ISSN 2229-5518

A Peer to Peer Overlay Approach for Topology Maintenance in Wireless Networks

J. Vijitha Ananthi, Jennifer S Raj

Abstract - Over the Internet today, computing and communications environments are significantly more complex and confusion than classical distributed systems, lacking any centralized organization or hierarchical control. Heuristic algorithm is used to maintaining a topology in wireless peer to peer networks. Here the topology of the Mobile Ad Hoc Network (MANET) is maintained via peer to peer overlay nodes. During mobility localization and node movement are the major issues. To solve these issues a new approach is proposed named as "TMP – Topology Maintenance in MANET using Peer to peer overlay nodes" based on distributed and localized computing, to predict the node position in a topology tree. The performance of the proposed method is analyzed in stable and mobile conditions by analyzing power consumption, active nodes, active links, hop stretch, packet delivery ratio, network life time and other Qos parameters.

Index Terms - Peer to Peer network, Peer to Peer Overlay, Mobile ad hoc network, Topology Maintenance, Hop stretch, Wireless Network,

1. INTRODUCTION

A Mobile Ad hoc NETwork (MANET) does not use any existing infrastructure or central administration to organize the wireless devices within it. The nodes communicate in multi– hop, peer–to–peer node. Figure 1: shows the peer to peer distributed network. Over the Internet today, computing and communications environments are significantly more complex and confusion than classical distributed systems, lacking any centralized organization or hierarchical control. There has been much interest in emerging Peer-to-Peer (P2P) network overlays because they provide a good substrate for creating large-scale data sharing, content distribution, and application-level multicast applications.

These P2P overlay networks attempt to provide a long list of features, such as: selection of nearby peers, redundant storage, efficient search/location of data items, data permanence or guarantees, hierarchical naming, trust and authentication, and anonymity. P2P networking has existed for quite some time, it has only been popularized recently and will probably be subject to even bigger revolutions in the near future. Napster was the first P2P application which really took off.

- *J. Vijitha Ananthi is currently pursuing masters degree program in communication systems from Karunya University, Coimbatore, India.*
  Email: vijithaananthi@gmail.com

- *Jennifer S. Raj working as a Assistant Professor in Dept of Electronics and Communication Engineering in Karunya University, Coimbatore, India.*
  Email: jennifer.raj@gmail.com

The way it worked was quite simple: a server indexed all the files each user had. When a client queried Napster for a file, the central server would answer with a list of all indexed clients who already possessed the file. Napster-like networks are known now as first generation networks. Such networks didn't have a complicated implementation and often relied on a central server (hybrid P2P). The central server model makes sense for many reasons: it is an efficient way to handle searches and allows to retain control over the network. However, it also means there is a single point of failure. When lawyers decided Napster should be shut down, all they had to do was to disconnect the server.

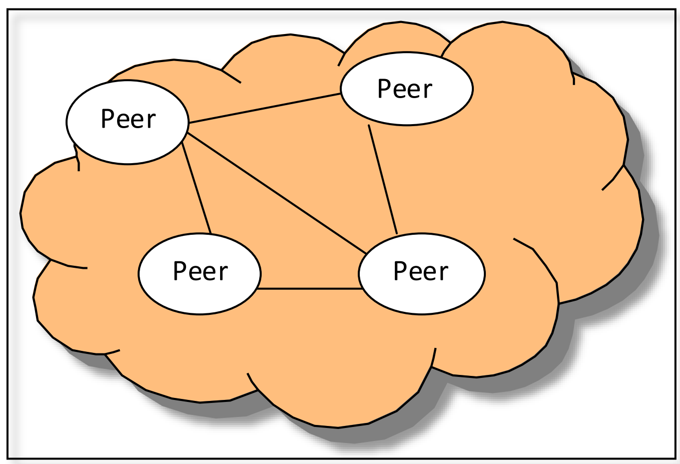

Figure 1: Peer to peer network

Gnutella was the second major P2P network. After Napster's demise, the creators of Gnutella wanted to create a decentralized network, one that could not be shut down by simply turning off a server. At first the model did not scale because of bottlenecks created whilst searching for files. Fast Track solved this problem by rendering some nodes more capable than others. Such networks are now known as second generation networks and are the most widely used nowadays. Third generation networks are the new emerging P2P networks. They are a response to the legal attention P2P networks have been receiving for a few years and have built-in anonymity features. They have not yet reached the mass usage main second generation networks currently endure but this could change shortly.

