Bandwidth and Delay Aware Routing Protocol with Scheduling Algorithm for Multi Hop Mobile Ad Hoc Networks

Y. Harold Robinson, E. Golden Julie, S. Balaji

Abstract— The scheduling based routing scheme is presented in this paper to avoid link failure. The main objective of this system is to introduce a cross-layer protocol framework that integrates routing with priority-based traffic management and distributed transmission scheduling. The reservation scheme is based on ID. The presented scheme guarantees that bandwidth reserved time slot is used by another packet in which end-to-end reservation is achieved. The Bandwidth and Delay Aware Routing Protocol with Scheduling Algorithm is presented to allocate channels efficiently. The experimental results show that the presented schemes performed well in various parameters compared to existing methods.

Keywords—Integrated routing, scheduling, MAC layer, IEEE 802.11.

I. INTRODUCTION

RESERVATION setup is used to reserve the time resources in the nodes along a path between a source and destination node. The resource reservation is initiated by the source node. The destination node computes a clear-to-reserve (CTR) message [50]. Transmissions in the real-time path must be protected against interference. If a reservation path breaks and a new one is established, the nodes of the old path should release their reservations [1].

The MANET introduces the framework for integrating with unicast and multicast routing which is based on mesh enclaves. The multicast ad hoc on-demand distance vector protocol preserves a collective tree for every multicast group consisting of receivers and relays [36]. A mesh-activation request has generated by the source node and transmitted by source S to destination D [2]. Energy-based dynamic encryption is used for security purposes [33] in Wireless Communication. Energy Efficiency has been maintained by Virtual Back Bone Path Based Cluster Routing Protocol [42]. The cross layer is introduced to realize maximum throughput. The main contribution of this approach is a joint optimization problem. There are two challenges for achieving maximum throughput [31]:

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- Data routing problem at the network layer.
- Power control problem.

These two challenges are achieved by joint optimization problem. A mesh network is the system's capability to competently maintain improved throughput in multicast applications over wireless links [4]. Trustworthy Link Failure Routing Algorithm is used to predict the link failure in MANETs [3].
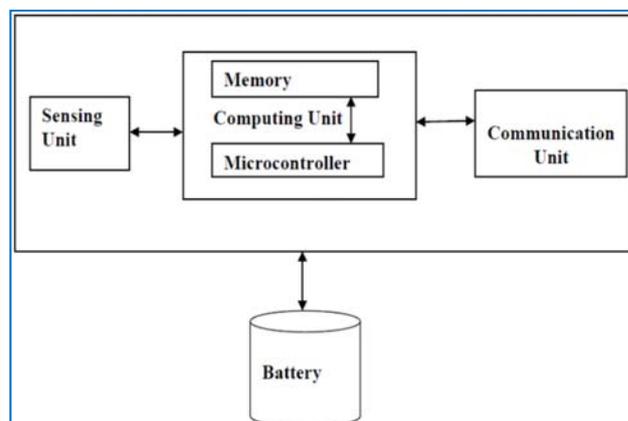

Fig. 1 Architecture of Wireless Sensor Node

The physical layer can be abstracted as a set of elementary capacity graphs. The network coding is used for multicast session [5]. The Fuzzy Enabled Device-to-Device Broadcasting Algorithm is used to transmit the packets from one device to another device [6]. Tree based Opportunistic Routing can be implemented in Mobile Ad hoc Networks to reduce the complexity [27]. Detection of Black Holes can be achieved in MANET Using Collaborative Watchdog with Fuzzy Logic methods [45].

The nonappearance of a packet at the decoder causes a decoding error, which translates into a quality drop that may propagate to subsequent frames. Joint source and channel coding is used to support the new H.264 video coding standard with increased throughput [30]. The joint optimization allows interaction and flexible resource allocation across the network protocol stack [7].The novel algorithm is used to provide loop free routes even while repairing broken links, because this protocol does not require global periodic routing advertisements. The Destination-Sequenced Distance Vector (DSDV) algorithm has been used as a modification of the distance vector routing technique by which wireless mobile

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nodes collaborate to shape an ad-hoc network [8]. Energy-aware Multipath Routing Particle Swarm Optimization algorithm is used to increase the Quality of Service in MANET [9]. The network layers aim at replacing in the classical open system interconnection (OSI) network stack. It may achieve extremely elevated performance in terms of the network performance related to every entity layers; they are not mutually optimized to exploit the overall network performance while minimizing the energy expenditure. The main drawback of this system is a lack of modularity and decreased robustness [58]. The deprived performances for the whole systems will depend on the lack of modularity and reduced robustness [10]. The packet radio network is totally asynchronous and based on completely distributed architecture. The synchronous time frame leads to efficient multimedia support implementation but introduces more complexity and less robustness [12]. A real-time connection is set up using a quick reservation technique. Namely, we imagine that real-time packets reach the specified destination at stable time periods. The first information packet in the multimedia rivulet makes the reservations along the destination. Once the first data packet is accepted on a link, a transmission skylight is reserved at suitable time periods for all the succeeding packets in the association [11].

