VOL. 12, NO. 21, NOVEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

CONSISTENT AND ENERGY COMPETENT ROUTING PROTOCOL FOR MOBILE AD HOC NETWORKS

M.Udhayamoorthi[1], P. Manimegalai[2] and S.Karthik[3]
[1]CSE, Karpagam Academy of Higher Education, Coimbatore, India
[2]ECE, Karpagam Academy of Higher Education, Coimbatore, India
[3]Dean/CSE, SNS College of Technology, Coimbatore, India
E-Mail: udaya.manasu@gmail.com

ABSTRACT

The intention is to focus on the most thriving network i.e. the mobile ad hoc networks. The autonomous nature and the restricted energy capabilities of nodes regular path breakages occur which create improved energy indulgences. The aim of the design is a dependable and energy competent routing with nodes with improved energy levels. The scheme focuses on the minimization of energy utilization during path breakages by adapting an ondemand local path revival scheme through a collection of supporting nodes termed as holdup nodes. The collaboration of the holdup nodes will minimize the energy utilization and considerably improves the consistency. The behavior of the designed scheme is estimated in terms of energy utilization, packet delivery ratio and end to end delays over the contradictory node and its packet size. The energy optimization and consistency is accomplished based on the designed scheme which offers an ultimate solution to the upcoming transmissions in mobile ad hoc network for a prolonged time.

Keywords: mobile Ad hoc networks, energy capabilities, path breakages, holdup nodes packet sizes, AODV.

1. INTRODUCTION

The mobile ad hoc networks (MANETs) which employ the autonomous devices as their nodes to perform communication with the help of wireless associations that is reasonable with restricted bandwidths. These nodes within the networks are autonomous and the topology of the network transforms quickly and they are not expected over time. Because of this autonomous network topology of the network, restricted energy of the autonomous nodes and time changing wireless medium the routing standards and the transmission operation of these networks are stimulating issues for addressing [1]. These features let the paths within the mobile ad hoc networks to be non static and create path failures which consequently utilize more of the network time and energy. Therefore precisely there is need for an effective routing protocol to acquire time based and dependable information dissemination with the help of minimal resource consumption. The routing protocols designed for the mobile ad hoc networks are normally categorized into a table based and on demand which revises the paths based on time. Diverse routing standards consist of DSDV [1] and FSR [2] falls under the table driven schemes and it varies in terms of routing tables influenced and the schemes employed to interchange and preserves the routing tables. On contrast, the tabledriven routing protocols possibly not all the revised routes are preserved at each and every node. The DSR [3] and AODV [4] illustrate the on demand driven protocols. On contrast, it is merely initiated exactly and effective paths among the routes of nodes but a significant intention of the routing protocol is to preserve the processing of the network to a greater extent. The fresh routing scheme termed as energy resourceful consistent routing (ERCR) is designed for addressing the possible issues. The routing protocol attempts to build a path based on the ability of the adjacent nodes and the ability of the adjacent nodes are estimated based on the energy resources. The energy resource is an aggregation of the nodes residual energy and the consistency and it is to be noted that the thriving packet transmission ability is measured as consistency. The aggregation of the residual energy of the node the scheme accomplished both the elevated energy competence and dependable packet delivery. The scheme permits local path identification during path breakdowns with the help of sustaining nodes and therefore the designed schemes build a dependable path which assures equalized energy utilization by minimizing the control messages of the autonomous nodes in the mobile ad-hoc environment.

2. Related Works

Diverse schemes are designed conventionally for carrying out optimizing energy in mobile ad hoc networks (MANETs). The AODV [4] is a reactive routing standard which builds a path as on-demand basis i.e. the paths are built on demand and are preserved until they are needed. The process of path creation in AODV utilizes escalated energy because it employs flooding of route demands, route response or HELLO messages. Because of the complex path breakages the scheme utilizes increased time attempts. The path identification process [5] was designed to improve the AODV termed as AODV with support routing. Here each and every node builds its interchange paths by eavesdropping the route response of the target. During the identification of path breakages, the node identifies the path breakage transmissions of the data packets to their one hop adjacent nodes in order to transmit the information to the target using pre planned support paths. It focuses on consistency for which it initiates postponed paths and the key setbacks of AODV are escalated end to end delays because of the postponed paths and also the debauchery of improved energy [6]. A changeable support routing based on AODV is designed which is identical to AODV support routing which builds