Freenet is a good example of a third generation. In this algorithm, we are using third generation P2P network. An overlay network is a virtual network of nodes and logical links that is built on top of an existing network with the purpose to implement a network service that is not available in the existing network. Current Internet P2P applications typically provide locator functions using time-to-live (TTL) controlled-flooding mechanisms. With this approach, the querying node wraps the query in a single message and sends it to all known neighbors. The neighbors then check to see whether they can reply to the query by matching it to keys in their internal database. If they find a match, they reply; otherwise, they forward the query to their own neighbors and increase the message's hop count. If the hop count passes the TTL limit, forwarding stops. The TTL value thus defines a boundary or "horizon" for the query that controls its propagation. However, flooding-based systems don't scale well because of the bandwidth and processing requirements they place on the network, and they provide no guarantees as to lookup times or content accessibility.

Overlay networks can address these issues. Overlay networks have a network semantics layer above the basic transport protocol level that organizes the network topology according to the nodes' content. The main applications of overlay network are routing, addressing, security and multicast. In this paper, peer to peer overlay multicast the information to every node. Due to that multicast, all nodes respond to the neighbors whether it's applicable or not. So it consumes more energy, to save the energy nodes will act as selfish peers in peer to peer overlay. Selfish peer means it does not forward any data to the neighbors and also using the unicast to transmit the data using AODV protocol. Existing approaches are benchmark algorithm and heuristic algorithm through this algorithm we can minimize the cost and also maintain the topology.

2. RELATED WORK

Fabrikant et al. [1-3] introduce a network creation game. In the game, nodes need to pay the links to reach the destination. in this distance based on the hop count. Links are constant, so topology changed due to some nodes enter or leaves in the network after that changes it comes to its original position means Nash equilibrium exists. Nodes are selfish, trying to have fewer direct neighbors while keeping the entire network as close as possible. A system parameter, α, catches the trade-off between the cost and benefit.

Moscibroda et al. [4-6] extends the work of Fabrikant et al., examining the effect of the network creation game on P2P topologies. The hop count is replaced by the stretch as the distance metric and overlay links are directional; otherwise the model remains the same. The authors provide an upper and lower bound on the price of anarchy. They go on to prove that there exist cases for which no Nash equilibrium exists, meaning that even in the absence of peer churn, the topology will never stabilize.

Chun et al. [7-10] simulate a P2P overlay creation game using Fabrikant et al.'s model. The cost to each neighbor may be different (e.g., congested links have a higher cost), and the number of neighbors is bounded. The authors use a heuristic random local search algorithm to calculate the Nash equilibrium graphs. They show that without constraining the node degree, the resulting topologies are near-star configurations, in which a small number of nodes will maintain a large number of connections. This allows other nodes to ''free ride" off of those nodes by connecting to them and achieving both a small number of connections and also a low distance metric. This results in less resilient topologies because a small number of node failures will result in a large degree of disconnection.

Afzal Mawji[11-12] proposed Both MANETs and P2P networks require nodes to help one another in order to make the network useful. P2P file sharing networks require nodes to share files, and MANETs require nodes to forward data. Unfortunately, helping others comes at a cost. By sharing files and forwarding data, mobile nodes are using their energy, bandwidth, CPU, and other resources. When resources are used by others, there is less available for the node itself. Node will act as a freeloaders and selfish to rise their resources. Freeloaders are users that download files themselves, but do not share anything in return. Selfish nodes do not forward data. Users cooperate with one another based on their remaining energy level.

Afzal Mawji and Hassam S. Hassanein [13] stimulate bootstrapping the two networks using bootstrap algorithm. In this Nodes discover overlays by finding peers that are already participating in a P2P network. This is accomplished by having the node first examine its local cache for previously–known peers. If none are found, or the information is stale, the node multicasts a join request. When a peer receives a request, it may multicast a reply and all nodes in the network cache the information. The node wanting to join the overlay then selects the best peers based on energy.

Afzal Mawji and Hassam S. Hassanein [14] suggest the effects of using network coding in a P2P file sharing overlay in a cooperative mobile ad hoc network. Because there is no centralized authority and no infrastructure, a tracker node cannot be used, as is commonly done in P2P networks. Instead we make use of multicasting for efficient communication within the overlay. The algorithm presented, called Deluge, uses the idea of a server node multicasting block, something that is impractical on the Internet, but is possible in MANETs. Clients request a certain number of blocks from multiple different servers, depending on the cost of acquiring them, resulting in multipoint–to– multipoint communication. In this cost is measured as hop distance. Therefore, nodes download files from the closest servers, which reduce overall network energy consumption.