Extremely Opportunistic Routing (EXOR) [13] is one of the principally in opportunistic routing protocols; it employs the Expected Transmission Count (ETX) as a parameter for intermediate node assortment. Simple Opportunistic Adaptive Routing Protocol (SOAR) [14] employs the ETX parameter for intermediate node assortment. Least-Cost Opportunistic Routing (LCOR) [16] is the other kind of opportunistic routing protocol that employs the Expected Any-Path Transmission (EAX) parameter for intermediate node assortment. In Opportunistic Any-Path Forwarding (OAPF) [17], secured cluster and sleep based energy-efficient sensory data collection with mobile sinks [15], enhanced cluster based key management techniques [18] are used for security related issues in mobile networks, and nodes are educated to pick a preliminary record of candidates with the ETX parameter. Minimum Transmission Selection [19] algorithm generates a specified opportunistic routing protocol using the EAX as a parameter for intermediate node assortment. In contention-based forwarding algorithm [20], the clustering formation can be done using dominant set and trust evaluation methodology [21]. The source node instigates the routing progression by establishing its own special data for delivering data packet. Position based opportunistic routing [22] selects the realizable detachment development during every intermediate node to the destination. Intermediate Node based Routing can be used in the parameters of distance based opportunistic routing [23] and Intermediate node assortment [39]. Additionally, [25], [26] proposed a trust-based methodology for sending data packets from source to their destination in a more consistent approach. For the improved data transmission, the Trust Management approaches can be implemented in several wireless networks [28, [29], [32]. Trust models can be implemented in wireless networks to maintain the Quality of Service [34]-[37], [38]. Conversely, [40] introduced a trust computation methodology for opportunistic using Positive Feedback Messages (PFM). Likewise, [41] and [43] proposed cryptographic methods that detected and isolated black hole attacks in the network nodes in opportunistic routing based networks. Moreover, as assured in [44] and [46], opportunistic routing protocols do better than established routing protocols while it comes to network performance by means of Quality of Service. The methods proposed in [47] and [49] have been used in exceptionally receptive situations such as military related real-time applications for reducing energy consumption and detecting explosions [57] in the area of security awareness in sensor networks. Distributed Self-Healing Protocol is used to transmit data packets in unattended wireless sensor network [51]. Underwater sensor networks are a talented part of wireless sensor networks with the reason of discovering and scrutinizing the world underneath the water's exterior models [52]. Reference [53] indicated that opportunistic routing protocols can be suitable solutions for addressing the capriciousness of such networks. An Encryption Scheme for User-Data Security in Public Networks [54] method has been proposed for User Data based Security problems, Securing Inimitable and Plundering Track for Ad Hoc Network [60] has been implemented for cryptographic issues. As cited in [55] and [56], wireless sensor networks (WSNs) and Internet of Things (IoT) have been used in several real-time scenarios. Opportunistic routing will be implemented in several number of re-broadcast for scheduling algorithm [59]. Security has been maintained by using the opportunistic routing based Secured MAS approach [39] with fuzzy based routing [48]. Clustering can be done using Tree Based Data Fusion Algorithm in WSN [24].

II. PROPOSED SCHEME

A. Channel Reservation

Here, the channel is reserved based on their ID. Each node ID is identified while forwarding the packets since those packets encompasses their network node ID. Every frame is a collection of N time slots from slot 0 to slot N - 1. The channel reservation schemes must be carefully designed to provide better QoS guarantee to the mobile users. The reservation is based on ID. Fig. 2 illustrates the data transmission in upstream mode, Fig. 3 illustrates the data transmission in downstream mode and Fig. 4 illustrates the data transmission using bandwidth allocation.

Every single one of the node can access the channel in time ordered sequence. A node x is relaying data packet from source to the destination for transmission.

B. Channel Reservation

The information needed to verify these conditions are stored in following method.
o   Neighbor Lists.
o   Ongoing Reservation Lists.
o   Reserved Slot List.

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If a free slot $slot_c$ is identified, then a node with identifier Id^x transmits a Reservation Request packet to its neighbors and waits for N seconds to collect the replies.

If all the nodes send a reply that Reservation is granted, then the packet is granting the reservation. Then node x considers the slot $slot_c$ as reserved by itself and moves that slot from its list of ongoing reservations to list of reserved slots. Otherwise, node x selects the next free slot in the interval and transmits a new reservation request. This procedure is repeated until a time slot is successfully reserved or all the free slots are allocated. In latter case, nodes wait for mesh announcement period and retry the reservation. Fig. 5 demonstrates the dynamic data transmission using bandwidth allocation.

