QUALITY LINK ESTABLISHED IN MULTICAST ROUTING METHOD IN MANET

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Abstract

The key application classes of mobile ad hoc networks are the group oriented services. Multicast routing protocol is basically used in the above services. Consequently it is required to design reliable and stable multicast routing protocols for MANETs in order to efficiently manage the flooding method based on service delay characteristics of the contributing nodes. This article proposes a mesh based multicast routing method that satisfies the delay requirements to flood the Join-Query messages. The contributing nodes are used as 'First In First Out' (FIFO) systems. The stable routes are found based on delay analysis, random packet arrival, service time process and random channel access in the forwarding nodes. The link stability is calculated by using the parameters such as distance between neighboring nodes and the quality of link is assessed using bit errors in a packet. The simulation results show that the control overhead is reduced in various scenarios as compared to basic ODMRP.

Key words: Ad hoc networks, Multicast routing, Multicast mesh network, Relay node, Quality Link

I. INTRODUCTION

Mobile ad hoc networks of wireless technologies are common as one of the major developing research areas[28]. The routing task in mobile ad hoc networks is exclusively dedicated to the contributing nodes. As a result, the presentation of routing protocols is powerfully impacted by the stochastic behavior of the nodes chiefly in scenarios where many topology changes occur. The design of routing methods can be dedicated to routing enhancement where the same information are transmitted to multiple destination nodes. Multicasting is intuitive to enhance the efficiency of wireless links for group oriented applications including audio, video conferencing as well as one-to-many data propagation[8]. Multicast data are added to the network only once and only data is duplicated at the branch points. Therefore the transmission overhead within the network can be efficiently managed. By minimizing bandwidth utilization, sender, router processing and delivery delay significant reduction of communication cost in multicast method can be achieved.

This article proposes the one hop delay characteristics such as network queuing, contention transmission delay and bit error ratio to improve the performance of the flooding method. High cost flooding method of ODMRP routing protocol is enhanced in this method. The proposed method supports path redundancy and mesh structure while decreasing network traffic congestions and control overhead of basic ODMRP. This is done by refining the flooding method during route setup and route maintenance segment.

II. LITERATURE SURVEY

They are many multicast routing protocols with unique features proposed for mobile ad hoc networks. MAODV (Royer and Perkins, 2000) is a well known multicast routing protocol. It is the extension of AODV routing protocol where the multicast groups are identified by a unique address and group sequence number. Vasiliou and Economides (2005) proposed that if a node wants to join a group that is not communicated yet, it becomes the leader of that multicast group and is responsible for maintaining the multicast group. Rodolakis G et al.,(2008) propose a shared mesh multicast routing protocol called protocol for unified multicasting through announcements (PUMA). It is a receiver initiative approach where receivers join the multicast group using the address of a special core node without the need for flooding of control packets from the source of the group (Ahmad, 2005). When a node wants to join a multicast group, it checks whether or not it is the first multicast receiver by checking the multicast announcement data. Multicast announcement data contains general information of the nodes such as message sequence number, core address, number of hops to the core of the group, group ID and the address of the node from which the multicast announcement is received. If the receiver node finds the core of the group, it broadcasts the multicast announcement data and advertises the core in the group else it considers itself as the core of the group and starts transmitting multicast announcements periodically to its neighbors (Ahmad, 2005).

ODMRP-MPR on demand multicast routing protocol with multi-point relay proposed by Ruiz and Gomez-Skarmeta (2004) reduces the packet overhead using multipoint relay nodes. The multipoint relay nodes decrease the broadcast over head by reducing duplicated packet forwarding (Oh et al. 2008). Saiful Azad et al (2009) proposed the technique that brings scalability and effectively solves the unidirectional link problem of wireless communication. Performance-enhanced ODMRP (PEODMRP) proposed by So et al (2004) reduces the packet over head by limiting the transmission area of Join-Query flooding. It shows the best simulation results in network scenarios where multicast group indicate many source nodes.

