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Framework for Integrated Routing, Scheduling and Traffic Management in Adhoc Sensor Network

Kanchan Chaware[1], Dr. Vaishali Khairnar[2], Dr. Deven Shah[3]
ME Student[1], HOD[2], Dean[3]
Department of Information Technology
Terna Engineering College, Mumbai University, Maharashtra, India[1, 2]
Thakur College of Engineering and Technology, Kandivali, Maharashtra, India[3]

Abstract:
A wireless Adhoc network is a decentralized wireless network. Each node is responsible for forwarding a data and finding a best route to reach to the destination. A new framework is introduced in the form of STORM which uses unicast and multicast routes and also it is fast and efficient for repairing the several routes. Unicast routing uses AODV or OLSR and for multicast routing ODMRP is used. STORM is an integration of scheduling, routing which are loop free and Traffic management by reserving a slot in a STORM frame in adhoc Sensor network. STORM gives better performance in real and elastic traffic also increases throughput and the capacity of channel, reduced the time delay and minimizing the bit error rate , in packet forwarding in network topology. STORM allows to transmit the packet in ordered form where each node may know the details of at least its 2 hop neighborhood also in a particular time which packet is send and at what time is also schedule in wireless mesh network.

Keywords: AODV, elastic traffic, mesh network, multicast, OLSR, unicast.

1. INTRODUCTION

In most of the wireless Adhoc networks the nodes compete to access the shared wireless medium, and may get the result of collision. Due to the decentralized nature of wireless ad hoc networks variety of applications especially the central nodes can't be relied on, and may improve the scalability of wireless ad hoc networks. Communication in between the remote nodes is based on hopping. Adequate configuration and quick accessible makes the ad hoc networks suitable in natural disasters or military conflicts. The presence of a dynamic and adaptive routing protocol will enable ad hoc networks to be formed quickly. MANETs do not require the support of wired access points or base stations for intercommunication. It is a collection of mobile nodes where communication is established in the absence of any fixed foundation. As in proposed algorithm it will integrate scheduling, routing and traffic management and bandwidth reservation. STORM is on the basis of decentralization where too much information is not stored in only one node. Each node contain the nodes information in its own table. STORM introduces a frame which is in the form of slot where every node find the shortest path to connect to the other node and start transmitting the data in priority based queuing system. Due to this packet loss may not occur. As proposed algorithm uses AODV (Ad-hoc On-Demand Distance Vector Routing Protocol). In AODV the source data packet contains destination address to reduced routing overhead. AODV is adaptable to highly dynamic network. The rest of the paper is presented as follows: section II gives the related work perform in STORM, section III presents detailed overview on STORM, section IVrelates to channel structure, section V gives neighbor protocol detail, section VIhighlights the scheduling algorithm, section VII explains the detailed overview of channel reservation and section VIII finally shows the conclusion of the STORM.

2. RELATED WORK

STORM performs better in adhoc network due to its less packet loss in unicast and elastic traffic. L. Bao and J.J. Garcia-Luna-Aceves [1], gives detail survey on A New Approach to Channel Access Scheduling. Two node wants to access the same channel then according to their identifier slot is reserved. Z.Cai, M. Lu, and X. Wang [3] in 2003, proposed end to end bandwidth allocation to the nodes for increasing the flow.E. Carlson[4] shows how end to end reservation were met, for forwarding a packet to the destination node it has to send the messages reservation request to the source node. When source get clear reserve trigger replay from destination then packet transmission were start. Chen and Heinzelman [5] gives a survey on various protocol for routing and also support the Qos to the sensor network as the nodes were mobile and distance matter for that quality of service is essential. P. Djukic[6] proposed a soft-TDMAC which can synchronizes clock in wide network and multihop environment. All the nodes access the channel by assuming that the network uses a software based TDMAC protocol for synchronization. For random way point mobility X. Hong [8] in 1999 survey for the group mobility in multihop environment. Where different mobility patterns are evaluated and implemented on network environment and various protocol respectively. All the members of the multicast group follow the movement of mobility group model. C.R. Lin [14] gives first approach on the integration of traffing management and scheduling in unicast routing for reservation of the real time packets in wireless network. For that MACA/PR were introduced which communicate fastly by using the Qos algorithm. Melodia

et al. [15] gives detail survey on cross layer in WSN, which is based on network layer of OSI model which shows various improvements on resources allocation. R. Menchaca-Mendez [16] in 2008 introduces a framework for integration of routing of unicast and multicast in mesh network and focuses on PRIME which provides updated routing information in unicast and multicast flow. C.E. Perkins [17] proposed a DSDV for distance routing among the mobile node, which require very less storage capacity and solve the problem of routing loop.