ARPN Journal of Engineering and Applied Sciences

a path by deeming diverse supported paths from instantaneous upper-level nodes through the process of threeway handshakes during the path breakages. The scheme cannot run away from crashes because of the diverse supported paths and based on the backoff timer [6] the designed scheme is an enhancement to the AODV enhanced support paths. It executes the local paths by focusing on a back off timer and handshake process and the scheme attempts to reduce the flooding of control messages along with collisions. The key setbacks of the scheme are escalated energy utilization for the semi dynamic supported routing schemes. Strong and dependable routing [8] employs path constancy parameter. The path constancy based routing [8] chooses an in between node with minimal levels of association constancy for route demand transmission. The R2 routing builds a path with minimal constancy nodes. The in between node chooses a path with escalated and strong path catalog value among diverse path demands acquired [10]. The string path catalog is estimated from the steered hop length related to the velocity of the node and node delays. The scheme is more efficient for extremely autonomous conditions. The key setback of the scheme is escalated protocol difficulties since the nodes require recovering its present metric values and its present position from diverse layers. The rate of route meeting is a routing parameter as the aggregation of squaring the rate of routing. The rate of route meeting protocol attempts to choose a path which is holding a minimal rate of meeting amongst the prevailing routes towards the target node. The rate of route meeting is suitable for nodes with reduced displacements or for minimal node concentrated regions. The routing scheme attempts to pass the overall traffic loads through a single and precise region which initiates susceptibility and also escalates the possibilities of the collision. There are diverse route parameters [10] [11] designed with the intention of meeting based parameters. For energy conscious routing [14] a node transmits the route demand message only if it has energy more than the fixed threshold values or else it discards the route demand messages. These sorts of routing schemes surmount the issues of overheads during episodic interchanges but during path breakages, it experiences escalated end to end delays to rebuild a path.

The EAODV [15] and the energy effective dependable routing [15] are the similar energy conscious routing standards with escalated lifetime for a network by choosing a path with the highest energy. But a node with restricted energy might prevail within the utmost energy paths which raise the possibilities of path breakdowns. The local energy conscious routing standards do not focus on the local path identification because it minimizes the packet delivery ratio and the network throughput considerably. The energy effective probability based routing standards [16] [17], considerably minimizes the dissemination of path demand messages with their designed parameters. The EEPR protocol does not focus on the dependability of the path and quality of associations and in terms of route constancy which considerably minimizes the lifetime of the network and information communication by killing the remaining energy within the nodes with deprived quality of associations. The EEPR is designed with an intention to considerably minimize the communication by selecting the parameter [18] [20] which aggregate the nodes residual energy value which has considerable authority on the quality of associations among the nodes.

3. Energy Consistency Parameter

For a network with a collection of nodes 'n_c' an individual recognition address 'i_r' is allocated to each and every node 'n_n' within the network. Consider 'E_o' n_n ε n_c where 'E_o' represents the initial energy and residual energy of the nodes within the network 'n_n', the nodes necessitate 'E_t' as the degree of energy to perform transmitting an information to the adjacent node 'A_n' as described in equation (1).

$$E_t = E_r + E_c \tag{1}$$

Here, 'E_t' represents the degree of energy needed to acquire a data packet and 'E_c' represents the degree of energy needed to communicate a data packet within the network.

Consistency is one among the parameter for measuring the packet transmission of a node in mobile ad hoc networks. It is estimated as the proportion of the essentially acquired packets from the adjacent nodes to the exactly forward data packet to the adjacent nodes. It is also termed as the packet delivery ratio for an individual hop. Therefore the estimation focuses on the aggregation of data packets and control packets acquired from the underneath node and forwarded to the next node. Consider nodes 'n_1' and 'n_2' be nodes communicating the data packets. Let 'p' be the packets forwarded from 'n_1' to 'n_2' from its one hop adjacent nodes and 'P_r' represents the packets acquired at node 'n_1' to node 'n_2' at any time instant 't_i'. The consistency among the node 'n_1' and 'n_2' is measured as,

$$C_{n_n(t_i)} = \frac{P_r}{p} \tag{2}$$

Within the time interval 't_i' the node concurrently performs transmission with the adjacent nodes and consider 'p' be the nodes forwarded from the node 'n_n' to their adjacent node 'a_n' and 'P_r' be the acquired packets at the node 'n_n' from their adjacent node 'a_n' at any time instant 't_i'. The subjective consistency of a node 'n_n' is estimated as,

$$r^{s}_{n_n(t_i)} = (1-\phi) r_{n_n(t_i)} + \phi \frac{P_r}{p}, 1 \le j \le i, j \ne a_n \tag{3}$$

Here, ϕ represents the subjective factor ($0 \le \phi \le 1$). Based on the estimation the energy consistency parameter for a nodes 'n_n' is estimated as,

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

$$C_{E(n_n)} = C_{E(n_n),\min} + (1 - C_{E(n_n),\min}) * \left(\frac{E_o * r_{n_n(t_i)}}{E_o \max * r^s_{n_n(t_i)}} \right) * 1 + \varphi \quad (4)$$

Here, $\varphi = \left(\mu \sqrt{\frac{r_{n_n(t_i)} - r^s_{n_n(t_i)} * E_t}{1 - r^s_{n_n(t_i)} E_t}} \right)$ is a constant which differs in relation to the subjective consistency. From the above equations and μ are predetermined minimal $C_{E(n_n)}$ and the subjective factor. Therefore the energy consistency parameter will perform choices whether a node is capable of sending the information or not. A node is chosen for information transmission until it convinces the below statement.

a) The node has adequate energy to acquire and send data from the adjacent nodes.

b) The node is capable of communicating information to all the other nodes.