III. LITERATURE SURVEY

ODMRP was developed by wireless adaptive mobility (WAM) laboratory (Li et al., 2009) at UCLA. It employs a mesh structure to forward multicast data packets. Core assisted multicast routing protocol (CAMP) was proposed by Garcia et al (1999) which is a receiver initiated shared multicast mesh routing protocol. CAMP extends the usage of core nodes to communicate multicast mesh. S-J.Lee et al. (1999) analyzed the behavior of ODMRP under a wide range of networks. Simulation analysis reveals that ODMRP performs considerably better in terms of packet delivery ratio as a function of node mobility and multicast network traffic load. ODMRP exhibits high robustness on account of its mesh structure (Lee SJ et al. 2000). In order to enhance the performance of ODMRP many extensions of ODMRP have been introduced, each of which tries to enhance the performance of ODMRP in terms of pack delivery ratio, packet overhead and delivery delay. Enhanced-ODMRP, proposed by Oh et al (2008) suggests a mechanism that dynamically adopts the route refresh time to the environment. This mechanism dramatically reduces packet overhead while keeping packet delivery ratio high. R-ODMRP, introduced by Pathrina and Kwon (2007), is a subset of nodes that are not on forwarding paths, stores and retransmits the received packets to the nodes located in their minimal hop count to overcome the perceived node failures. Addition to storage and retransmission mechanisms in these nodes increases the packet delivery ratio. R-ODMRP enhances network reliability at the cost of higher delivery latency and packet overhead.

Asif et al (2008) planned the delay requirements for high throughput applications that the packet should be delivered by multicast receivers before the maximum of threshold of 250 m. The delay over a single hop consists of multiple elements. The waiting time (delay) over the link lab from node ‘a’ to ‘b’ is represented as

$$d_{lab} = d^{q}_{lap} + d^{c}_{lab} + d^{wt}_{lab} + d^{ber}_{lab} \quad ...(1)$$

IV. METHODOLOGY

A queuing theoretical representation for network layer queuing delay was proposed in this study considering the broadcast delay incurred by the MAC mechanism originally considered for multicast method. In the proposed method, each node can estimate one hop delay to the neighboring nodes. The nodes that satisfy the necessary delay threshold are permitted to broadcast the Join-Query messages to their neighboring nodes.

This model uses random nodes that contributes traffic forwarding using Kendall notations. This is based on a study by Tijms (2003) proposing M/M/1/K queuing system. The contributing nodes are assumed as single servers with (FIFO) queuing policy. Packet arrival rate at the node ‘a’ follows an poison distribution denoted by and service rate follows an exponential distribution denoted by %. The maximum queue size in each node is represented by K. If already there are K packets in the node’s queue then the arriving packet is dropped. On the other hand if the packets arrive at the relaying node by rate and service rate μ, where $< \mu$ then the probability of having n packets in a node’s queue is denoted by pn.

The probability of n packets

$$p_{i-1}\,\lambda = p_i\,\mu$$

$$p_i = \left(\frac{\lambda}{\mu}\right) p_{i-1}$$

In Particular $p_1 = \left(\frac{\lambda}{\mu}\right) p_0$ ...(2)

$$P_2 = \left(\frac{\lambda}{\mu}\right) p_1$$

$$= \left(\frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right) p_0$$

$$= \left(\frac{\lambda}{\mu}\right)^2 p_0 \ [u \sin g \, \text{eqn}(2)]$$

In general $p_i = \left(\frac{\lambda}{\mu}\right)^i p_0$

$$p_i = \rho^i p_0 \quad ...(3)$$

we know that

$$\sum_{i=0}^{k} p_i = 1$$

$$= \sum_{i=0}^{k} \rho^i p_0 = 1 u \sin g \, \text{eqn}(3)$$

$$= p_0 = \frac{1}{\sum_{i=0}^{k} \nu^i} \quad ...(3)$$

$$p_0 = \frac{1}{1 + \rho + \rho^2 + \ldots\ldots + \rho^k} = \frac{\rho - 1}{\rho^{k+1} - 1}$$

$$p_0 = \frac{(\rho - 1)}{\rho^{k+1} - 1} \quad ...(4)$$

Expected number of packets in the node's queue

$$N = \sum_{i=0}^{k} ip_i$$

When $\rho = 1$

$$N = \sum_{i=0}^{k} i \frac{1}{k+1}$$

$$= \frac{1}{(k+1)} [0 + 1 + 2 + \ldots\ldots + k]$$

$$= \frac{1}{k+1} \frac{k(k+1)}{2}$$

$$= \frac{k}{2}$$

Thus $N = \frac{k}{2}$ ...(5)

When $\rho \# 1$

$$N = \sum_{i=0}^{k} i p_i$$

$$= \sum_{i=0}^{k} i \rho^i p_0$$

$$= \sum_{i=0}^{k} i \rho^i \frac{(\rho - 1)}{(\rho^{k+1} - 1)}$$

$$\frac{\rho (k+1) \nu^{k+1}}{(\rho^{k+1} - 1)} - \frac{\rho}{(\rho - 1)}$$

$$= \frac{(k+1) \rho^{k+1}}{(\nu^{k+1} - 1)} + \frac{\rho}{(\rho - 1)}$$

Thus $N = \frac{(k+1) \rho^{k+1}}{\rho^{k+1} - 1} + \frac{\rho}{(1 - \rho)}$ ...(6)