3. STORM

Scheduling and Traffic Management in Ordered Routing Meshes (STORM) introduces new cross layer framework which can combine scheduling, traffic management and routing in adhoc sensor network. In past paper, it focused on centralized algorithm as a result the integration of routing and scheduling is worst as it only uses unicastflow. The nodes in STORM shares a common medium for transmission they used the fixed amount of time slot in a frame. For participating in transmission mechanism every node reserve the slot, if not reserve the slot by node in that case they used distributed election algorithm on the basis of node identifier. STORM acts efficiently in repairing the routes in case of failure of path as it provides some other routes. It can distribute the information to only that nodes which are actively participate in the transmission rather than the whole network. STORM contains a frame, neighbor detail information of the nodes. For channel access scheduling Priority Based Algorithm is used to manage reservation of packet transmission, queuing system contains the queue for real time traffic and non-real time traffic because of that interference among them may avoid. Real time flow always has the highest priority. Time slots always reserved the slot for elastic traffic. First in first out algorithm is design to Select Packets from transmission queues.

4. CHANNEL STRUCTURE

STORM frame is organized in the form of slot. This slot is formed on the basis of TDMA. The STORM frame shown in Figure 1. STORM frame consist of N number of slots i.e. starts from slot 0 up to slot$N-1$. Whatever be the position of slot is the identifier of the slot and there is no specific structure of that frame. Only a specific time slot is there to add the new node otherwise any time slot can be used for forwarding the packet. For admitting a new node the time slot occurs at every A time slot. $A >> N$, in that case nodes are allowed to transmit the hello packet. As a slot is assign to the node then it can forward many packets on that slot. FIFO algorithm is used to select various packets from Transmission queue. The proposed system of STORM uses priority based queuing algorithm. Where highest priority is always giving to the Reservation packet ($pRsv$), after that signaling packet ($pctr$) have second priority, data packet have third priority which is in data queue, the packets waiting in that queue is elastic or real time traffic (pRT) which always have highest priority rather than elastic traffic ($pelastic$).Hello packet always have lowest priority ($pHello-< pelastic$). Neighborhood information get refreshed if $hello\_period$ has to transmit more than one and has to be pass. Finally the slot is given to the node according the following organization. $pHello -< pelastic < pRT < pRT+ < pctr < pHello+ < pRsv$.