The aggregated energy consistency routing parameter assures the capability of the node to perform communication or forward the information to all the other nodes without any breakages unless it satisfies equation (5).

$$C_{E(t_i)} > C_{E(t_i),\min,} (t_i) \varepsilon N_n, (t_i) \neq Origin, (t_i) \neq target \quad (5)$$

Therefore for any node, the prevailing 'C_E' value must be above the minimal 'C_E' value then only the node is capable of performing the transmission.

4. Proposed ERCR Scheme

The ERCR scheme is performed in two ways namely the path identification and path preservation.

4.1 Path Identification

Here, similar to AODV when the source node holds the information and desires to perform communication to a target node it performs broadcasts termed as the route demand (RREQ) packets to its one hop adjacent node by initializing the address of the holdup nodes as zero. Therefore the holdup node is described as the node which is capable to recreate an association among the predefined source and target pairs during path failures. Primarily each and every node creates a collection of holdup nodes to trounce the issues of path breakages. Soon after the acquirement of the route demands at the adjacent nodes it verifies for redundancy and executes the identical accomplishment to AODV after which it investigates for a path to perform routing to reach the target.

In case the adjacent node originates any path for forwarding data it will offer a response to the origin node through a path response packet and estimates their 'C_E' parameter it merely rejects the route demands. In case the acquired 'C_E' parameter is above the pre determined value the adjacent node sends the route demands. In case the origin does not locate any path for routing the data it estimates its individual 'C_E' parameter based on equation (4). In case the acquired 'C_E' parameter is higher than the predetermined value then it performs re broadcasting the route demands to the target. After the acquirement of route demands at the target, it provides a response to the origin with the help of path response. On acquirement of the route response by the in between node it revises the address of the holdup node from the path response and also revises the routing table. The zero space is held for the holdup nodes are packed by the address of the successive hop node. The process resumes at each and every in between nodes before the route response arrives at the origin.

Consider from Figure-1 the origin desires to forward a data to the target't' so it needs a path to 't' for which is performs transmission of route demand (RREQ) packets within the network. The node 'x' acquires the RREQ and verifies the target after which it performs re transmissions to the target't'. The nodes 'y', 'z' and 'k' acquires the RREQ where only the node 'y' performs retransmissions of RREQ since due to minimized energy levels of the node 'k' and node 'z'. In the same manner, the node also performs transmission of RREQ until it arrives at the target. Soon after the reception of RREQ at the target, it responds with a path response. The in between nodes acquires the path response and then it revises their routing table with the address of the holdup nodes. The origin acquires the path response and initiates to forward to the target through the initialized routes.

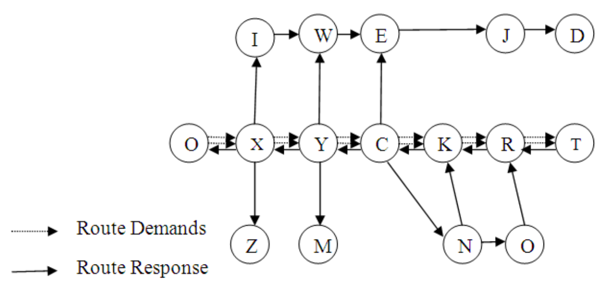


Figure-1. Path Building.

4.2 Path Preservation

Because of the improved node displacements the presence of association breakages it is quite intricate to acquire the 'HELLO' message endlessly for a determined time interval based on which presumes that the association is broken. During identification of association breakages by an individual node on the initialized route, it executes the below entailed deeds.

a) Accumulate the information and forward an announcement to the preceding nodes.

b) Reduce path breakages and improve path links.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

For instance, as illustrated in Figure-2 when the node ‘z’ identifies association breakdowns among ‘z’ and ‘k’ it executes the above entailed deeds.