III. Scheduling Algorithm

Procedure Find_Channel (node, destination, Cost)
    $cost_{node}$:=$Exp\_Tran\_Cnt_{node,destination}$
    $Cost\_Source_{node,destination}$:= Empty ;
    while $(|Cost\_Source_{node,destination}|$ <   Cost)   &&
    (shortest_Path(node, destination)) do
        Optimal_path : = shortest_Path(node, destination)
        Channel :=Find_Neighbour(node, Optimal_path)
    if (Channel := destination) then
          merge(Cost_Source_{node,destination}, destination)
          cost(destination) :=0
     else
     cost(Channel): = $Exp\_Tran\_Cnt_{Channel,destination}$
     if cost(Channel) < cost(node) then
    merge (Min_Cost_Source_{node,destination}, Channel)
     end if
     end if
    Remove_Edge(node, Channel);
    Sort_By_Distance_Progress(Cost_Source_{node,destination},   node, destination)
    neighbours :=Find_Neighbor(node)
    Eligible_Neighbors := Empty;
    for everyneighbor in neighbors do
     if $distance_{neighbor,destination}$<$distance_{node,destination}$ then
    merge (Available_Neighbors, neighbor)
    end if
    end for
      Sort_By_Distance(Eligible_Neighbors)
    Channel := find_Best_Possible_Neighbor(node)
        Optimal_path : = shortest_Path(node, destination)
        Channel := Find_Neighbour(node, Optimal_path)
  End Procedure

Procedure Req_REQ_discovery_phase(Source, Destination)
  If (route_table_seqno < req_src_seqno) then
    route_table_seqno = req_src_seqno
    Acknowledged_hops = ∞
    delete_table(Source)
    insert_reversepath(Source)
  else if(route_table_seqno = rq_src_seq_no) **and** (Acknowledged
_hops > rq_hop_count) **then**
    update_reversepath(Source)
  end if
  if (Active_Path(i, S) = UP) **then**

    if (data_shielded(S)) **then**
      send_information(S)
    end if
  end if
  if (corrected_destination) **then**
    dest_seq_num + = 1
    if (established = 0) **then**
      Num_of_established = 0
      established = 1
      send_Res_RREQ(S)
    end if
  else
    update_Res_REQ(D)
    forward_Res_REQ(D)
  end if

If (route_table_seqno < rrq_dest_seqno) **then**
  route_table_seqno = rrq_dest_seqno
  Acknowledged_hops = ∞
  delete_table(Destination)
  insert_forwardpath(Destination)
else if (route_table_seqno = rrq_dest_seqno) and (Acknowledged
_hops > r_rq_hopcount) **then**
  update_ forward _path(S)
    merge(Min_Cost_Source_{node,destination}, destination)
    min_cost(destination) :=0
      Optimal_path : = shortest_Path(node, destination)
      Channel :=Find_Neighbour(node, Optimal_path)
End if
if (Active_Path (i, Destination) = UP) **then**
  if (information_buffered(Destination)) **then**
    information_send (Destination)
  end if
end if
if (i! = Source) **then**
  update_Res_REQ(Source)
  forward_Res_REQ(Source)
      Optimal_path : = shortest_Path(node, destination)
      Channel :=Find_Neighbour(node, Optimal_path)
end if

Initialize_packet(Destination,Source)
If (information_received = 1) **then**
  information_received = 0
  start_waiting_timer_val()
else If (NumofCONFIRM < threshold) **then**
  Num_of_validate + = 1
  information_received = 1
  send_Res_RREQ(S)
  start_waitingtimer()
end if
If (packet_type = Information and destination) **then**
  data_received = 1
  Num_of_Established = 0
  Established = 0;
    Optimal_active_path : = shortest_Path(node, destination)
    Channel := Find_Neighbour (node, Optimal_path)
End if
End Procedure

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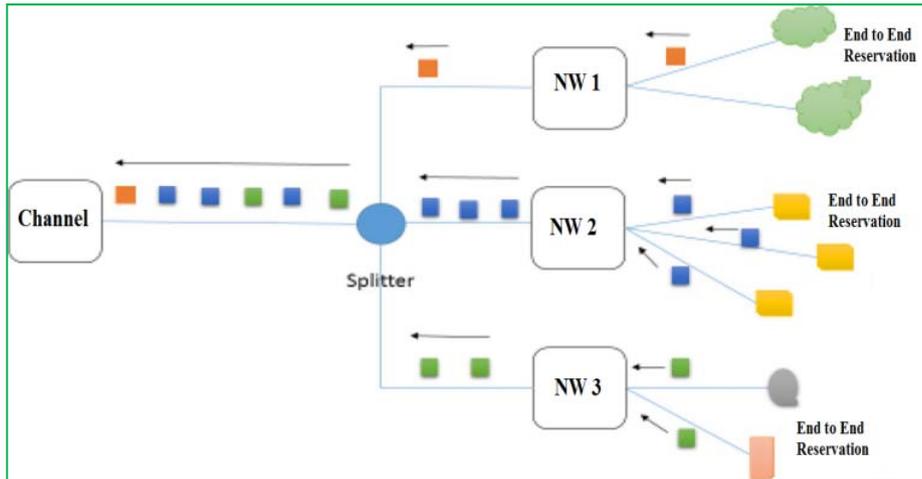Vol:10, No:8, 2016