The waiting time from the time a packet arrives at the relaying nodes to the time the packet reaches the head of line of the queue in node is given by

By little's formula, waiting time $d_{q+c} = \frac{N}{\lambda}$

when $\rho = 1$

$$d_{q+c} = \frac{N}{\lambda} = \frac{K}{2\lambda} \geq \frac{K}{2\mu}$$

Maximum $d_{q+c} = \frac{k}{2\mu}$

when $\rho \neq 1$

$$d_{q+c} = \frac{N}{\lambda} = \left[\frac{(K+1)\,\rho^{k+1}}{(\rho^{k+1}-1)} + \frac{\rho}{1-\rho} \right] \frac{1}{\lambda}$$

Maximum queue $d = \underset{\rho \to \alpha}{lt}\ d_{q+c}$

$$= (k+1-1)\frac{1}{\lambda}$$

$$= \frac{k}{\lambda}$$

$$\geq \frac{k}{\lambda}\left[\because \frac{1}{\lambda} \geq \frac{1}{\mu} \right]$$

$$\therefore \text{ maximum } d = \frac{k}{\mu} \qquad \text{...(7)}$$

V. TRANSMISSION METHOD

This part focuses on transmission method used for multicasting in random access wireless communications. The fundamental difference between unicast and multicast method is that data link layer handles multicast data differently. Multicast method does not involve RTS/CTS before data transmission. In addition the multicast nodes need not send acknowledgement to the source node. This causes a huge impact on increasing packet error rate during transmission period. MAC layer is used when to transmit data packets using physical medium during random access time. Due to the nature of physical medium wireless communication is shared. The source node uses CDMA/CA protocol to avoid packet collision with other nodes when simultaneously occupying the wireless link resources. If a node has data to send, it receives the physical medium that is idle and then the packets are inserted into the network. Else it waits until the medium gets idle and then it counts down a certain period of time called back-off time before sending a data packet. Yang et al (2006) proposed that back-off time is exponentially distributed and is determined by pseudo random integer distribution in [0,Wi-1] where wi indicates the contention window at the ith back-off slot. If the physical medium is idle then it sends the packets to the neighboring nodes. When medium gets busy before the back-off time expires, the node timer freezes till the channel gets free. The nodes lie within the area 2A(r) where r is the radius of a circle centered at the source node called interference nodes.

Bisnik et al.,(2009) proposed that when the channel of the relaying node becomes free, the node starts forwarding multicast data. The back-off timer of the neighboring nodes in the area 2A(r) gets frozen during the transmission time. The propagation area 4r2 with interfering nodes during wireless channel available for data transmission for an arbitrary node can be expressed as

$$d = \frac{\phi\, 4\, \pi\, r^2 m}{bw}$$

Here m denotes the packet size and bw represents the single hop bandwidth between two nodes. Therefore the channel free for data transmission per unit of time is

$$d_{\text{feee}} = 1 - T_{\text{buzy}}$$

$$= 1 - \frac{\phi\, 4\, \pi\, r^2 m}{bw}$$

The MAC layer uses CDMA with no RTC/CTS and ACK messages in the contributing nodes. The service time can be calculated as

$$T_{\text{service time}} = bc + \frac{m}{bw} \qquad \text{...(8)}$$

where '*bc*' is the period of the back-off time and '*m*' represents the time required to send the complete packet bits and '*bw*' represents the link bandwidth. Therefore "m/bw" indicates the transmission time. The transmission time needed to insert a packet in the network can be defined as the time required to send the packet over the free channel available for data transmission. Transmission delay is given by

$$d_{wt} = \frac{bc + \frac{m}{bw}}{1 - \frac{\phi\, 4\, \pi\, r^2 m}{bw}} \qquad \text{...(9)}$$

To transmit a packet from node 'a' to its neighboring nodes using single hop delay can defined as

$$d_a = d_{q+c} + d_{wt}$$

$$= \frac{k}{\mu} + \frac{bc + \frac{m}{bw}}{1 - \frac{\phi 4 \pi r^2 m}{bw}} \qquad ...(10)$$

Equation (10) is applied by the contributing nodes to calculate the delay interval from the packet arrival at the node to the packet insertion into the network.

