MANETs world wide. A lot of protocols had been proposed to improve and optimize AODV routing protocol to achieve the best in quest of reliable protocol.

In this paper, we present some improvement suggestion to AODV routing protocol. Our proposed protocol, called AODV-PP, improved AODV in Priority models and in Power consumption. We also measure performance indicators for some metrics, such as energy, routing overhead, end-to-end delay, and packet delivery ratio, in WiMAX adhoc network.

Keywords: AODV; AODV- PP, Routing Protocol, WiMAX, Power Consumption, Hybrid ad hoc network, MANET, Priority, Mobility.

I. INTRODUCTION

For the last decade, many researches had been performed in mobile ad hoc networks (MANETs), especially in routing protocol of Ad hoc On-demand Distance Vector (AODV) [40] for the optimization or better performance. Many people expect that someday there will be a robust and reliable protocol due to the nature and characteristics of MANETs that always change, decentralized, self-configured, and had no infrastructure to manage.

In the early 2000s, researchers focused on the development of basic functions or services of the AODV protocol, such as shared channel, route discovery, and dynamic nodes. The purpose of their studies was to manage an ad hoc network topology that always change and answer the problem of disconnected route (route error) caused by the level of mobility ad hoc node that can not be predicted.

A major drawback of all existing ad hoc routing protocols is that they do not have provisions for conveying the energy and priority and/or quality of a path during route setup. Hence they cannot balance the load on different routes therefore we have taken Priority and Power into consideration. Also, both proactive and reactive protocols chose a route based on the metric, the smallest number of hops to the destination. But it may not be the most significant route. It may cause the packet drop rate, packet end-to-end delay, or routing overhead to be increased.

Conventional on-demand routing protocols such as AODV and DSR are energy-unaware. Routing is done based on shortest path, the cost metric either considers number of hops or end-to-end delay at the time when route is established. The protocols do not proactively modify routes until they break. If nodes are energy-constrained, such metrics may have adverse effect on the network lifetime on the whole. Since recharging or replacing the battery is not feasible in most of the ad hoc network applications, it is imperative to study and design routing protocols which are able to conserve node energy to prevent premature death.

In this paper, we proposed a new variant of AODV routing protocol, called AODV-PP, which performed some improvement such priority models and energy consumption.

II. DESCRIPTION OF AODV ROUTING PROTOCOL

Ad hoc On-demand Distance Vector (AODV) routing protocol is an on-demand protocol that is it discovers routes on an as needed basis using route discovery process. It uses traditional routing tables, one entry per destination to maintain routing information [2]. When a route to a new destination is needed, the node broadcasts a RREQ to find a route to the destination. A route can be determined when the RREQ reaches either the destination itself, or an intermediate node with a 'fresh enough' route to the destination. A 'fresh enough' route is a valid route entry for the destination whose associated sequence number is at least as great as that contained in the RREQ.

AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. These sequence numbers are carried by all routing packets. The route is made available by unicasting a RREP back to the origination of the RREQ. AODV relies on routing table entries to propagate a RREP back to the source and subsequently, to route data packets to the destination. An important feature of AODV is maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes that use that entry to route data packets. These nodes are notified with RERR packets when the next hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link.

Characteristics of AODV

- Unicast, Broadcast, and Multicast communication.
- On-demand route establishment with small delay.
- Multicast trees connecting group members maintained for lifetime of multicast group.
- Link breakages in active routes efficiently repaired.
- All routes are loop-free through use of sequence numbers.
- Use of Sequence numbers to track accuracy of information.
- Only keeps track of next hop for a route instead of the entire route.
- Use of periodic HELLO messages to track neighbors.