Fig. 2 Data Transmission in Upstream Mode
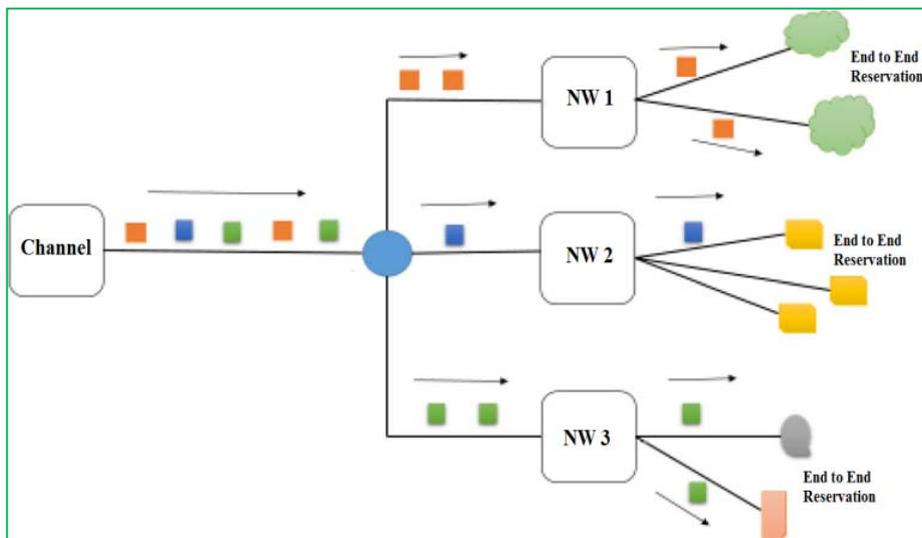
Fig. 3 Data Transmission in Downstream Mode
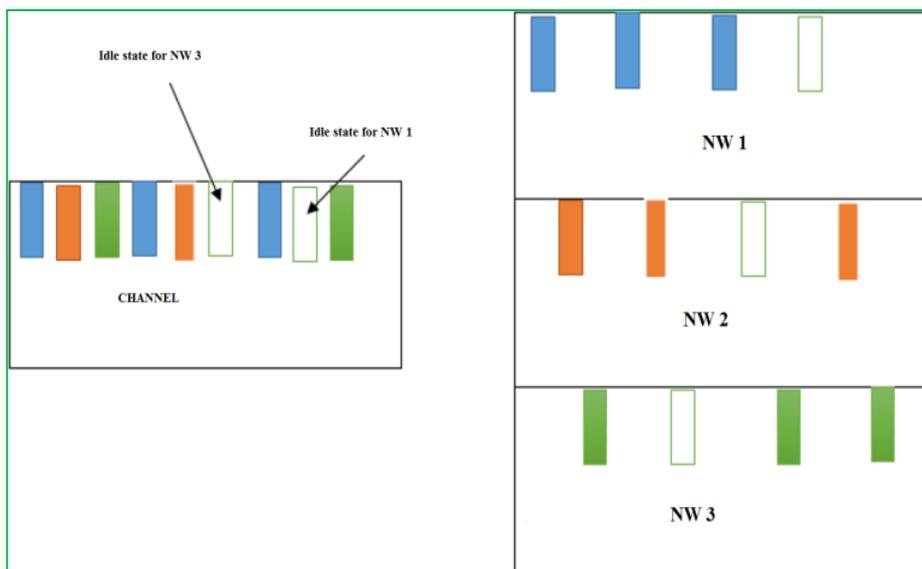
Fig. 4 Static Data Transmission using Bandwidth Allocation
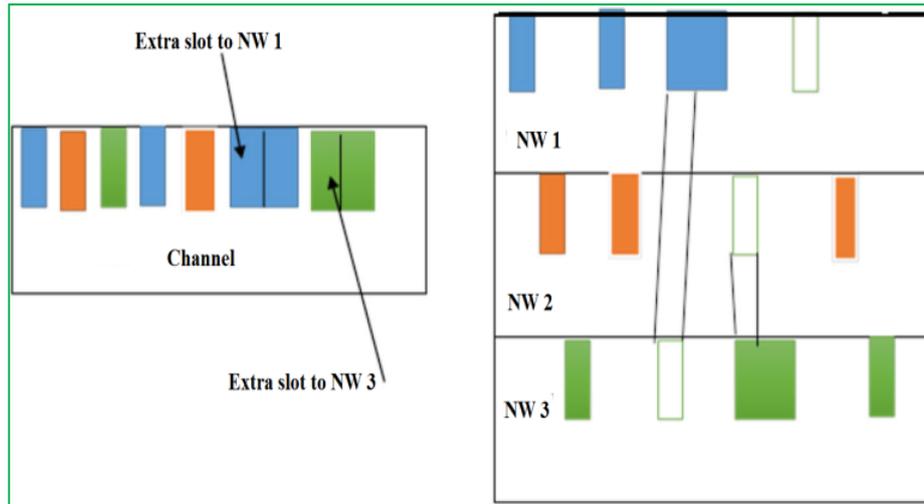
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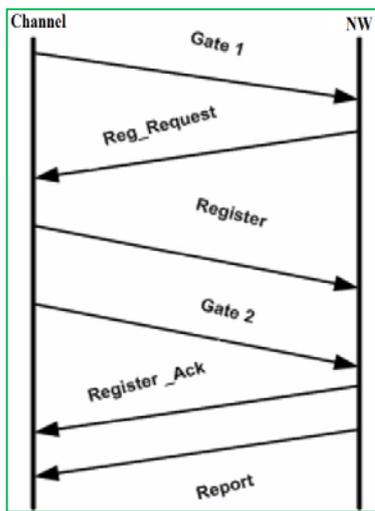Fig. 5 Dynamic Data Transmission using Bandwidth Allocation