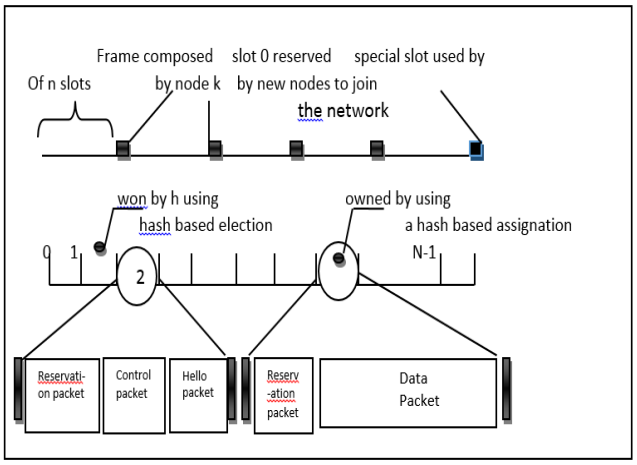


Figure. 1. Channel Structure

5. NEIGHBOR PROTOCOL DETAIL

STORM uses distributed algorithm which means there is no burden on one node. Every node should know the detail information of its one hop as well two hop neighborhood. If there is a undirected graph G then let V be the vertices means set of nodes and E be the set of edges where$G = (V, E)$. In case of one hop neighborhood let us assume node u, node vcan share the same edge $(u, v) \epsilon E$.A node has to send the hello messages on every $hello\_period$ of its two hop neighborhood node to get the detailinformation. The message is in the form of tuple list which consist list of one hop neighbor, List of identifier of the time slot and reserved time slot length. When the node sends the hello messages to its one hop neighborhood and that node did not respond in three consecutive hello message then that node will not be the neighbor of that Node. Conflicting reservation may not occur Due to this information about every node. As the same Slot is reserved by the two node then, the node who have lowest identifier losses its reservation on that slot and give it to highest identifier.

6. SCHEDULING ALGORITHM

STORM uses the scheduling algorithm which is shown in Algorithm 1for accessing the channel which gives the various way to occupy the time slot by the node. For every time slot t which have identifier $(t \ mod \ N)$,Node u has to be given identifier as id^u has to identified whether node u be owner of that slot in that frame(i.e. If$(t + id^u) \ mod \ N = 0$) and if no one be the owner then node u is the owner of that slot. If node u cannot access the slot then it checks in its two hop neighborhood if it is down by its neighborhood (i.e., if $v \epsilon IN\ (IN\ (u))$ such that $(t + id^v \ mod)\ N = 0$)in that case node u should give up that slot. If node u finds that in its two hop neighborhood the Owner of that slot is not present then it will check the possibility to already have a reservation on that time by using slot $(t \ mod \ N)$ in that case node u can use that channel. Above two conditions will not be their then node u uses hash based election scheme. In the absence of the owner of particular node the time slot is not present and also not present in the two-hop neighborhood, node u checks if it has a reservation on the slot$(t \ mod \ N)$, in which case it can access the channel. Otherwise, node u checks if there is $v \epsilon\ (IN\ (IN\ (u))$ such that v

has reserved the slot $(t \ mod \ N)$,if that node exists, node u listens to the channel.

```
if (t + id^u) mod N = 0 then
    C ← {v : v ∈ ℕ(ℕ(u)) ∧ (t + id^v) mod N = 0};
    if C = ∅ then
        Access channel;
    else
        compute p_u^t =Hash(id^u ⊕ t) ⊕ id^u;
        ∀v ∈ C compute p_v^t =Hash(id^v ⊕ t) ⊕ id^v;
        if ∀v ∈ C : p_u^t > p_v^t then
            Access channel;
        else
            Listen to channel;
else
    if ∃v ∈ ℕ(ℕ(u)) | (t + id^v) mod N = 0 then
        Listen to channel;
    else
        if u has reservation on t mod N then
            Access channel;
        else
            if ∃v ∈ ℕ(ℕ(u)) | v has reservation on t mod N then
                Listen to channel;
            else
                for v ∈ ℕ(ℕ(u)) ∪ {u} do
                    compute p_v^t =Hash(id^v ⊕ t) ⊕ id^v;
                if ∀v ∈ ℕ(ℕ(u)) | p_u^t > p_v^t then
                    Access channel;
                else
                    Listen to channel;
```

Algorithm.1. Channel Access for Transmission Scheduling

7. Channel Reservation

STORM uses reservation protocol for reserving a slot in future. Nodes send the real time data packet for reserving a slot. STORM is handled by routing layer where node has to select the slot in the form of slot r ϵ [0, N-1].
Channel reservation include two steps:

- Reservations: Control Signaling
- Maintenance of End-to-End Reservations

7.1. Reservation: Controlling Signaling

STORM frame contains a time slot which can be reserved if the slot is empty. Slot reservation means that if a node u itself and its two hop neighborhood has not reserved that slot. Whether the slot is free or not this information regarding reserving a slot require various ways i.e. 1) Neighbor List which reserves the identity of nodes and information regarding slot reservation in its two hop neighborhood, 2) Ongoing reservation list which is handled by Reservation protocol and contains the information of ongoing reservation of a node and 3) Reserved slot list that contains the list of that node which is currently reserved that slot. If the slot is free to occupy by the node u, then it is identified by$(slot_c)$ for that transmission uses identifier id^u. For reservation request R_sR^x=$(id^u,slot_c)$ and send to all the neighbor and wait for $N_T$seconds and also wait for neighbors reply, if the node sends reservation granted as R_sG =$(id^u,slot_c,id^v)$, that means node u added this slot in his ongoing reservation list. This process is continued till all the slots in the frame are reserved.

