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Efficient Scheduling Policy for Delay Tolerant Network Using Store Carry Forward Protocols

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ABSTRACT: In order to achieve data delivery in Delay Tolerant Networks (DTN), researchers have proposed the use of store-carry- and-forward protocols that is a node may store a message in its buffer and carry it along for long periods of time, until an appropriate forwarding opportunity arises. The combination of long-term storage and message replication imposes a high storage and bandwidth overhead. Thus, efficient scheduling and drop policies are necessary to decide on which messages should be discarded when node buffers operate close to their capacity.

KEYWORDS: DTN, AODV, Optimal Scheduling.

I. INTRODUCTION

A wireless ad-hoc network is a decentralized type of wireless network. An ad hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. In such an environment, it may be necessary for one mobile host to enlist the aid of other hosts in forwarding a packet to its destination, due to the limited range of each mobile host's wireless transmissions. Delay-Tolerant Networks (DTN) have introduced new security issues emerging from high communication delays, as well as from decentralized design.

II. RELATED WORKS

Delay Tolerant Networks are wireless networks where disconnections may occur frequently due to propagation phenomena, node mobility and power outages. Propagation delays may also be long due to the operational environment (e.g. deep space, underwater). In order to achieve data delivery in such challenging networking environments, researchers have proposed the use of store-carry-and-forward protocols: there, a node may store a message in its buffer and carry it along for long periods of time, until an appropriate forwarding opportunity arises. Additionally, multiple message replicas are often propagated to increase delivery probability. This combination of long-term storage and replication imposes a high storage overhead on untethered nodes (e.g. handhelds).Their simulations were based on synthetic model and real world mobility traces. They are based on the Random Waypoint model, ZebraNet wildlife tracking experiment and San Francisco's Yellow Cab Taxi Trace.

In [5], Zhang et al. present an analysis of buffer constrained Epidemic routing, and evaluate some simple drop policies. The authors conclude that drop-front and a variant of it giving priority to source messages, outperform drop-tail in the DTN context. A somewhat more extensive set of combinations of heuristic buffer management policies and routing protocols for DTNs is evaluated in [4], confirming the performance of drop-front. In [6], Do- hyung et al. present a drop policy which discards a message with the largest expected number of copies first to minimize the impact of message drop. However, all these policies are heuristic, i.e. not explicitly designed for optimality in the DTN context. Also, these works do not address scheduling. In a different work [7], we address the problem of optimal drop policy

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only (i.e. no bandwidth or scheduling concerns) using a similar analytical framework, and have compared it extensively against the Simple Scheduling Policy.

III.PROPOSED SYSTEM

In this paper, we propose an efficient joint scheduling and drop policy that can optimize different performance metrics. We first introduce a congestion based scenario that estimates and divides the buffer size of the nodes. Based on this, we derive a distributed scheduling and drop policy that can approximate the performance of the optimal policy in practice. Using simulations based on synthetic traces, we show that our optimal scheduling and drop policy outperforms the existing Scheduling scheme i.e., First-In-First-Out scheme for DTNs. Also we add an enhancement to the AODV routing by allowing it to search the best path based on buffer size of the intermediate nodes[8]. Finally, we examine the drop count under different scheduling regimes and prove the optimality of the proposed Joint Scheduling and Drop Policy.
An optimal scheduling and drop policy algorithm for Delay Tolerant Networks has been proposed which maximizes packet delivery rate and minimize delay. Delay Tolerant Networks are those which uses “store-carry-and-forward” protocol. When no forwarding opportunity is available, instead of dropping the respective packets, nodes store and carry messages until new communication opportunities arise.

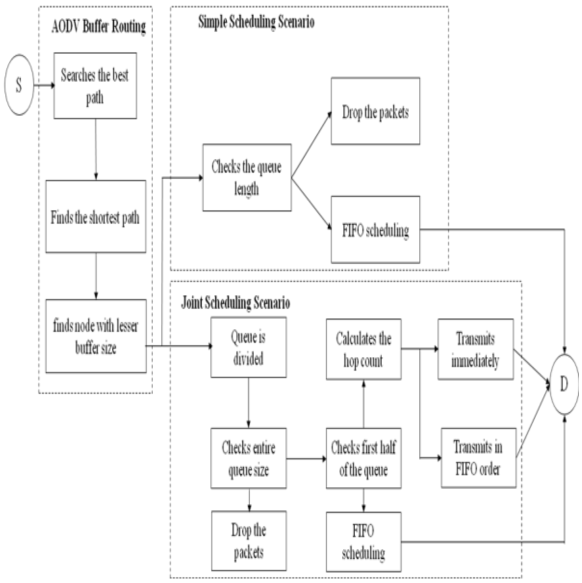

Fig 1.Proposed Architecture

The system architecture Fig.1. consists of the flow from source node and destination node, the blocks of AODV Buffer Routing, Simple scheduling scenario and Joint Scheduling Scenario. In the above system architecture fig 1 'S' refers to the source node and 'D' refers to the destination node.