Afzal Mawji, Hassam S. Hassanein, [15] suggest the most P2P overlay topology control algorithms assume that peers is cooperative. Unfortunately, peers are selfish in many cases. They seek to minimize their own costs, in the case of MANETs, to minimize the number of links to other peers and the distance to all destinations. Several studies investigate the impact of selfish peers on the topology in the context of non-mobile networks. However, they study the theoretical bounds or require peers to have global knowledge to construct the overlay. No practical overlay topology control algorithm, even for non-mobile networks, exists. As well, a study of the impact of selfish peers in the context MANETs is needed. He proposed the heuristic algorithm with low k metric and high degree constraint.

3. PRELIMINARIES

Existing P2P topology control schemes designed for wired networks are able to accommodate a changing topology due to the expectation that peers will constantly be joining and quitting. Most P2P overlay control algorithms assume that peers are co-operative. Due to that co-operative nodes, energy consume will more. Degree-constrained minimum spanning tree (DCMST) is a degree-constrained spanning tree in with the sum of its vertices has the minimum possible sum. Finding a DCMST is an NP-Hard problem. More Resilience in Nash equilibrium, after the topology changes due to entering some nodes, it's very difficult to construct the topology to its original position.

4. PROPOSED WORK

Heuristic algorithms that can solve the problem in polynomial time have been proposed, including Genetic and Ant-Based Algorithms. The heuristic algorithm has a fairly low k metric due to the degree constraint. The heuristic technique is an experienced based technique for problem solving, learning and discovery. This method is used to speed up the process of finding a good enough solution. A genetic algorithm (GA) is a search heuristic that mimics the process of natural evolution. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution. In existing approach, they use two algorithms and compared those results also. The two algorithms are benchmark algorithm and heuristic algorithm. Here we are going to propose TPP i.e., (Topology maintenance in P2P overlay) algorithm. In this algorithm to find the minimum cost between the two peers using this below equation,

$$Cn = E + D \qquad \rightarrow (1)$$

Where, Cn is the minimum cost between the two peers. E is the energy level of the neighboring peer and D is the stretch distance between the selected peer and initial peer. Distance based on the stretch. Stretch is defined as the ratio of number of physical hops to the shortest physical distance. The total cost is the sum of all peer costs

$$T.C = \sum_{n=1}^{N} Cn \qquad \rightarrow (2)$$

Where, T.C represents total cost of the peer to peer overlay network, Cn is the cost between the two peers and N represents number of nodes in the peer to peer overlay network. Using this above two Equations we can find only the minimal cost but we cannot maintain the topology because of resilience. Resilience is nothing but resuming its original position after the node enters or leaves in the network. So overcome that this we go for heuristic algorithm. In heuristic approach, we can find the minimum cost and also maintain the topology after the node enters or leaves in the network. It does not need of global knowledge to transfer the data. It uses the local knowledge to select the best peers in the neighbors to transfer the data. To find the minimal cost between the peers we can use the same equation of the benchmark algorithm.

If a node wants to enter into the peer to peer overlay means, it can select the best peer based on the hop count and energy level of the mobile ad hoc network. Mostly it selects the best peer alone.

4.1 Algorithm: Peer To Peer Overlay

1. Connected graph G (V, E)
2. Overlay network graph G^1 (V, E)
3. Divide G (V, E) into G^1 (V, E) & G^{11} (V, E)

4. $G^1 \rightarrow$ Distributed of (V, E); $G^1 \in G$
5. $G^{11} \rightarrow$ Cluster MANET of (V, E); $G^{11} \in G$
6. From G^{11} (V, E), V_1 act as intermediate node
7. From G^1 (V, E) any node sends 'P' to V_1;
8. If it receives 'A', it will form as G^1 (V, E)
9. Else it select V_2 node in G^{11} (V, E)

Algorithm explains that G (V, E) is a whole network which is our input and G^1 (V, E) is overlay network which is our output. From that G (V, E), we have to split the networks as peer to peer network G^1 (V, E) and mobile ad hoc network G^{11} (V, E). Peer to peer network should be distributed network, mobile ad hoc network based on cluster formation. From mobile ad hoc network selects the one node act as an intermediate node i.e., V_1. From P2P network any one of the node sends packet 'P' to the intermediate node. In that packet contain ID and 0, 0 represents request. If intermediate node acknowledged 'A' to the peer to peer network, it will form as overlay network G^1 (V, E). Else it selects the another node from G^{11} (V, E). In these two networks have one intermediate node to send the request from peer node to MANET node.