Limitations/Disadvantages of AODV

- Requirement on broadcast medium: The algorithm expects/ requires that the nodes in the broadcast medium can detect each others' broadcasts.
- Overhead on the bandwidth: Overhead on bandwidth will be occurred compared to other protocols, when an RREQ travels from node to node in the process of discovering the route info on demand, it sets up the reverse path in itself with the addresses of all the nodes through which it is passing and it carries all this info all its way.
- No reuse of routing info: AODV lacks an efficient route maintenance technique. The routing info is always obtained on demand, including for common case traffic.
- It is vulnerable to misuse: The messages can be misused for insider attacks including route disruption, route invasion, node isolation, and resource consumption.
- AODV lacks support for high throughput routing metrics: AODV is designed to support the shortest hop count metric. This metric favors long, low bandwidth links over short, high bandwidth links.
- High route discovery latency: AODV is a reactive routing protocol. This means that AODV does not discover a route until a flow is initiated. This route discovery latency result can be high in large-scale mesh networks.

III. LITERATURE SURVEY

A. Optimized AODV

In [3,4] provided a very comprehensive and in depth survey about the QoS of routing in MANETs. Their papers offer a recent survey of major contributions to the MANETs routing protocols published in the period of 1997- 2011. It discussed about the QoS routing metrics, protocols, the factors that affect the performance of protocols, created the classification of protocols. The conclusions focus on several things as follows:

- The design of protocol is classified based on MAC.
- The optimization of route discovery.
- Reliability protocol.
- Management session.
- Measurement of performance indicators.

They also identified several future research areas that can be done as follows:

- Optimization algorithm.
- Network topology and environment.
- Multi-constraint routing.

According to RFC3561 [4] AODV routing protocol still has many weaknesses. From several variants of AODV protocol proposed, it can be identified that the problems encountered in optimizing the AODV protocol requires when handling a link failure (route error) using priority and energy model using load balancing.

A. Rani and M. Dave [11], in 2007, modified AODV for load balancing purpose. In their proposed protocol each node measures the number of packets queued up in its interface. When a source node begin a route discovery procedure by flooding RREQ messages to network, then each node receiving a RREQ will rebroadcast it and add its own interface queue length. Destination node will select the best path and replies with RREP.

ISSN 2249-6343
International Journal of Computer Technology and Electronics Engineering (IJCTEE)
Volume 2, Issue 1

A.A. Pirzada et al. [13] then extended AODV with multi-linked, and the protocol is called AODV-ML. AODV-ML provides an improvement of more than 100% in terms of packet delivery rate, latency and routing overhead over the standard multi-radio AODV routing protocol. In contrast to Multi Radio AODV (AODV-MR) [25], AODV-ML provides multi-homed nodes to discover multiple concurrent bi-directional links between each node during the route establishment process of a reactive routing protocol.

B. AODV with Energy Model

On-demand protocols such as AODV typically pick the shortest path route during the route discovery process, and then sticks to this route until it breaks. Continuous use of the route may drain the nodes of battery power. This is particularly true if one or more nodes are on other routes as well. Note that each message transmission and reception drains battery power. If a node runs out of battery energy and unable to forward any messages, it effectively falls out of the network. In this case, the route breaks and AODV finds an alternate route via another route discovery. However, nodes dying such as this adversely affect the operational life time of ad hoc network.
First, many applications where the dying nodes are the communication end points will fail. *Second*, even when the dying nodes are not the communication end points, network connectivity will become sparser and network partition becomes more likely [2], [36].

The goal of our protocol is routing or re-routing around nodes low on battery power as far as possible. This will prolong the network lifetime. However, this should be done in such a way that other useful performance metrics (e.g., end-to-end delay and throughput) are not compromised in a significant way. We take a two-step approach to design the adaptive energy-aware protocol. First, the nodes are classified according to their remaining battery energy. Depending on their classification the nodes react differently to the routing protocol dynamics. Second, a new cost function is used as routing metric taking into consideration both the hop-wise distance and the battery levels of the nodes.