7.2. Maintenance of End-to-End Reservations

Even if the network topology changes still the end to end reservation remain unchanged. Assume that if node x sends the real time packet and forwards to the destination and if the distance changes from $d_D^x$to $d_D^{'x}$than node x can cancel its reservation and request for new slot. As the request is accepted by the frame then it allows reserving the appropriate slot. STORM contains routing mesh where, in case of transmission of packets, various nodes actively participate to connect to the destination. Also STORM uses Mesh Announcement (MA) which sends to every node that gives the information about updating of routing table. When a sender has to send a packet to the destination then source confirm whether MA advertising is accessible or not within last three MA periods. In that case, the source sends the packet or disseminate the MR packet. In STORM if the source destination pair is available or not is checked by the node in the form of (senders address) in the data cache. If the information is available then packet gets dropped. Otherwise that pair is included in the data packet cache.

8. TRANSMISSION SCHEDULING

Scheduling done to know which node must transmit in a time slot. The node with its identifier first checks if it is the owner of the slot, the owner can access the channel. If the node does not own the slot, it checks if the owner is present in its two-hop neighborhood and listen to the channel. If there is a collision, the time slot is not considered as owned by any of the nodes and a hash-based election is held among the nodes participating in the collision. If the owner of that time slot is absent in the two-hop neighborhood, then node checks whether it has a reservation on that slot in which case it can access the channel. Otherwise it checks whether neighbor node has reserved the slot, if they reserved they can access the channel. If no two-hop neighbor nodes have reserved, hash based election scheme is done to select the node that can access the network.

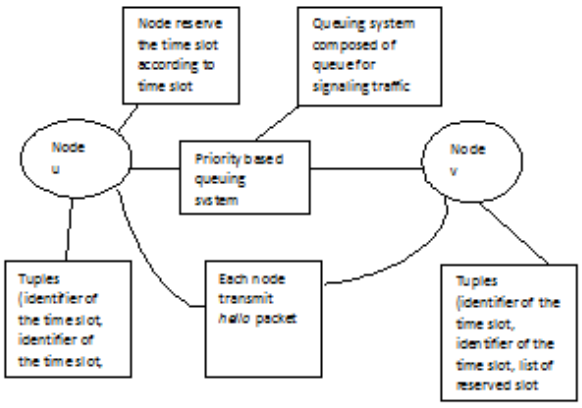


Figure .2. Sending and receiving data in STORM

The maximum end-to-end delay experienced by a real-time data packet that fits in a time slot and is transmitted node is flow ordered for a given real-time flow if and only if the node can reserve a time slot (or set of time slots) at the appropriate position in the STORM frame as required by the end-to-end schedule of the flow shows in Figure 2. Enclaves are used to confine the dissemination of signaling packets into connected regions of the network that contain those nodes with interest in a given data flow .Once an enclave is established, it is used to restrict the dissemination of control information to those nodes that are part of the enclave.

9. PERFORMANCE EVALUATION

Network performance in networking is play an essential role for measuring a service of quality. Various ways are available for evaluating the performance according to the behavior of network. For measuring a performance bandwidth, delay, throughput is used. Bandwidth is measured in bit/second at maximum rate where data is transfer. Throughput is the rate that packet is transferred.

9.1 Delay

The packets adhoc networking experience some delay for forwarding its first packet and receive to the end node. In node mobility environment, packet gets delay especially in multi hoppingrefer (1). For evaluating following formula is used

$$Dend-end = N[DTrans + Dprop + Dproc] \quad (1)$$

Where:

$$Dend-end = End-to-End\ Delay$$
$$Dtrans = Transmission\ Delay$$
$$Dprop = Propagation\ Delay$$
$$Dproc = Processing\ Delay$$

In STROM, end to end delay is lower than delay in Non-STORM.