VI. QUALITY LINK

It is a primary component that decides the link stability to form multicast routes. It is derived by the ratio of bits in error the total number of bits received (ie Bit Error Ratio (BER)). David day et al., (2003) and J. Reddy et al (2000) have stated that its true value should be estimated over an infinitely long time as small intervals of BER are imprecise. The adequate number of transmitted bits can be calculated for the preferred approximation quality. It can be acquired by using the concept of statistical confidence levels (SCL). The bit error ratio confidence level can be defined as the probability that the true BER would be less than a specified bit error ratio (SBER). Equation (10) can be defined mathematically (Justin Read et al., (2004)) as

$$SCL = PROB\ [TrueBER \geq SBER] \qquad ...(11)$$

David Day et al., (2003) has presented that if 'S' is the average of standard deviations of many bit error trials and 'a' is the accuracy of received bits, then true bit error ratio between nodes I and j within a SCL is given by the following equation (12).

$$BER_{ij} = \frac{s^2}{a^2} \qquad ...(12)$$

The link quality qij between two neighboring nodes i and j is inversely proportional to BER. For a better approximation of link quality with proportionality constant K the following equation (12) is used.

$$q_{ij} = Kx \frac{1}{BER_{ij}} \qquad ...(13)$$

Link quality '*qij*' depends on the parameters such as the interference effect of the wireless channel, additive white Gaussian noise and signal transmission range.

The stability factor between two neighboring nodes can be defined as in equation (13)

$$ql = q_{ij} + \frac{k}{\mu} + \frac{\zeta + \frac{m}{bw}}{1 - \frac{\phi 4 \pi r^2 m}{bw}} \qquad ...(13)$$

By applying the above equation in contributing nodes, each node can calculate the stability factor and store in neighboring nodes. The stability factor estimation determines the receiving packet signal strength and distance between each node distance. The signal strength is based on receiving and transmitting signal during data transmission periods.

The large one hop delay value can be determined through a large queuing delay. It generally shows that higher delay occurs due to higher packet arrival rate at a node when nodes are located in a network traffic congested area. Due to neighbor intrusion, higher delay can also expose longer waiting time that the nodes should use to access the channel. Therefore one hop delays may be located in congested areas where packet error rate is high due to shared wireless device. When a node receives a Join-Query message, it checks with one hop delay constraint within the Join-Query message. If the node satisfies the delay condition then it floods the network with Join-Query message else it plunges the input of Join-Query message. This method limits the flooding process to the nodes that can assure the required one hop delay. This method avoids the node located in areas where the nodes have higher service delays.

VII. RESULTS

In this part, the performance of the proposed technique and the original ODMRP under different simulation scenarios are compared.

The simulation setting used is based on NS2 and consists of wireless nodes placed randomly in a 1200×800 m2 area with a maximum node speed of 10 m/s. The simulation time is 900s. The radio propagation range is 250m and the channel capacity is 2Mbps. Two Ray propagation model is assumed. The source generates constant bit rate (CBR) traffic. Each node is a drop-tail queue. The packet size is 512 bytes. The packets are sent at the rate of 4 packets/ second. Single hop delay threshold is defined as 10 m with a interval of 3s. Each scenario consists of 1 multicast group with 1 multicast source and 20 multicast receivers.

The following parameters were used to assess the performance of the protocols.

Average-end-to-end delay: It is the ratio of time difference between every constant bit rate packet sent and received to the total time difference over the total number of constant bit rate packets received.

Control Overhead: The normalized routing loads are measured as a ratio of the total number of routing packets sent to the number of data packets delivered successfully.

A wide range of scenarios were applied to investigate the behavior of the LSODMPR. The performance behavior of the LSODMRP, RODMRP and ODMRP was investigated in terms of network traffic and number of nodes.

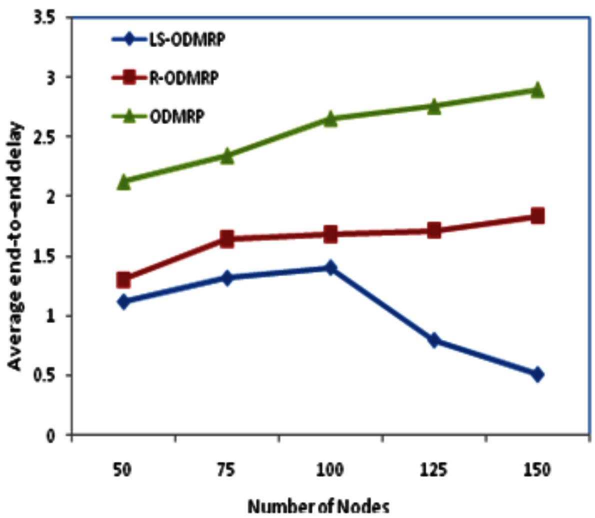

Fig. 1. Average end-to-end delay as a function of Number of nodes

Figure 1 shows the average communication delay of data packet transmission from source nodes to destination nodes. The delay of ODMRP rises remarkably at high network loads. The proposed protocol LSODMRP shows good performance as compared to other two protocols.