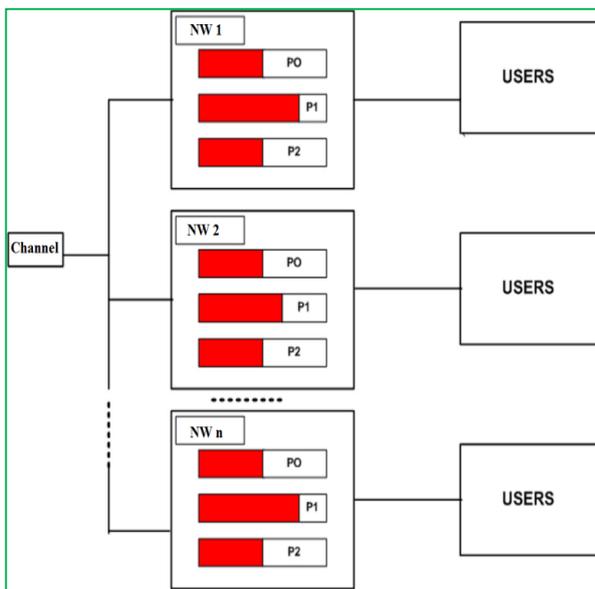Fig. 6 Register Request format

Fig. 7 Scheduling Process

IV. BANDWIDTH AND DELAY AWARE ROUTING PROTOCOL
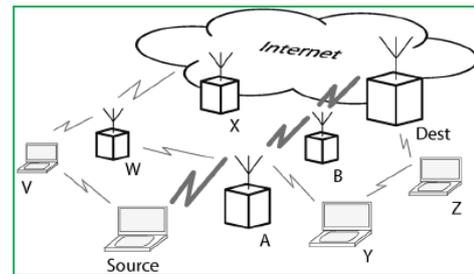
A. Network Model

Fig. 8 Network Model

Data_Flow_Matrix can be calculated as

$$DFM_{n \, x \, n+1} = \begin{bmatrix} DT_{10} & \cdots & DT_{1n} \\ \vdots & DT_{ij} & \vdots \\ DT_{n0} & \cdots & DT_{nn} \end{bmatrix} \quad (1)$$

DT_{ij} Denotes the total amount of data transmission from the node i to node j. The network model is illustrated in Fig. 8.

The Main node computes a sequence of queuing model based on the Data_Flow_Matrix $DFM_{n \, x \, n+1}$.

"x" is feasible distance to the core of D ($f\_d \, {}_D^x$) is a non increasing function over time that can only be reset by a change of core or by a new sequence number. Feasible distances are used to select a feasible set of next hops.

$$f\_d \, {}_D^x = \min \{ f\_d \, {}_D^A, f\_d \, {}_D^B \} \quad (2)$$

The sequence number stored at node x for the core of destination D ($c\_d \, {}_D^x$) is a strictly increasing function overtime that can only be reset by a change of core

$$c\_d \, {}_D^x = \max \{ c\_d \, {}_D^A, c\_d \, {}_D^B \} \quad (3)$$

A node transmits MAs to inform other nodes about updates

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in its routing state. These updates can be originated by such time period occurrences as a transform in the group association status (a node joining or leaving a multicast group) that modify the value of $m\_m \ _D^x$, or the generation of a new sequence number in the case of the core; or by an external event such as the reception of a neighbor B. Therefore, whenever the core of a destination generates a new MA with a superior sequence quantity, the concluding is distributed beside the enclave advertising the new sequence number and establishing next hop pointers toward the core. The mesh composed of these next hop pointers from a source to the core is called the routing mesh of that source.