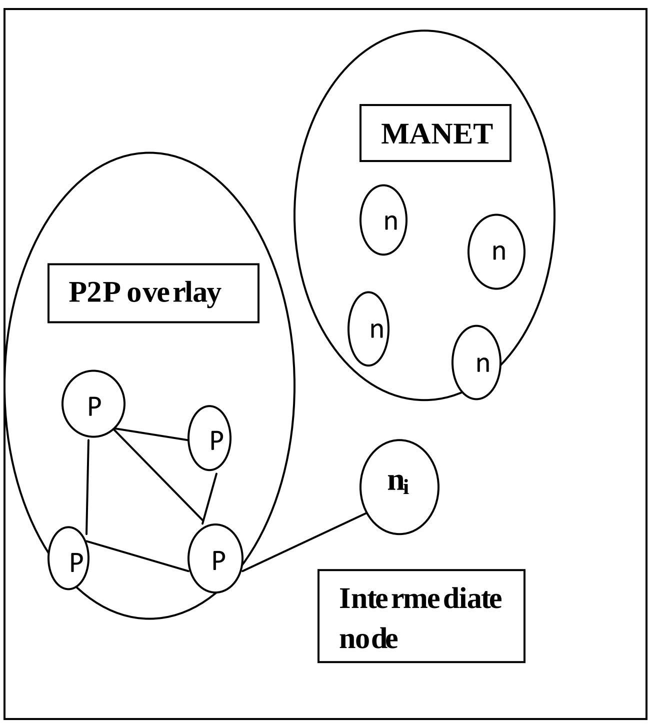

Figure 2: peer to peer overlay network

So we have to maintain the energy level of the intermediate node. Intermediate nodes are coming from mobile ad hoc network. If the energy fails in first intermediate node, it will change the link to next node.

Figure 2: shows that the peer to peer overlay, P2P network and MANET used to connect with one intermediate node.

We used to select the MANET nodes for P2P overlay through that intermediate node alone. So we have to concentrate more on that intermediate node. They are using this intermediate link repeatedly for selecting the nodes in mobile ad hoc networks. When the intermediate node fails due to energy, we have to change the link to other node. In this algorithm, we have to find the minimal cost between the two peers, overlay the two networks we have to maintain the energy level of the intermediate nodes and maintain the topology. The main application is use as a network creation game. It doesn't have connectivity issue and it has a high throughput. It is efficient topology maintenance for peer to peer overlay in mobile ad hoc networks. It may reduce the total cost network-wide. It reduce the energy consumption and to improve the response time and reliability.

5. EXPERIMENTAL RESULTS

We now evaluate the performance of TMP algorithm and compare its performance to heuristic algorithm and also maintain the energy level of intermediate node between P2P network and MANETs. These algorithms are implemented in the network simulator ns-2. In our simulations, we use 100 MANET nodes, with the number of nodes participating in a P2P overlay varying from 50 to 100 increments of 10. The network area is 1500m* 1500m, the transmission rate is 54 Mbps, and the communication range is 240m by default. Here, using Omni directional antennas by all nodes.

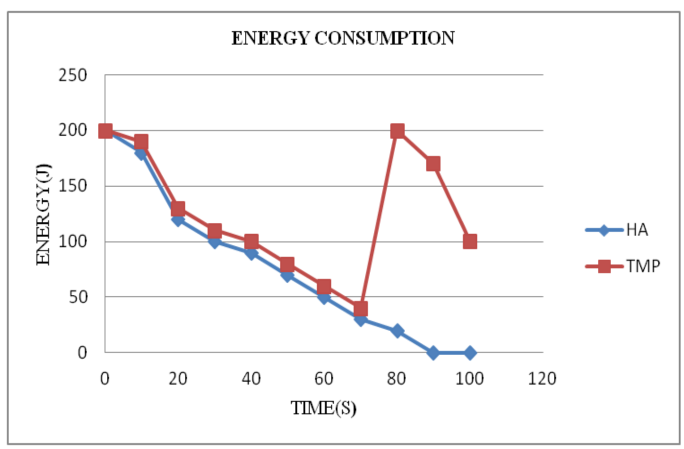

Figure: 3 Energy Analyses

Figure: 3 show the energy analysis between the time and energy. Initially a node having 500 joules, after a particular time it may receive or transmit based on that application; it will reduce the particular energy level. But in