After the identification of path breakages at any in between nodes, it hoards the overall information of the battered path in its temporary storage. The battered information will be hoarded until a static degree of local buffer passes on to 70% hoardings of the nodes temporary storage it performs communication of the stored data soon after path identification process. During the excessive buffer load, a path response of the identical target is sent to their one hop adjacency by representing the flag value as 1. After acquiring the route response by the preceding successive node it halts the information transmission and initiates to hoard the information in its local buffer. During which the node marks the state of the flag as 2 indicating restore. The identical process is resumed for other successive nodes till the path responses arrive at the origin. Soon after acquiring the path response at the origin a fresh path will be identified to the target. From Fig. 2 the node ‘z’ hoards the information in its buffer to the utmost level and inform to ‘y’. The node at which the path breakages is identified will perform transmissions of path demand message (PDM) with the address same as the target and also the address of the holdup nodes by preserving the time of communication time. On acquiring the PDM the in between node executes the process of path building. The prevailing origin node acquires the path response message and sends it to other 1 hop adjacent nodes to revise the address of the holdup nodes of the earlier successive nodes.

The routing flag of the routing table is positioned to live state during the calculated buffer possession level is reduced below the previously determined levels. From Figure-2 the node ‘z’ performs transmissions of PDM to the target ‘t’ with holdup node ‘r’ to restore the path among the nodes ‘z’ and ‘k’. The nodes ‘m’ and ‘n’ acquires the path demand message and verifies for a path to the holdup node and performs retransmissions of PDM since they do not locate any path and also the ‘C_E’ parameter is above the pre - determined value. In the same manner, the PDM performs transmission and lastly arrives to maintain node ‘r’ through node ‘q’ and holdup node ‘r’ answers to the successive node ‘z’. Therefore a local path z - m - q - r is created and node ‘z’ begins to send the information to target ‘t’. The algorithm 1 indicates the path demands behavior during path identification. The algorithm 2 indicates the path preservation during path breakages.

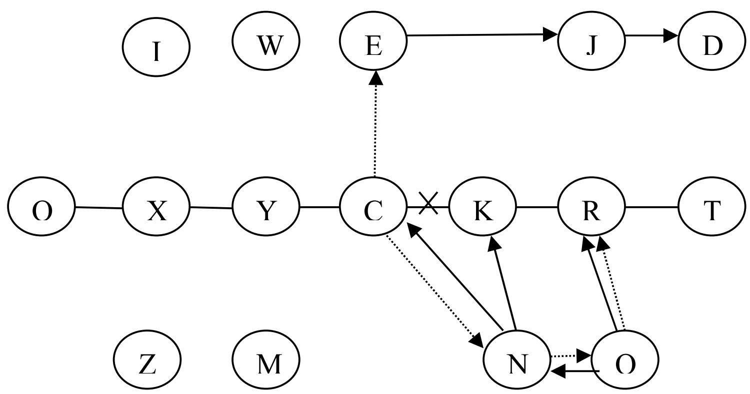
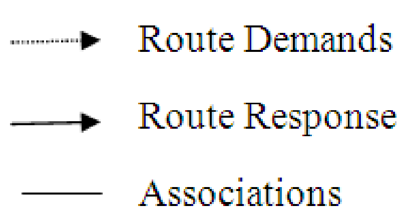


Figure-2. Path Preservation.



Algorithm 1
collection of network node ‘n_c’
the source and target, ‘n_o’ and ‘t’ ε ‘n_n’
‘n_o’ performs transmission of RREQ
in case in – between node has previously acquired RREQ
abandon RREQ
else
verify the target address
if in – between node address = target address
respond to origin ‘n_o’ with path response
els
verify path from ‘n_o’ to ‘t’
abandon RREQ
else
estimate its energy consistency parameter using

$$C_{E(n_n)} = C_{E(n_n),\min} + (1 - C_{E(n_n),\min}) * \left(\frac{E_o * r_{n_n(t_i)}}{E_o \max * r^{s}_{n_n(t_i)}}\right) * 1 + \varphi$$

if $C_{E(n_n)} \geq C_{E_{(n_n)}}, \min$
perform a backward repeat to predecessor node and perform transmission of RREQ to theadjacent node
else
abandon RREQ
end if
end if
end if
end if

VOL. 12, NO. 21, NOVEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Algorithm 2
path breakage at 'a_n'th node, a_n ε n_n
the 'a_n'th stores the prevailing information in its local buffer and forwards a management signal to its predecessor node with flag = 2.
'a_n'th node performs transmission of PDM with identical target address along the address of the holdup node
if the in – between node has previously acquired the PDM
abandon PDM
else
verify for the target address
if present node address = target address
respond to prevailing origin node with path responses
else
verify for holdup nodes address
if present node address = holdup node address
estimate $C_{E(n_n)}$ based on equation (4)
if $C_{E(n_n)} \geq C_{E_{(n_n)}}$, min
send PDM to the target
else
send PDM to its 1 hop adjacent node
end if
end if
end if
end if

5. Performance Analysis

The performance analysis is performed in terms of energy utilization, packet delivery ratio and end to end delays. The outcomes of the designed scheme are estimated based on diverse schemes with differing displacements and size of packets. The behavior is estimated for AODV, AODV-PE, EEPR and designed ERCR routing scheme by differing node displacements from 0 ms to 50 ms. The parameters used for simulation purposes are tabulated in Table-1.