The priority function $priority_{xy}$ of $link_{xy}$ as

$$priority_{xy} = \frac{DT_{xy} + DT_{yx}}{|DT_{xy} - DT_{yx}|} \qquad (4)$$

A Queue Link Q_L is defined to trace n+1 pairs of the links from the source to the destination links in the network. $Q\_L_1, Q\_L_2, Q\_L_3, \ldots, Q\_L_q, \ldots, Q\_L_n$ can be combined into a sequence queue as

$$\begin{pmatrix} Q_{L_1} \\ Q_{L_2} \\ Q_{L_3} \\ \ldots \\ Q_{L_q} \\ Q_{L_{q+1}} \\ \ldots \\ Q_{L_n} \end{pmatrix} \qquad (5)$$

The queuing scheduling segment establishes the suitable broadcast instructs which stores in a queuing succession. This queuing succession is used in the complex time-slot task segment to allocate appropriate time-slots for every broadcast. In the complex time-slot task segment, there are two situations happened, collision-free and collision detection.

In the collision-free situation, the complex time-slot task segment allocates appropriate time-slots to every $broadcast_{xy}$ according to the queue sequence order. Q_L_q routes before Q_L_{q+1} in queue sequence. Each Q_L_q begins to route at time slot 2k, and $q \le k \le n$.

A group of same type of packet distribution $P_{D_{xy}} = \{P_{D_{xy_0}}, P_{D_{xy_1}}, P_{D_{xy_2}}, \ldots\ldots, P_{D_{xy_s}}, \ldots\ldots\ldots, P_{D_{xy_p}}\}$ is usedto store p+1 packet type distribution from $node_x$ broadcasting to node y, where $P_{D_{xy}}$ s denotes the sth broadcast packet type form x to y and $0 \le s \le p$.

A time-slot $W_{S_{xy}}$, which is defined as the x's wake up time-slot between $link_{xy}$. A set of time-slot offset $S_{O_{xy}} = \{S_{O_{xy_0}}, S_{O_{xy_1}}, S_{O_{xy_2}}, \ldots\ldots, S_{O_{xy_s}}, \ldots\ldots\ldots, S_{O_{xy_p}}\}$ is definedto store q+1 time-slot equalizes from $node_x$ broadcasting to node y, and $0 \le t \le q$. The$S_{O_{xy}}$ t denotes the tth time-slot offset broadcast from x to y. $S_{O_{xy}}$ is gathered form $P_{D_{xy}}$ and $P_{D_{yx}}$, which is used to expect the engaged time-$slot_{offset}$ by $link_{xy}$. For using advance time-slot leasing, master declares every slave $W_{S_{xy}}$ and $S_{O_{xy}}$. Slaves wake up at allocated period $W_{S_{xy}}$

and observe the group of time-slot offset $S_{O_{xy}}$ to broadcast data.

$$S_{O_{yx_t}} = S_{O_{xy_t}} + P_{D_{xy_s}} \qquad (6)$$

$$S_{O_{xy_{t+1}}} = S_{O_{yx_t}} + P_{D_{yx_s}} \qquad (7)$$

$$W_{S_{yx}} = W_{S_{xy}} + P_{D_{xy_1}} \qquad (8)$$

for the period of generating $S_{O_{xy}}$, if master runs out of the $P_{D_{xy}}$ set, $P_{D_{xy_{p+t}}}$ sets to 1 for Acknowledgment reacting.

In the collision detection situation, some occupied time-slots have been allocated over to broadcast probably. Before broadcast, master should notice this situation first. A group of used time-slot $U\_S = \{U\_S_0, U\_S_1, \ldots, U\_S_k\}$ is defined to store k + 1 used time-slots. Master sums$W_{S_{xy}} + S_{O_{xy}}$ into U_S after allocated time-slots for x. If master assigns time-slots including in U_S to slaves, time-slot collision will occur in the network. Master creates the following formula to verifythe collision position.

$$(W_{S_{xy}} + S_{O_{xy}}) \cap U_S \ne \{\emptyset\} \qquad (9)$$

Algorithm
INPUT: L_i; {m_x}
 OUTPUT: Q_L (query list); S_i (demandpossibility)
for everylatest query, Q_L_i(d_j) **do**
 Use m_x to determine S_i*;
 $S_i = 1 - (1 - S_i)(1 - S_i*)$;
 Q_L = Q_L∪d_j;
 Forward(S_i);
end for
for each server transmit time, L_i**do**
if Q_L = ∅**then**
Ensure the key list, I_i;
 Download the requireddata_item(S_i);
end if
if Q _L = ∅**then**
if auncertainty has missed two servertransmit**then**
$S_i = 1$;
end if
Forward(S_i);
end if
end for
 Function transmit(S_i)
if random<S_i **then**
Forward a demand;
 Q_L = ∅; $S_i = 0$;
End if

Fig. 9 demonstrates the scheduling process, Fig. 10 illustrates the broadcast traffic and send request and Fig. 11 demonstrates the Block Slot.