TMP algorithm after the energy reduces particular threshold level it replace the new node instead of old node. After the time of 60 second, heuristic algorithm (HA) loses energy. But TMP it increase the energy level and also reduces the energy consumption. One important aspect of ad-hoc networks that was ignored by these studies is energy-efficiency. In real life systems, energy consumption is a major issue. For many ad-hoc networks, the nodes are small and portable, imposing stringent constraints on the battery size and power. In this study, we considered a network where each mobile node has a limited initial energy.

As a node sends, receives or forwards packets, the energy of the node is decremented accordingly. Once the energy of the node reaches zero, the node is shut-down (a "node death") and is considered terminated by the system. Since the ad-hoc routing protocol determines which nodes will forward the packets and the amount of routing overhead each node needs, the type of protocol definitely affects the energy performance of the system. The protocols affect the energy dynamics in two ways – first, the routing overhead affects the amount of energy used for sending and receiving the routing packets, and second, the chosen routes affects which nodes will have a faster decrease in energy.

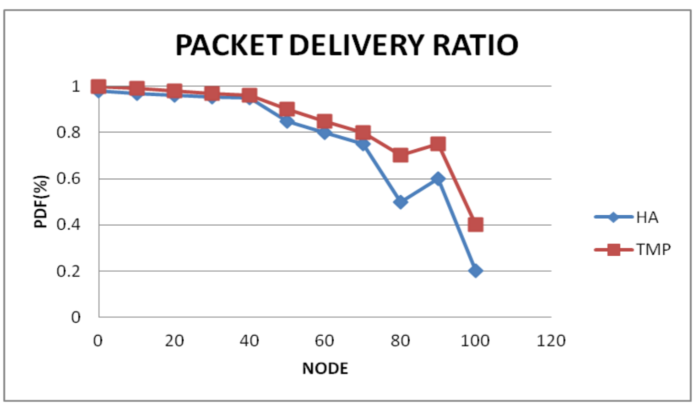

Figure 4: Packet Delivery Ratio

Packet delivery ratio, packet delivery time and packet drop ratio are some of the qos parameters. Packet delivery ratio is obtained by dividing the number of data packets correctly received by the destinations by the number of data packets originated by the sources. Figure 4: shows the packet delivery ratio, in this defining sequence numbers with the received packets. Packet delivery ratio is defined as the ratio of packets delivered to the destination to those generated by the CBR sources. Compared to heuristic algorithm, TMP algorithm increases the packet delivery rate.

Figure 5: shows the cost vs. time. When the time increases cost may increase or decrease. Initially cost increases because of the distance and energy. After the mobility distance may decrease and the energy also decrease, due to this cost also decreases. From this time of 50 sec nodes moves dynamically, so distance increases from the source node. So cost also increases.

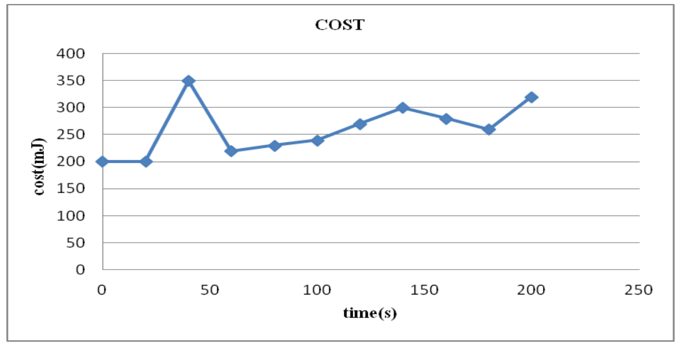

Figure 5: Cost

In this network having number of nodes, each node having links between the other nodes. Due to this selfish peer, some of the nodes act as inactive links. So we have to plot the graph between nodes vs. total number of links and the active links.