Developing routing protocol for mobile ad hoc networks (MANETs) could be from any point of views. However, the majority of proposed routing proposals have not focused on the energy constraints of wireless nodes, although many proposals have been proposed recently with energy-aware routing protocols, but only a few proposals have especially focused on the design of route determination protocols that provide efficient energy utilization when performing route discovery [12, 13,14].

Since mobile nodes use wireless connection in MANETs then energy and load are two factors which very important problems for routing protocols in MANETs [18]. They proposed mathematical model of MANETs by considering sustainable energy, consumed energy and bandwidth estimation model. Their goal was to improve AODV routing protocol by takes the minimum hops as the selected route with no problem in energy and bandwidth. Their proposed to improve AODV routing protocol based on energy and bandwidth is described by adding four fields in the RREQ message, energy weight (*Ep*), load weight (*Bp*), remaining energy threshold (*Ew*) and overload threshold (*Bw*). In this, the node will select the best route to forward data which has maximum weight value (Amax). But the node will choose the the best route that has least hops If Amax is corresponding with several routes.

To estimating the bandwidth, they tried to avoid selecting the overloading nodes. To get a balanced distribution, it will choose node with less load. So, when RREQ message broadcasted or forwarded, each node detects its path information about the condition in real time. However, their research in mathematical model only, not implemented for simulation or testbed. In [19] presented a comprehensive energy optimization both locally and globally for AODV routing protocol. Their research investigated about combination of runtime battery capacity and propagation power loss information. The energy information embedded at Hello message and route discovery message. In order to maintain local connection, Hello message is broadcasted only one hop. Energy information is embedded to it, so neighbor nodes can update the energy information of each neighbor node. They also modified RREQ/RREP message for end-to-end or global optimization. They implemented their algorithm into AODV in simulation using OPNET.

C. *Priority*

Dola Saha, Siuli Roy, Somprakash Bandyopadhyay, Tetsuro Ueda and Shinsuke Tanaka in IEEE Communication Society, 2004, have proposed a scheme for supporting priority-based QoS in mobile ad hoc networks by classifying the traffic flows in the network into different priority classes, and giving different treatment to the flow-rates belonging to different classes. They have adopted a control-theoretic approach to adaptively control the low-priority flows so as to maintain the high priority flow-rates at their desired level, thus guaranteeing QoS to high-priority flow [39].

ISSN 2249-6343
International Journal of Computer Technology and Electronics Engineering (IJCTEE)
Volume 2, Issue 1

Alia Asheralieva, Jamil Y. Khan and Kaushik Mahata in 2011 supported that priority based packet transmission techniques are commonly used in communication networks to support multimedia services. In wireless networks mainly type of service or queue measurement based packet transmission priority techniques are used. Their paper introduces a novel two stage traffic prediction and type of service based priority technique for an infrastructure based Wireless Local Area Network. The developed algorithm alters the priority of transmission queues and services in a radio access network based on the predicted traffic volume and the conventional type of service priority technique for multimedia packet transmissions. Simulation results show that their proposed algorithm improves the QoS of multimedia traffic significantly[38].

IV. Description Of Proposed Protocol

In this section, we present an overview of our proposed new variant protocol, we called it AODV-PP. Actually in this research; we improve our proposed protocol by including priority issues. Our aim is to design an algorithm that has a capability to determine battery of intermediate node along with the priority of the application. Our proposed protocol, AODV-PP, has main objectives for selecting a node with energy as a parameter. Every mobile node has an initiated amount of energy. In order to increase the lifespan of the node, it is desirable to take into account the remaining energy. Therefore, it is significant to select a node with a high remaining energy. [40]

The algorithm route discovery process in AODV-PP in WiMAX [1] is as follows:

1) Find the energy level of the route and update regularly.
2) Calculate the average route energy and the battery power of lowest charge node.
3) Check the priority of applications.
4) Select the high average energy route for data transmission.

V. Simulation And Parameter

Simulation Environment

We have used Exata 1.1 advance version of Qualnet for our simulations. As mentioned earlier, we have performed our study with AODV and modified AODV protocol (AODV-PP).