The reservation path might break during the real-time transmission if the network topology changes. Such changes might occur if nodes switch off or fail or if the channel conditions change. Evidently, the path breaks must be repaired initially, and then only the real-time transmission will continue

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the process. To initiate a path repair, the node preceding the "hole" in the path must notice the broken link.
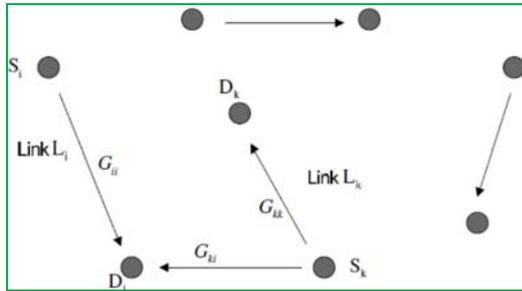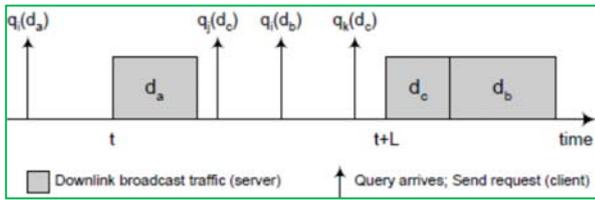

Fig. 9 Scheduling Process

Fig. 10 Broadcast Traffic and send request

Fig. 12 gives an example: Node B switches off and node A detects its link failure to node B. The subsequent path repair is done in two steps: Route repair and reservation repair. First, the MAC layer indicates the link break to the network layer. As in standard DCF, this event triggers the routing protocol to update the route. After the routing protocol has repaired the route between source and destination, the protocol repairs the
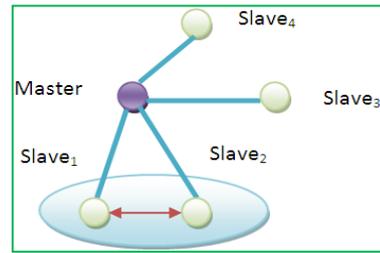
reservation at the MAC layer.
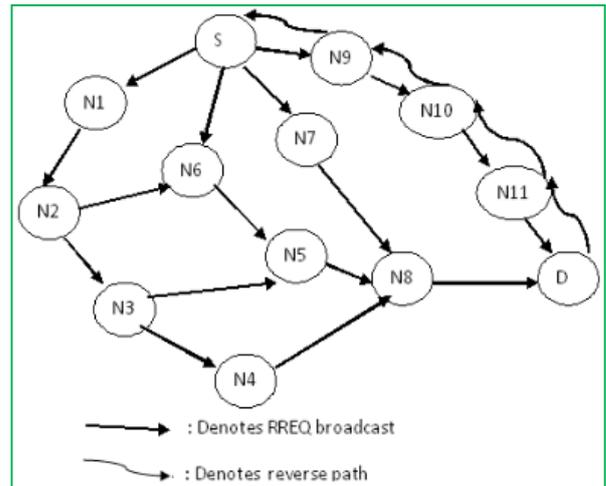