Table-1. Parameters for Simulation.

Settings	Values
Area	1000m * 1000m
Node Count	100
Speed of Displacement	0, 5, 10, 15, 20, 25, ……., 50 ms
Origin – target pairs	15
Packet Size	1 byte
CBR Rate	4 packet / size
Pause time	60

The energy utilization for the contradictory node displacement and for the differing the packet size is represented in Figure-3 and Figure-6 where the designed ERCR scheme holds minimal energy utilization as estimated with other schemes. For escalated path breakages of improved non static autonomous environment, the ERCR utilizes minimal energy because it retards the nodes with a very minimal degree of energy.

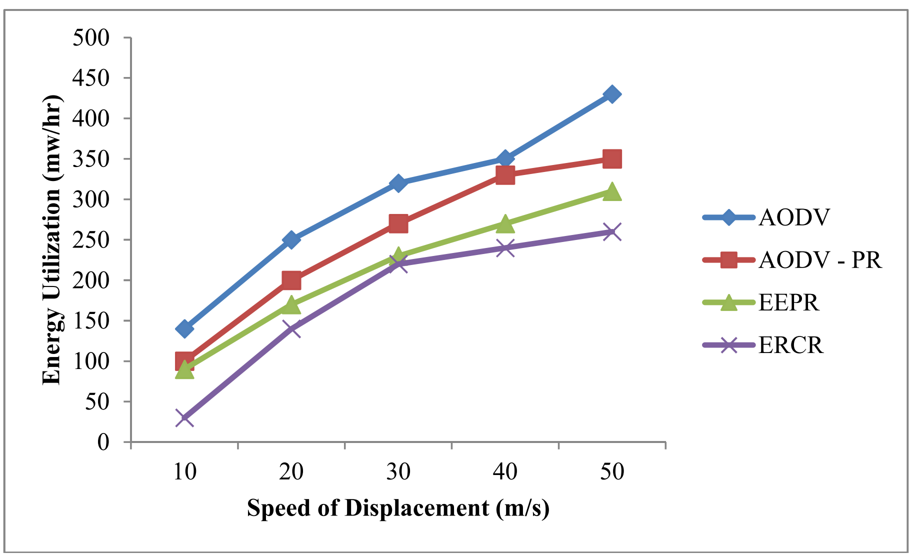


Figure-3. Energy Utilization for contradictory Node Displacements.

Because of node displacements, there is regular incidence of path breakdowns in mobile ad hoc networks. The packets are plunged due to the regular incidence of path breakdowns in all the other prevailing protocols. The designed ERCR accomplishes improved performance due to the incidence of ondemand local path identification scheme and information buffering abilities which considerably minimizes the rate of packet drops. The packet delivery ratio for differing node displacements and for differing packet size is depicted in Figure-4 and Figure-7.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

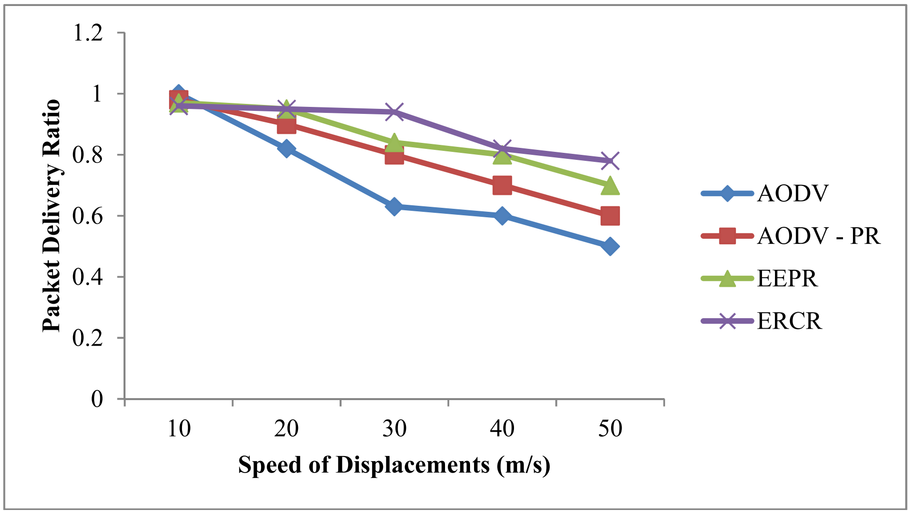


Figure-4. Packet Delivery Ratio for contradictory Node Displacements.