We used 50, 100, 150, 200 and 250 nodes in a grid of dimensions 1500x1500m. We run each simulation for 2500 sec. We used a Constant Bit Rate (CBR) source as the data source for each node.

Each source node transmitted packets with a packet size of 512 bytes. A movement scenario arranges the movement and the position of the nodes according to the random waypoint model. The antenna used is omni directional. Linear battery model has been implemented according to Gaussian distribution (from website random.org) with mean charge value of 5.0 and standard deviation of 1.0 and depends upon the number of nodes in the scenario.

Performance Metrics

We use the following performance metric to evaluate the effect of AODV-PP [2].

Average end-to-end delay - It is defined as the delay between the time instant at which the data packet is originated at the source node and the time instant it reaches the destination. This is the average overall delay for a packet to traverse from a source node to a destination node. This includes the route discovery time, the queuing delay at a node, the transmission delay at the MAC layer and the propagation and transfer time in the wireless channel. End-to-end delay is defined as the time between the point in time the source wants to send a packet and the time the packet reach its destination.

Average throughput: It is defined as the ratio of total packets received to the simulation time. Some parameters evaluated and analyzed based on simulation are as follows:

Remaining energy is the available energy after the simulation completed.

Remaining Energy is defined as:

InitialEnergy - EnergyUsed

Energy consumption is the energy used for various node density and speed.

VI. Result And Analysis

In this research paper, we have implemented the AODV-PP in WiMAX environment. We evaluate the performance of AODV-PP routing protocol. Also we did the comparative study of AODV-PP along with the standard AODV routing protocol for WIMAX environment.

Furthermore, since the nodes are battery operated they need to be energy conserving so that battery life is maximized. Based on the simulations we can conclude that using power awareness to find routes is very beneficial because the difference in battery consumption between various nodes is reduced. This typically means longer network life and longer time to node failure. We are also giving priority to the data packets for better and fast communication. Our study shows that this intelligent protocol reducing power consumption of a mobile node significantly.

ISSN 2249-6343
International Journal of Computer Technology and Electronics Engineering (IJCTEE)
Volume 2, Issue 1

In our simulation, average end-to-end delay is less as compare to standard AODV in WiMAX Adhoc netork

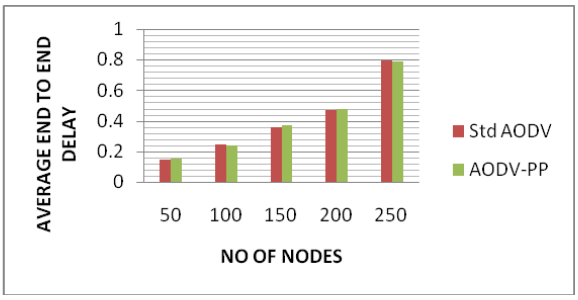

Figure 1: Analysis of average end-to-end delay Vs number of nodes

We did analysis on various scenario based on different number of nodes. The following throughput analysis graph shows that AODV-PP generates good throughput approx. in every situation.

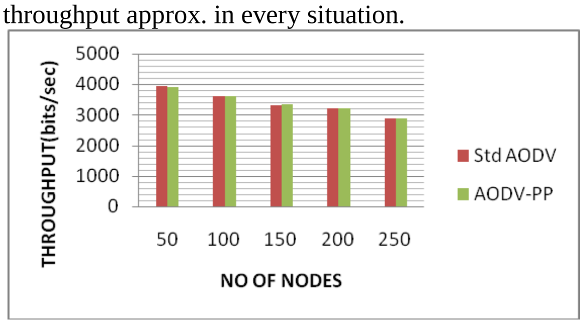

Figure 2: Analysis of throughput Vs number of nodes

AODV-PP performs better in case of first node dies as compare to AODV. The result of this is more network life time of MANET.