Figures 2 and 3 show the control overhead of LSODMRP (Link Stable on Demand Multicast Routing Protocol) protocol. It shows a better performance than that of ODMRP and RODMP. This is chiefly because of great reduction of the cost of new method and mesh network of ODMRP. The LSODMRP protocol shows its

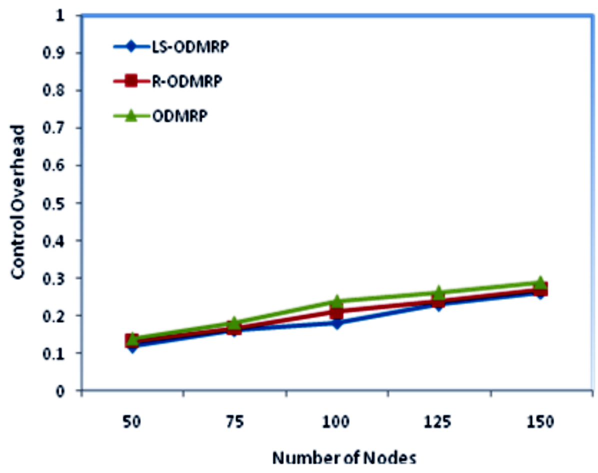

Fig. 2. Control overhead as a function of number of nodes

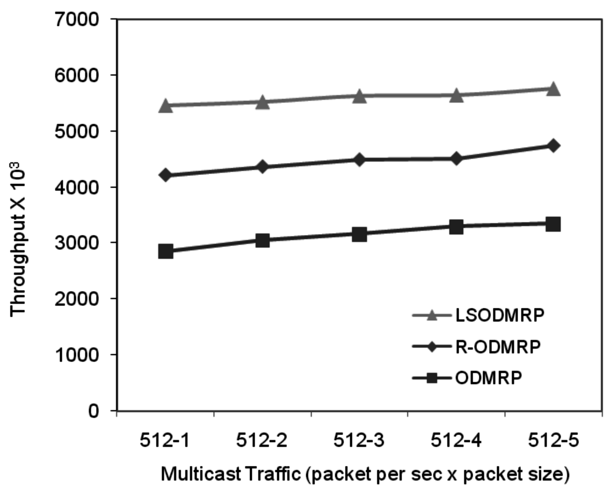

Fig. 3. Throughput as a function of Traffic

best performance under higher traffic rates. The control overhead of LSODMRP is improved by about 23% at highest packets transmission rate.

Figure 4 represents the effect of network traffic on the network performance. The packet sending size differs from 4 to 30 packets per second. During simulation period the packet size was 512 bytes with one multicast source and 20 receivers in the multicast group. Figure shows that the protocols decrease on increasing the packet sending rate. Higher congestion and the accompanied packet loss occur due to higher node buffer size, lower bandwidth and higher packet sending rate in the network.

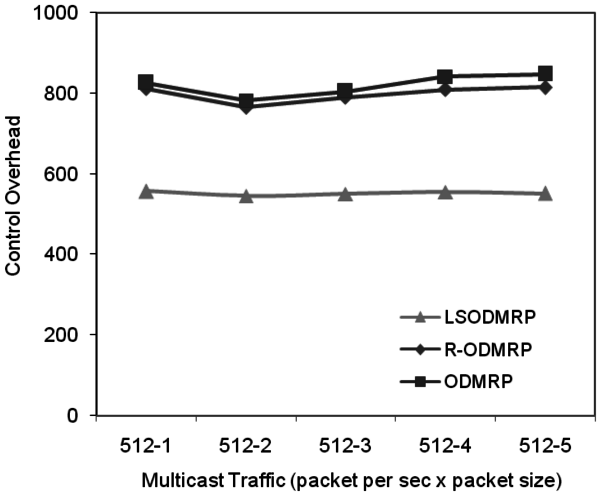

Fig. 4. Control overhead as a function of Traffic

VIII. CONCLUSION

In this article a model (LSODMRP- Link Stability ODMRP) for effective route and quality link was established and evaluated with the purpose of delay minimization. It has been proved that the delay method of a node can show the ability of nodes for packet forwarding within the network. In the proposed method only the nodes that show good delay method are permitted with bit error ratio to flood the join query messages within the network.

The simulation experiments also show around 24% improvement in the control overhead in highly congested scenarios. LSODMRP provides higher performance output in terms of throughput without bit errors and average end-to-end delay under high traffic loads.

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