The end to end delay differences of ERCR for contradictory node displacements and for differing packet sizes are represented in Figure-7 and Figure-10. The ERCR chooses a path with minimal hop counts and improved lifetime, the end to end delays becomes minimal. Figure-7 illustrates that the end to end delays increases in parallel to increased velocity of node displacements. The delay is holding iterative features when the designed ERCR scheme is estimated with the conventional schemes for estimating delays it is minimal.

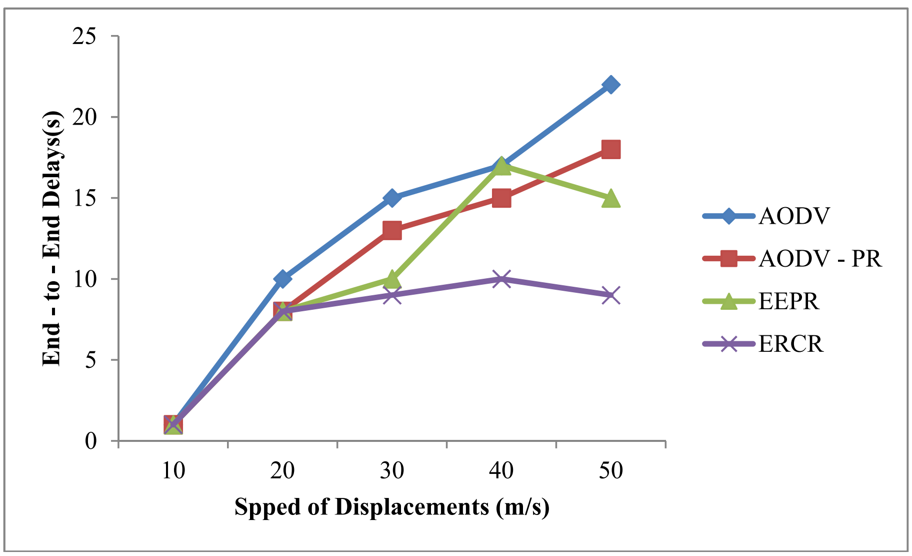


Figure-5. End to End Delays for contradictory Node Displacements.

Figure-6, Figure-7 and Figure-8 represents the behavior of the ERCR in terms of energy utilization, packet delivery ratio and end to end delays by differing packet sizes. Therefore the differing packet sizes imitate the multimedia data packets since the multimedia data holds huge packet sizes. The designed schemes are verified over the multimedia information broadcasts and the acquired outcomes assert the designed ERCR scheme outperforms the conventional schemes for communicating the multimedia information.

VOL. 12, NO. 21, NOVEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

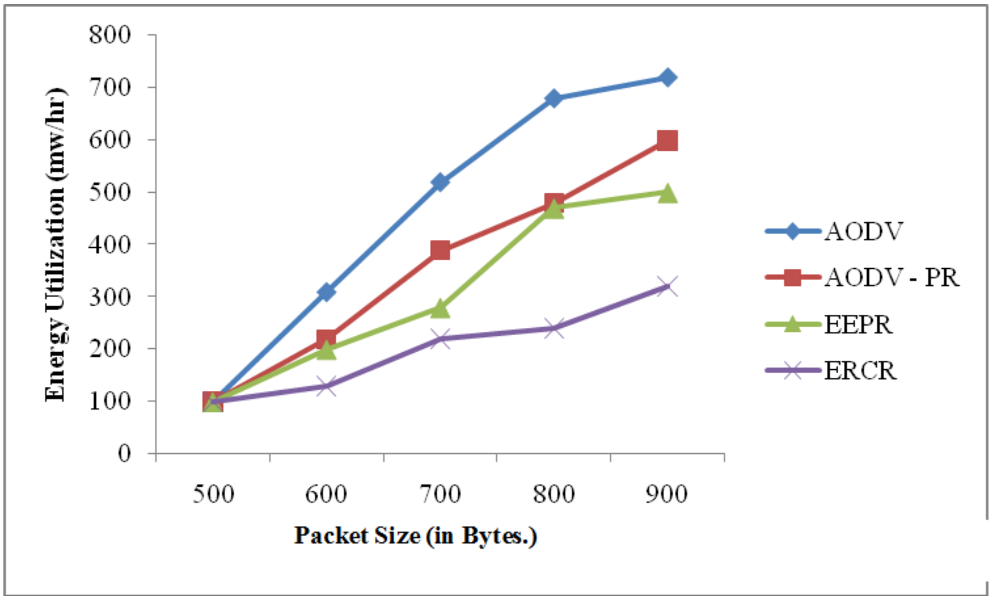


Figure-6. Energy Utilization for contradictory Node Displacements.

Figure-6 depicts the energy utilization by contradictory packet sizes. With the increase in packet sizes, the degree of energy utilization also improves. Even though the packet sizes improves the designed scheme consumes a minimal level of energy for sending the overall data packets since the designed scheme estimates a route with minimal energy utilization and also with a minimal number of nodes. The designed scheme deems the aid of holdup nodes thus the ERCR holds minimal energy utilization as estimated with the conventional schemes.