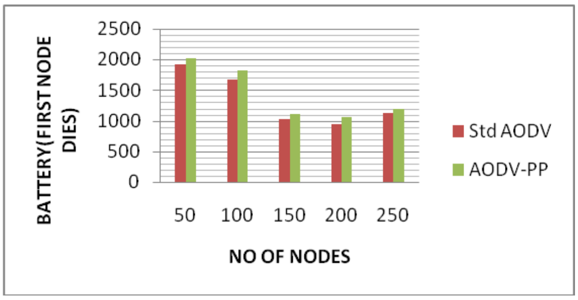

Figure 3: Analysis of first node dice in the situation different no. of nodes

As AODV-PP is concentrating on battery and power constraints of node, it improves the ratio of number of node dies per sec. This ultimate reduce the frequency of path establishment.

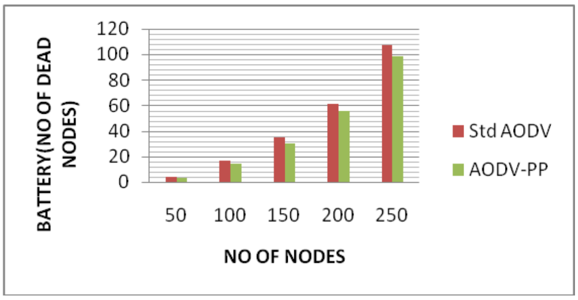

Figure 4: Analysis of number of nodes dead in the situation of different number of nodes

By using AODV-PP we are reducing the energy consumption of network as each node is now aware of its power constraints for data communication.

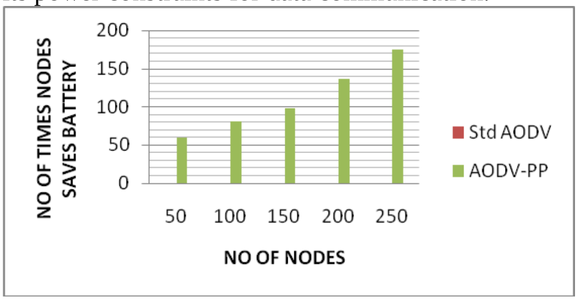

Figure 5: Anlysis of energy consumed in the situation of different number of nodes

VII. Conclusion

A new model has been proposed which takes care of energy features based on priority of data for communication from source to destination. The new scheme will be incorporated on AODV and the results will be compared with existing AODV extensions with embedded energy and priority concept. Almost results are expected to be better than the standard AODV. The graphical notation will be used for representation. The metrics used will be Packet delivery ratio, the end to end delay and throughput and battery oriented parameters for nodes. Successful delivery of RREP message is very important in a MANET as a lot of route discovery effort is wasted if a reply message is lost, moreover a new route discovery process has to be reinitiated. Our simulation results show that AODV-PP protocol has better network lifetime with minor change in throughput in WiMAX Adhoc network.

In this study the two on-demand routing protocols AODV & AODV-PP are analyzed and their performances have been evaluated. This paper can be enhanced by analyzing other MANET routing protocols with different traffic sources.