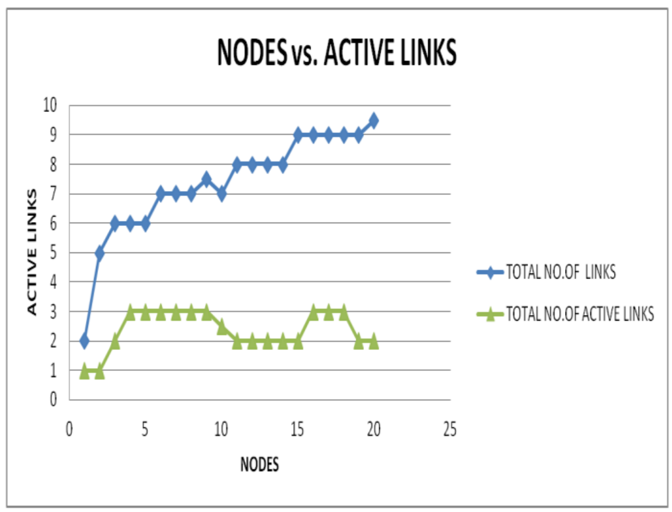

Figure: 6 Nodes vs. Active links

Compared to the total number of links to number of active link is very lesser. So we go for the benchmark algorithm. In this benchmark algorithm, it will check the connection either the node having very lesser active links means it will create the connection and also find the minimum cost. Figure: 6 show the active links vs. nodes. Initially node having some active links, after a particular time interval some of the nodes will act as selfish nodes. Due to these selfish nodes some links may act as inactive.

Then we are going see about the existing approach. In existing it will select the node and also it checks the links in node, its already having number of links higher than the active link means it will find out the cost of the entire topology, otherwise it will create the connection and also find the cost.

The hop count is a measure of distance across an IP-based network. It is a count of the number of routers an IP packet has to pass through in order to reach its destination. Hop count is usually not used by itself, since any in between router or cable may have or be subject to varying data throughput (bandwidth), load (see: quality of service), reliability (especially of cable), and latency. Hop counts are often useful to find faults in a network (see: Time to live), or to discover if routing is indeed correct.

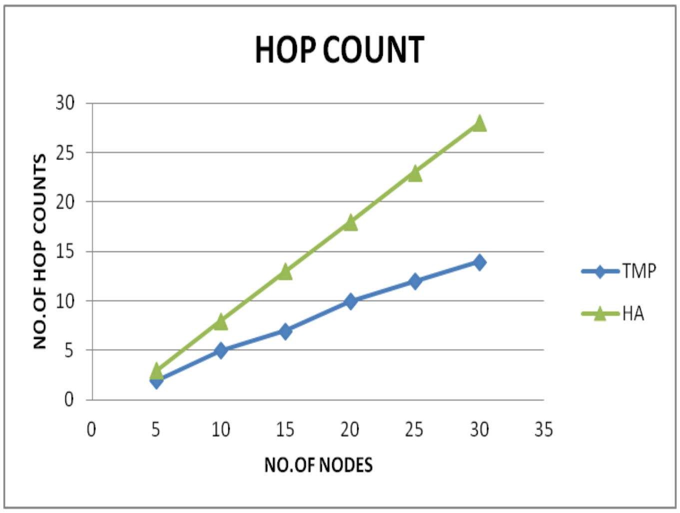

Figure 7: Comparison of Hop count

Figure 7 shows the above graphs plotted the comparison of hop count between the heuristic algorithm and topology maintenance in P2P algorithm in P2P overlay network. In this HA to reach the destination it needs more hop count. But in TMP in P2P overlay reduces the hop count through the minimum cost.

The below graph shows the comparison of throughput between mobile nodes and stable nodes. In stable nodes increases the throughput with respect to time. Compared to mobile nodes, stable node increases the throughput and also packet delivery rate.