9.2 Throughput

Equation (2) shows the Throughput which successfully delivered packet to the receiver node which is controlled by the bandwidth traffic, and limitation of the hardware. For that following formula is used for calculating is used.

Throughput

$$(Bits/sec) = \frac{Number\ of\ Delivered\ packets \times packet\ size \times 8}{Totals\ simulation\ period} \quad (2)$$

9.3 Energy Consumption

For calculating Overall Energy Consumption by the STORM network refer (3), following calculation take place.

$$Tx\ part\ is\ turned\ ON = Supply\ Voltage\ (V) * Current\ consumed\ for\ turning\ on\ the\ Tx\ circuit * time\ period. \quad (3)$$

TxAs transmission time. The unit is watts-sec or joules.

10. RESULT ANALYSIS

In STORM we used ns2 simulator where all the nodes of the multicast group can move according to group mobility model. Its packet size is set to 500 slot. Overall simulation information is shown in the table Table I.

Table I. Simulation Environment

Simulation Area	1200x1200 m^2
Simulation Time	150s
Data Source	CBR
Total Nodes	33
Qtype	Queue/DropTail/PriQueue
Physical Model	Mac/80211
Packet size	500
Energy Consumption	166716.76725154981

When the simulation start, time synchronization process will start. Where, every node synchronized its clock with other node, for forwarding the packet. We used 33 nodes start from node 0 to node 33.Initially the clock get synchronised.

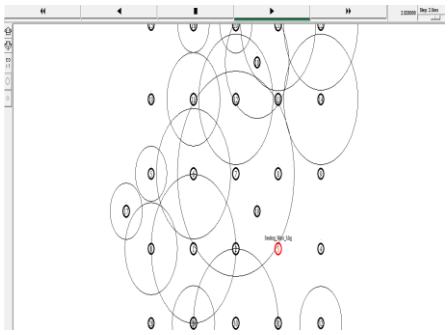
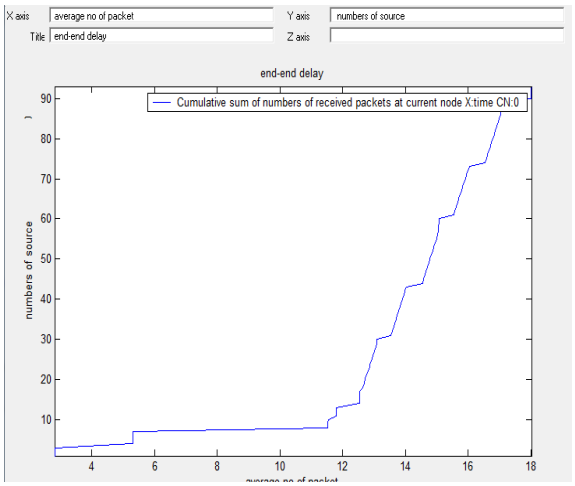


Figure .3. Synchronize with other nodes and sends hello packet

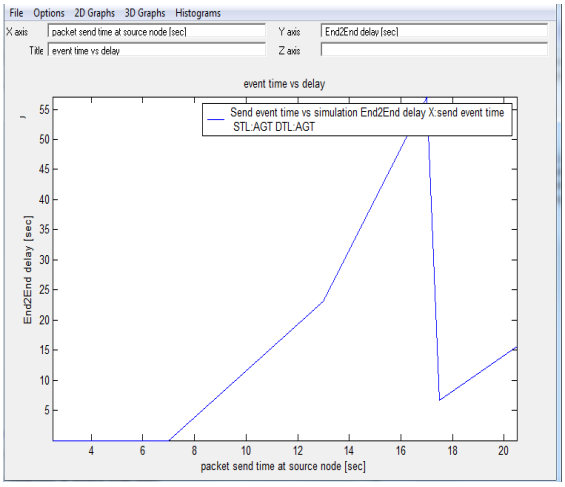
All the nodes finds its neighbor for packet transmission sending hello then actual data sending process get started. After that node 3 activates and synchronized with its group, and ready to send its first hello packet and search for a one hop neighbor. Shows in Figure 3 as the neighbor node 19 accept the request by sending hello packet.