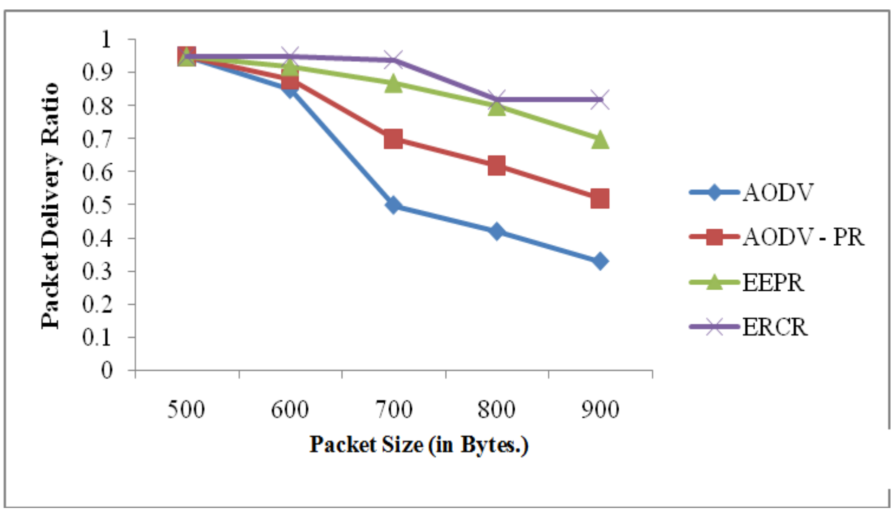


Figure-7. Packet Delivery Ratio for Differing Node Displacements.

The features of the packet delivery ratio are depicted in Figure-7 for differing packet sizes. The packet delivery ratio of the ERCR is monitored to be high as estimated with conventional schemes since the ERCR deems the consistency during the path identification and holdup nodes during path preservation.

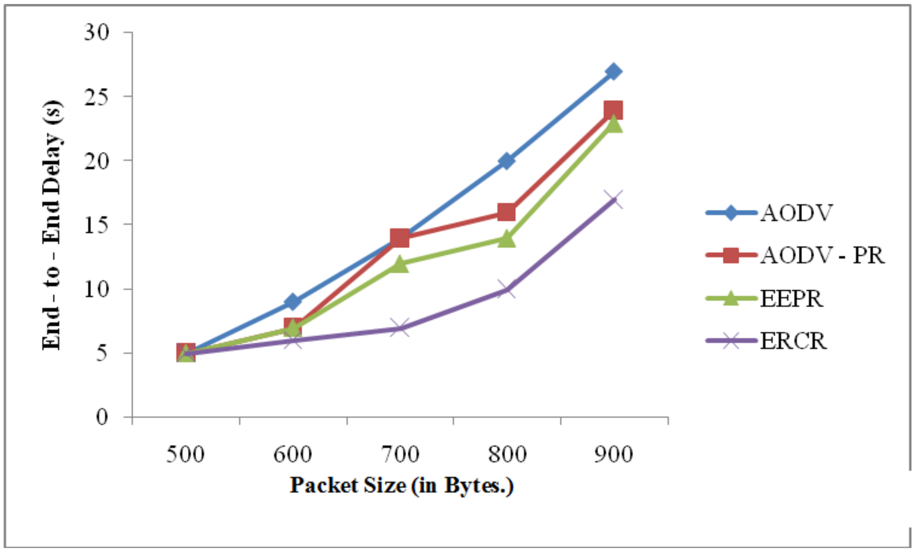


Figure-8. End to End Delays for Differing Node Displacements.

With the increase in packet size the degree of time required for sending also increases. Figure-8 depicts the features of end to end delays for differing packet sizes for conventional schemes and designed schemes. Even though there are escalated delays for improving the size of packets the designed ERCR has minimal end to end delays as evaluated with conventional schemes because the ERCR sends the data using holdup nodes thus the delay is minimal as estimated against the conventional algorithms.

6. CONCLUSIONS

An energy competent routing and also on demand local path identification scheme for reliable information dissemination is designed for mobile ad hoc networks. The ERCR locates most optimal path in terms of consistency, energy competence and hop counts. The consistency expresses to minimize the packet dropping possibilities and improves the packet delivery ratio. The power competence expresses minimal energy utilization and minimized hop counts to reduce delays. The outcomes of the simulation reveal improved behavior of ERCR in terms of energy utilization, packet delivery ratio and end to end delays over the contradictory node displacements and packet sizes. The schemes reveal the resource competence of the networks.

REFERENCES

[1] C. E. Perkins. 2001. Mobile Ad hoc Networking. Addison-Wesley, Upper Saddle River, NJ, USA.