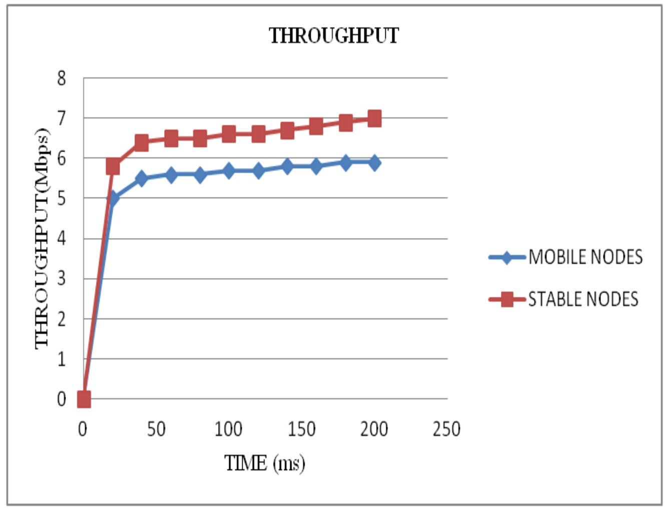

Figure 8: Comparison of throughput

Neighbor knowledge in mobile ad hoc networks provides important functionality for a number of protocols. An approach where each node acquires neighbor knowledge by observing not only hello packets but also flooded packets is presented. Analysis results show that this method offers significant improvement over the original scheme. Figure: 9 show the control overhead vs. time. From these graph we can identify in AODV protocol there is no congestion due to control overhead. Control messages are limited only with varies time. Compared to heuristic algorithm, TMP algorithm reduces the control overhead.

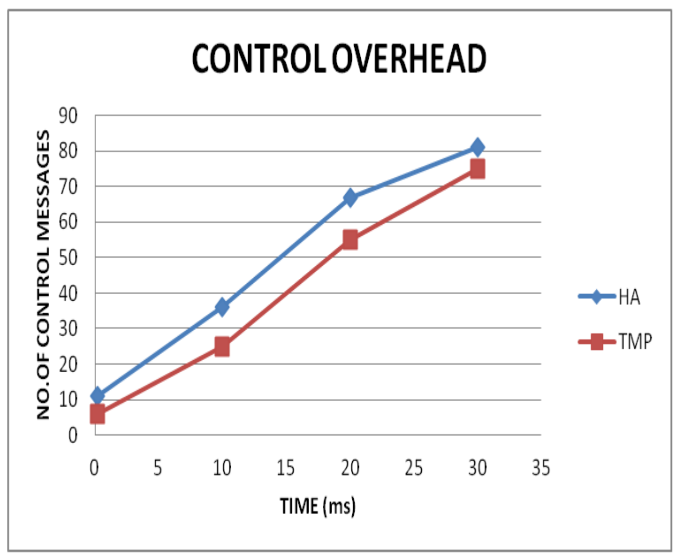

Figure 9: Control overhead

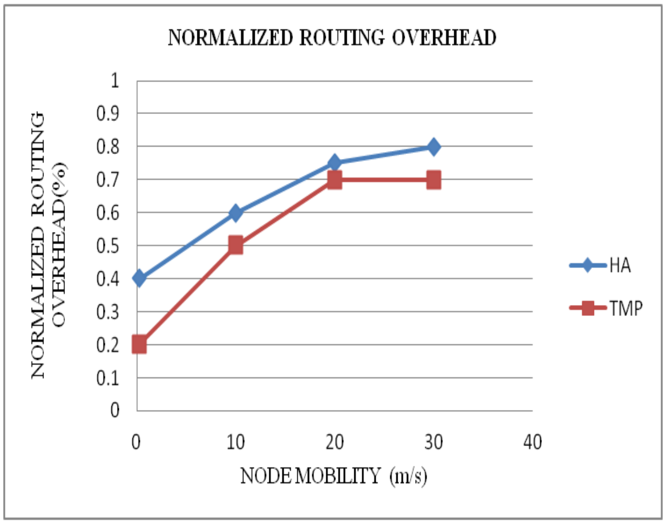

Figure 10: Normalized routing overhead

Figure 10 presents the control overhead in normalized routing load. Normalized routing load is the ratio of the number of control packets propagated by every node in the network and the number of data packets received by the destination nodes. This value hence represents the protocol efficiency. When there is no mobility, it has the least value. This result is expected because AODV protocols generate more control packets while building multiple routes. When the mobility increases, normalized routing overhead also increases.

6. CONCLUSION

This algorithm provides an examination of overlay construction and thus resilient from the maintenance of intermediate link energy between the peer to peer network and mobile ad hoc network. Mostly peer to peer networks have co-operative nodes in mobile ad hoc network, but in this algorithm some of the nodes act as selfish peers to minimize the energy consumption and also reduce the distance to their destinations. From this identify the QOS parameter of this proposed algorithm. The performance of this algorithm is compared to benchmark algorithm. Compared to heuristic algorithm (HA), Topology Maintenance in P2P (TMP) algorithm is more stable and feasible in throughput, packet delivery ratio and hop count. This approach uses the link based on minimum cost and high level energy. Through this algorithm energy consumption will be reduced due to selfish peers in P2P network. In MANET, when the node decreases in energy level it will hand over the link to other node. The results were obtained and also the graphs were plotted for throughput, packet delivery ratio, packet drop, control overhead and cost of the entire topology.