Figure.4.Reservation packet sends first followed by signaling packet

STROM uses priority based algorithm first reservation packet(R) is send then signaling packet (N) is send and finally packets from data queue selected. Shows it clearly in Figure 4. After receiving all the packets from source node 3. Other nodes get activated and start their packet transmission according to priority based algorithm.



a) Packet Delay in STROM



b) Non-STORM as ODMRP

Figure .5.End to End Delay a) Packet Delay in STORM
b) Packet delay in Non-STORM as ODMRP

Delay rate for STROM is slightly low in Figure 5a as compare to non STROM in Figure 5b. When the network work in mutihop environment then delay sometime increases. But delay of packet in STORM is less due to its multipath environment.

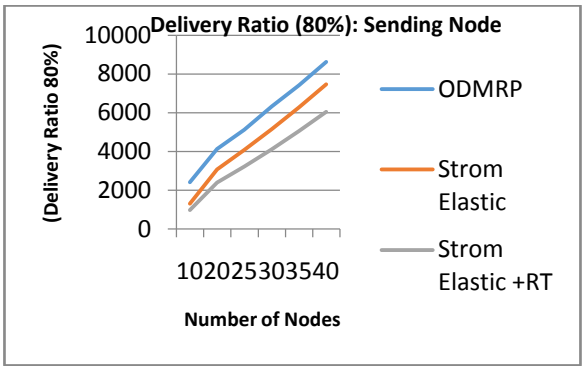


Figure .6. Packet Delivery Ratio

In STORM packet delivery of overall node is reached in time with very less packet loss. Above graph Figure 6 shows the results of ODMRP and STROM. Where highest packet loss is in ODMRP. As the packet loss is higher in one path then alternate path is used for sending the data, so STORM deliver its packet appropriately.

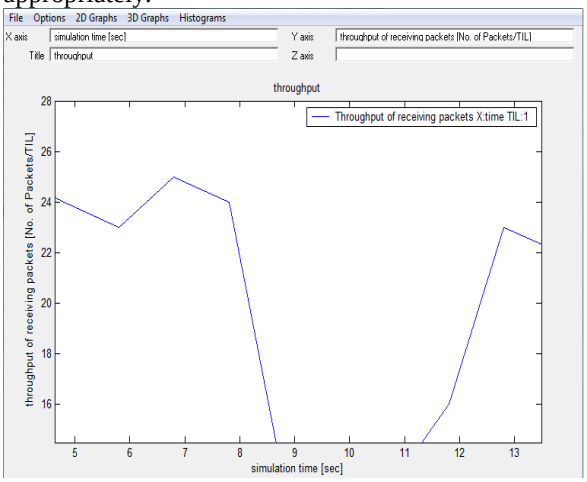


Figure.7. Throughput for STORM

STROM gives better performance due to its unicast and multicast way. When simulation time get increases the number of packet receive appropriately within that specified time, as shown in Figure 7.

11. CONCLUSION

We introduced STORM, which works in both the environment of unicast and multicast group and routes are totally loop free ,and also integrate traffic and scheduling. STORM gives its best result in AODV. Entire network used in STORM is timely synchronized by using TDMAC. Transmission scheduling uses priority based algorithm, traffic management, and end to end reservation, table maintained by MA which is handled by routing. All these thing work together and perform end to end delay, bandwidth reservation guarantees in multicast group in multi hop wireless adhoc sensor network.

12. FUTURE SCOPE

New approach of STROM also required some extension which includes: detail analysis on the energy consumption which gives appropriate real time calculation on to the simulation environment. Also we can use some alternate way of cock Synchronization. If network environment uses random way point mobility then increases in the bandwidth consumption. STROM time reservation slot will be very effective if the packet information is display in the way like reservation packet, data packet, how many packet drop, how many packet receive, which route is used.

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