REFERENCES

1) Farhat Anwar, Md. Saiful Azad, Md. Arafatur Rahman, Mohammad Moshee Uddin, "Performance Analysis of Ad hoc Routing Protocols in Mobile WiMAX Environment", IAENG International Journal of Computer Science, 35:3, IJCS_35_3_13. 2010.
2) Abdusy Syarif, Riri Fitri Sari, "Performance Analysis of AODV-UI Routing Protocol With Energy Consumption Improvement Under Mobility Models in Hybrid Ad hoc Network", International Journal on Computer Science and Engineering (IJCSE), ISSN : 0975-3397 Vol. 3 No. 7 July 2011, pp 2904-2918
3) P. Chenna Reddy, Dr. P. Chandrasekhar Reddy, "Performance Analysis of Adhoc NetworkRouting Protocols", Academic Open Internet Journal, ISSN 1311-4360, Volume 17, 2006.
4) L. Chen, W.B Heinzelman, "A Survey of Routing Protocols that Support QoS in Mobile Ad hoc Networks", IEEE Communication Society Networks, Vol. 21, 2007
5) M.A.L. Thathacar, PS Sastry, "Varietes of Learning Autmata: An Overview", IEEE Transactions on Systems, Man, and Cyberetics Part: B, Vybernetics, Vol. 32, No. 6, December, 2002
6) Request For Comment (RFC) AODV, http://www.ietf.org/rfc/rfc3561.txt
7) A. Hamidian, "Performance of Internet Acces Solutions in Mobile Ad hoc Networks", Master Thesis, Lund University, 2001
8) B. Wiberg,"Porting AODV-UU Implementation to ns-2 and Enabling Trace-based Simulation", Master Thesis, Uppsala University, 2002
9) E. Nordstrom,"APE-a Large Scale Ad hoc Network Testbed for Reproducible Performance Test", Master Thesis, Uppsala University, 2002
10) C. Kim, E. Talipov, B. Ahn , "A Reverse AODV Routing Protocol in Ad hoc Mobile Networks", IFIP-International Federation for Information Processing, Seoul, Korea, August 2006
11) E. Talipov, D. Jin, J. Jung, I. Ha, YJ Choi, C. Kim,"Path Hopping based on Reverse AODV for Security", APNOMS, Busan, Korea, September 2006
12) M. Zarei,"Reverse AODV Routing Protocol Extension Using Learning Automata in Ad hoc Networks", Computer, Control and Communication, IC4, Karachi, 5 May 2009
13) A. Rani, M. Dave, "Performance Evaluation of Modified AODV for Load Balancing", Journal of Computer Science 3, Science Publication, 2007
14) A.A. Pirzada, M. Portmann, "High Performance AODV Routing Protocol for Hybrid Wireless Mesh Networks", 4rd Annual International Conference on Mobile and Ubiquitous System: Networking & Services, MobiQuitous, Philadelphia, USA, 6-10 August, 2007
15) A.A. Pirzada, R. Wishart, M. Portmann, "Multi-Linked AODV Routing Protocol For Wireless Mesh Networks", IEEE Global Telecommunications Conference, Globecom, Washington, DC, USA, 26-30 November, 2007
16) A.A. Pirzada, M. Portmann, J Indulska, "Evaluation of MultiRadio Extensions to AODV for Wireless Mesh Networks", in Proceedings of the 4rd ACM International Workshop on Mobility Management and Wireless Access (MobiWac), Torremolinos, Spain, 2 October, 2006
17) H. Babaei, M. Romoozi, "Multi Objective AODV Based On a Realistic Model", International Journal of Computer Science Issues, Vol 7, Issue 3, No. 3, May 2010
18) G. Di Caro, F. Ducatelle, L. M. Gambardella, "Special Issue on Self-Organization in Mobile Networking. AnthocNet : An Adaptive Natured-Inspired Algorithm for Routing in Mobile Ad hoc Networks", European Transactions and Communications, Vol. 16, 2005
19) HY. Zhang, M.E Bialkowski, G. Einicke, J. Homer, "An Extended AODV Protocol for VoIP Application in Mobile Ad hoc Network", ECTI Transactions on Electrical Eng., Electronics, and Communications Vol.7, No.2, August, 2009
20) L. Ding, L. Wan," Improvement Suggestions to the AODV Routing Protocol", International Conference on Wireless Networks and Information Systems, WNIS, pp. 370, 28-29 December, 2009
21) X. Jing, MJ Lee,"Energy-Aware Algortihm for AODV in Ad hoc Networks", Proceeding of International Conferemce on Mobile Computing and Ubiquitous, ICMU, Japan, 8-9 January, 2004
22) F.D. Tolba, D. Magoni, P. Lorenz,"Energy Saving and Connectivity Tradeoff bys Adaptative Transmission Range in 802.11g MANETs", International Conference on Wireless and Mobile Communication, ICWMC, IEEE Conference, pp. 45, 29-31 July, 2006
23) F. D. Tolba, D. Magoni, P. Lorenz," Connectivity, Energy and Mobility Driven Clustering Algorithm for Mobile Ad hocs Networks", Global Telecommunications Conference, GlobeCom IEEE, pp. 2786-2790, 26-30 Nov, 2007
24) L M. Feeney," An Energy Consumption Model for Performance Analysis of Routing Protocols for Mobile Ad hoc Networks', Mobile Networks and Applications, pp. 239-249, 2001
25) J.C. Carlos,P. Manzoni,"A Performance Comparison Energy Consumption for Mobile Ad hoc Routing Network Protocols", In Proceedings of the 8th International Symposium on Modelling, Analysis and Simulation of Computer and Telecommunication Systems, San Francisco, CA, 2000
26) R. F. Sari, A. Syarif, K. Ramli, B. Budiardjo, "Performance Evaluation Of AODV Routing Protocol On Adhoc Networks Testbed Using PDA", IEEE Malaysia International Conference On Communications And IEEE International Conference On Networks, Kuala Lumpur, Malaysia,16 -18 November, 2005
27) B. Liang, J.H Zygmunt,"Predictive Distance Based Mobility Management for PCs Networks", in Proceedings of IEEE Infocom-99, New York, March, 21-25, 1999
28) The BonnMotion Software, http://net.cs.uni-bonn.de/wg/cs/applications/bonnmotion