Finally TMP algorithm is fairly stable, relative to minimum cost algorithm and when the degree-constrain is relaxed, it minimizes its cost.

7. REFERENCES

[1]. Afzal Mawjia, Hossam Hassanein, Xiangyang Zhang. "Peer-to-peer overlay topology control for mobile ad hoc networks" Telecommunications Research Lab

[2]. Fabrikant, A. Luthra, E. Maneva, C.H. Papadimitriou, S. Shenker, "On a network creation game," in: *ACM Symposium on Principles of Distributed Computing, 2003*, pp. 347–351.

[3]. L.M. Feeney, "An energy-consumption model for performance analysis of routing protocols for mobile ad hoc networks," *Mobile Networks and Applications 6 (3) (2001)* 239–250.

[4]. S.-T. Park, A. Khrabrov, D. Pennock, S. Lawrence, C. Giles, L. Ungar, "Static and dynamic analysis of the Internet's susceptibility to faults and attacks," in: *IEEE INFOCOM, vol. 3, 2003*, pp. 2144–2154.

[5]. T. Moscibroda, S. Schmid, R. Wattenhofer, "On the topologies formed by selfish peers, in:" *5th International Workshop on Peer-to-Peer Systems*, February 2006.

[6]. Hossam S. Hassanein, Yu Yang, Afzal Mawji. "A new approach to service discovery in wireless mobile ad hoc networks". *IJSNet, 2007*: 135~145

[7]. Yu Yang, Hossam S. Hassanein, Afzal Mawji. "Efficient Service Discovery forWireless Mobile Ad Hoc Networks." *AICCSA'2006*. pp.571~578

[8]. B.-G. Chun, R. Fonseca, I. Stoica, J. Kubiatowicz, "Characterizing selfishly constructed overlay routing networks", in: *IEEE INFOCOM, vol. 2, 2004*, pp. 1329–1339.

[9]. Ngai-Pan Chow, Ajit Singh, Afzal Mawji. Architecture of a Reconfigurable and Reusable Web-Based Environment. International Conference on Internet Computing'2004. pp.42~45

[10]. Afzal Mawji, Ajit Singh. Load Balanced Exhaustive Network Data Processing With a Parallel Cluster. PDPTA'2004. pp.207~213

[11]. H. Hassanein, Y. Yang, and A. Mawji, "A new approach to service discovery in wireless mobile ad hoc networks," *Int. J. Sensor Networks*, vol. 2, no. 1/2, pp. 135–145, 2007

[12]. Afzal Mawji and Hossam Hassanein "Incentives for P2P File Sharing in Mobile Ad HocNetworks" *ICC'2008*. pp.2248~2252

[13]. Andrew Ka-Ho Leung and Yu-Kwong Kwok, "On Topology Control of Wireless Peer-to-Peer File Sharing Networks: Energy Efficiency, Fairness and Incentive."

[14]. Afzal Mawji, Hossam S. Hassanein. "Bootstrapping P2P Overlays in MANETs" *GLOBECOM'2008, pp.763~767*

[15]. Afzal Mawji, Hossam S. Hassanein. "Efficient Multipoint P2P File Sharing in MANETs." *GLOBECOM'2009*. pp.1~6 Computing, Queen's University, Kingston, Ontario, Canada, K7L 3N6 Department of Computer Science, King Saud University, Saudi Arabia

Author's Biography

Ms. J. Vijitha Ananthi received B.E degree in Electronics and communication from Anna University, in 2010. Since July 2011, she has been a student of M.Tech in Communication systems in Karunya University, Coimbatore. Her research interest includes overlay in wireless networks.

Mrs. Jennifer S Raj received the Masters degree in communication System from SRM University, India. Currently she is pursuing Ph.D in Information and Communication Engineering at Anna University of Technology, Coimbatore, India and working as a Assistant Professor at Karunya University, Coimbatore, India. Her interests are in wireless networks with self organization and topology control structures. She is a life member of ISTE, India. She is book reviewer for Tata Mc Graw hill publication and publishes more than fifteen research articles in the journals and IEEE conferences.