Fig. 11 Block slot

Fig. 12 Link Failure Example

Fig. 13 Energy Consumed

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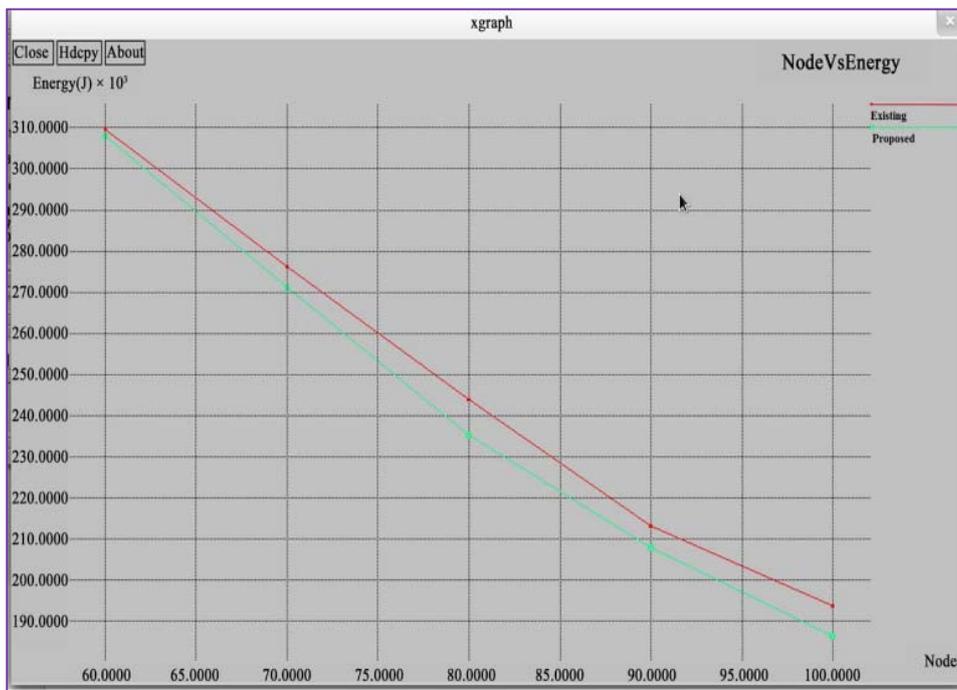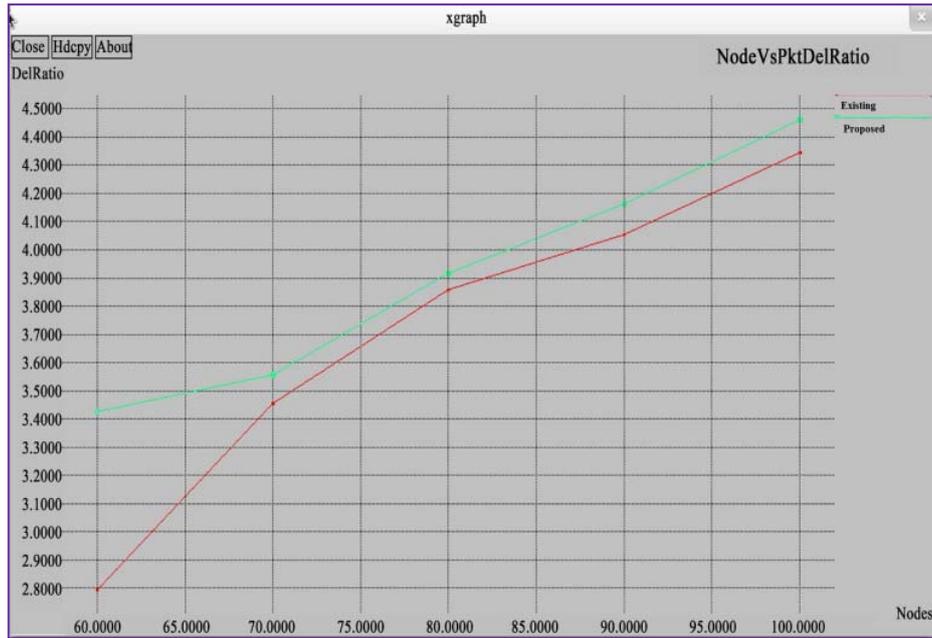International Journal of Computer and Information Engineering
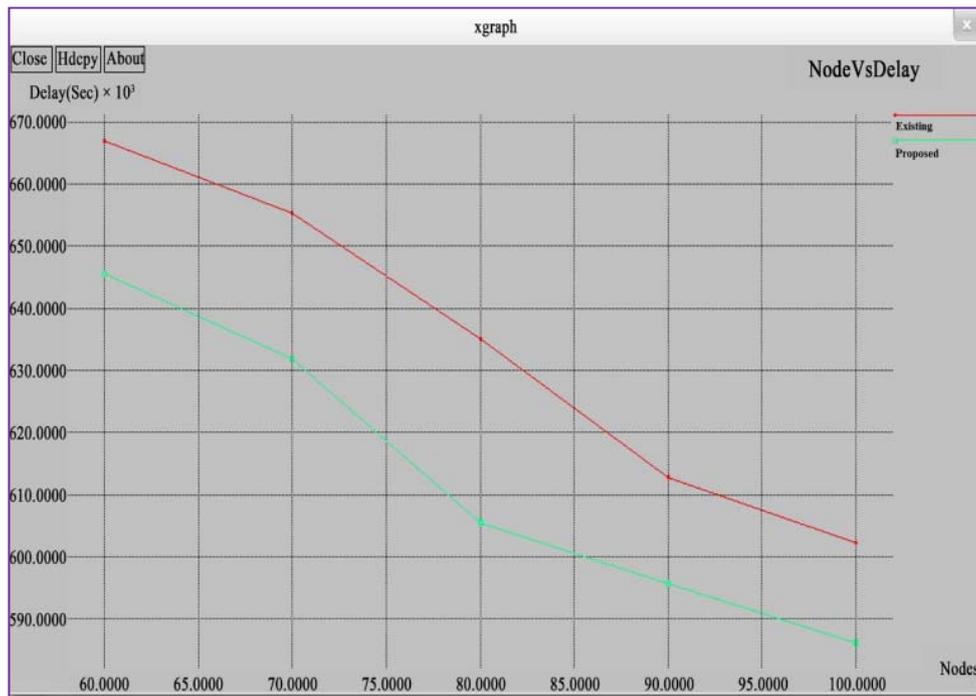Vol:10, No:8, 2016

Fig. 14 Packet Delivery Ratio

Fig. 15 Delay

V. PERFORMANCE EVALUATION

This paper presents a Bandwidth and Delay Aware Routing Protocol with Scheduling Algorithm for link failure. Both theoretical and simulation results are given to exhibit the efficiency of the proposed scheme. Fig. 13 demonstrates the Energy Consumed by the proposed method, Fig. 14 illustrates the Packet Delivery Ratio for the proposed method and Fig. 15 denotes the Delay for the presented method.

VI. CONCLUSION

This paper presents a link metric based routing scheme for link failure. In multicast routing if any node fails to receive three consecutive acknowledgements from the neighbor then move that node from the neighborhood list and finding the next best-hop to reach their appropriate destination. Both theoretical and simulation results are given to demonstrate the effectiveness of the presented scheme.

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