ISSN 2249-6343
International Journal of Computer Technology and Electronics Engineering (IJCTEE)
Volume 2, Issue 1

29) M.A. Sayid, H. Suhaidi, G. Osman, M.M Kadhum,"Pause Time Optimal Setting for AODV Protocol on RPGM Mpbility Model in MANETs", International Journal of Advanced Computer Science and Applications, Vol 1, No.6, December 2010
30) Liang, B. Haas, J. Zygmunt ."Predictive distance-based mobility management for PCS networks. In: Proc. of the IEEE Infocom, S. 1377-1384, 1999
31) Mobility User Manual, http://nile.cise.ufl.edu/important/mobility-user-manual.pdf
32) Abdusy Syarif et al. / International Journal on Computer Science and Engineering (IJCSE)
33) Perkins, C.E., 2001. Ad Hoc Networking: Addison Wesley, USA.
34) Sun, J.Z. and J. Sauvola, 2002. On Fundamental Concept of Mobility for Mobile Communications: Proc. Of 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communication, Lisbon, Portugal, 2: 799-803.
35) Abolhasan, M., T. Wysocki and E. Dutkiewicz, 2001. A Review of Current On-demand Routing Protocols: ICN 2001, LNCS 2094, pp: 186-195.
36) Nishant Gupta and Samir R. Das, "Energy-Aware On-Demand Routing for Mobile Ad Hoc Networks", Proceedings of the 4th International Workshop on Distributed Computing, Mobile and Wireless Computing pp 164-173.
37) M. Tamilarasi, T. G. Palanivelu, "Integrated Energy-Aware Mechanism for MANETs using On-demand Routing", International Journal of Computer and Information Engineering , 2008, pp 212-216.
38) Alia Asheralieva, Jamil Y. Khan and Kaushik Mahata, "Traffic Prediction Based Packet Transmission Priority Technique in an Infrastructure Wireless Network", published in Wireless Communications and Networking Conference (WCNC), 2011 IEEE, pp 404-409
39) Dola Saha, Siuli Roy, Somprakash Bandyopadhyay, Tetsuro Ueda and Shinsuke Tanaka in IEEE Communication Society, 2004, pp 4172-4176
40) L. Hanzo, R. Tafazolli, "A Survey of QoS Routing Solution For Mobile Ad hoc Networks", IEEE Communications Surveys & Tutorials, Vol. 9, Issue: 2, 2007