[2] Perkins C, Bhagwat P. 1994. Highly dynamic destination sequenced distance-vector routing (DSDV) for mobile computers, Computer Communications Review. pp. 234-244.

[3] Pei G, Gerla M, Chen T-W. 2000. Fisheye state routing: a routing scheme for ad hoc wireless networks. Proceedings of IEEE International Conference on Communications (ICC). pp. 70-74.

[4] Johnson D, Maltz D. 1996. Dynamic source routing in ad hoc wireless networks, book Mobile Computing, edited by Tomasz Imielinski and Hank Korth, Kluwer Academic Publishers. pp. 153-181.

[5] Perkins C, Royer E. 1999. Ad-hoc on-demand distance vector routing, Proceedings of 2nd IEEE Workshop on Mobile Computing Systems and Applications. pp. 90-100.

[6] S.-J. Lee and M. Gerla. 2000. AODV-BR: Backup routing in ad hoc networks, in Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC '00), IEEE, Chicago, Ill, USA, September. pp. 1311-1316.

[7] W. K. Lai, S.-Y. Hsiao and Y.-C. Lin, 2007. Adaptive backup routing for ad-hoc networks, Computer Communications. 30(2): 453-464.

[8] J. Jeon, K. Lee and C. Kim. 2011. Fast route recovery scheme for mobile ad hoc networks, in Proceedings of the International Conference on Information Networking (ICOIN'11). pp. 419-423.

[9] M. M. R. Bosunia, M. A. Razzaque and M. M. Islam. 2013. A robust and reliable routing protocol for energy-constrained mobile ad hoc networks. International Journal of Computing Communication and Networking Research. 2(2): 26-39.

ARPN Journal of Engineering and Applied Sciences

[10] M. Aparna, M. Reza, P. Sahu and S. Das. 2012. An efficient approach towards robust routing in MANET. in Proceedings of the International Conference on Communication Systems and Network Technologies (CSNT '12). IEEE, Rajkot, India. pp. 388-391.

[11] T. T. Son, H. L. Minh, G. Sexton and N. Aslam. 2014. A novel encounter-based metric for mobile ad-hoc networks routing. Ad Hoc Networks. 14: 2-14.

[12] T. C. J. Boleng and W. Navidi. 2002. Metrics to enable adaptive protocols for mobile ad hoc networks. in Proceedings of the International Conference on Wireless Networks (ICWN '02), Las Vegas, Nev, USA. pp. 293-298.

[13] C. Yawut, B. Paillassa and R. Dhaou. 2008. Mobility metrics evaluation for self-adaptive protocols. Journal of Networks. 3(1): 53-64.

[14] F. Ingelrest, N. Mitton and D. Simplot-Ryl, A turnover based adaptive hello protocol for mobile ad hoc and sensor networks. in Proceedings of the 15th International Symposium on Modeling Analysis, and Simulation of Computer and Telecommunication Systems (MASCOTS '07), October 2007, pp. 9–14.

[15] K. Woo, C. Yu, D. Lee, H. Y. Youn and B. Lee. 2001. Non-blocking, localized routing algorithm for balanced energy consumption in mobile ad hoc networks. in Proceedings of the 9th International Symposium in Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS '01), p. 117, IEEE Computer Society, Washington, DC, USA.

[16] Z. Zhaoxiao, P. Tingrui and Z. Wenli. 2009. Modified energy-aware AODV routing for ad hoc networks. in Proceedings of the WRI Global Congress on Intelligent Systems (GCIS '09). 3: 338-342.

[17] C. Ni, T. Lee, G. Kim and C. Kim. 2009. An energy aware routing protocol using multiple replies for ad hoc networks. in Proceedings of the 2nd ISECS International Colloquium on Computing, Communication, Control, and Management (CCCM '09). pp. 225-228.

[18] G.M. Rao, M. N. Baig, M. F. Baba and K. K. Kumar. 2011. Energy efficient reliable routing protocol for mobile ad hoc networks. in Proceedings of the 3rd International Conference on Electronics Computer Technology (ICECT '11), India. pp. 296-299.

[19] X. Wang, L. Li and C. Ran. 2004. An energy-aware probability routing in MANETs. in Proceedings of the IEEE Workshop on IP Operations and Management. pp. 146-151.

[20] R. Gopinathan P. Manimegalai. 2016. Energy and Latency Aware Position Based Packet Forwarding Protocol for Wireless Sensor Networks, International Journal of Applied Engineering Research ISSN 0973-4562, 11(13): 7961-7966.

[21] P. Nand and S. C. Sharma. 2011. Probability based improved broadcasting for AODV routing protocol. in Proceedings of the International Conference on Computational Intelligence and Communication Systems (CICN' 11). pp. 621-625.