A. *AODV Buffer Routing*

The AODV Routing protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. The major difference between AODV and Dynamic Source Routing (DSR) stems out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed.

However, in AODV, the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the RouteRequest

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packet in the network when a route is not available for the desired destination[9]. It may obtain multiple routes to different destinations from a single RouteRequest. The major difference between AODV and other on-demand routing protocols is that it uses a destination sequence number (DestSeqNum) to determine an up-to-date path to the destination. A node updates its path information only if the DestSeqNum of the current packet received is greater or equal than the last DestSeqNum stored at the node with smaller hop count.

A RouteRequest carries the source identifier (SrcID), the destination identifier (DestID), the source sequence number (SrcSeqNum), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the time to live (TTL) field. DestSeqNum indicates the freshness of the route that is accepted by the source[10]. When an intermediate node receives a RouteRequest, it either forwards it or prepares a RouteReply if it has a valid route to the destination. The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the RouteRequest packet[11]. If a RouteRequest is received multiple times, which is indicated by the BcastID-SrcID pair, the duplicate copies are discarded. All intermediate nodes having valid routes to the destination, or the destination node itself, are allowed to send RouteReply packets to the source. Every intermediate node, while forwarding a RouteRequest, enters the previous node address and its BcastID.

A timer is used to delete this entry in case a RouteReply is not received before the timer expires. This helps in storing an active path at the intermediate node as AODV does not employ source routing of data packets[12]. When a node receives a RouteReply packet, information about the previous node from which the packet was received is also stored in order to forward the data packet to this next node as the next hop toward the destination.

Pseudo code for AODV Buffer Routing:

```
Sends Request
if(new request)
                    {
//searches for the best path
if(shortest path && less buffer size)
                    {
                              selects the path;
                    }
          sends back the response;
                    }
```

B.Simple Scheduling Scenario

In Simple Scheduling Scenario, the nodes transmit their packets to their destinations in which the FIFO scheduling fig 2 is used. The message which enters the node's buffer first will leave the buffer first. Drop count is calculated. The term qlim denotes the length of the queue.

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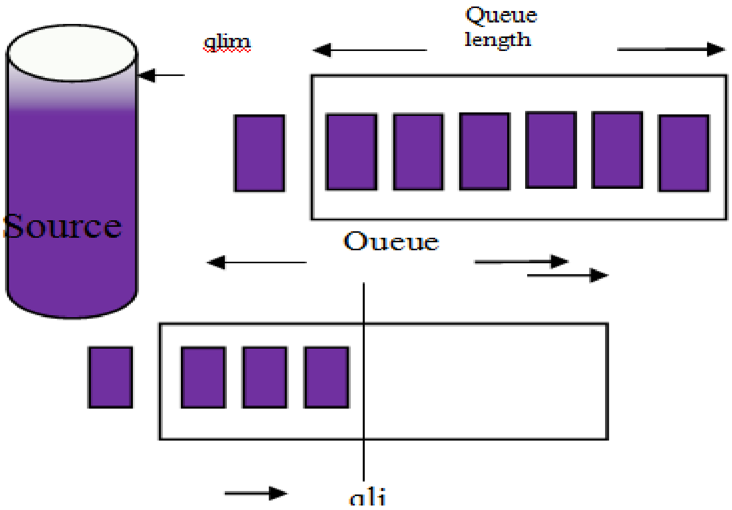

Fig 2. Scheduling based on FIFO

CJoint Scheduling Scenario

In Joint Scheduling Scenario, queue is logically divided into two and is denoted by qlim/2. In the first half of the queue, packets are enqueued based on First in First out Scheduling fig 3.5[13]. Once the first half of the queue is full, the hop count of the arriving packets is identified first half of the queue

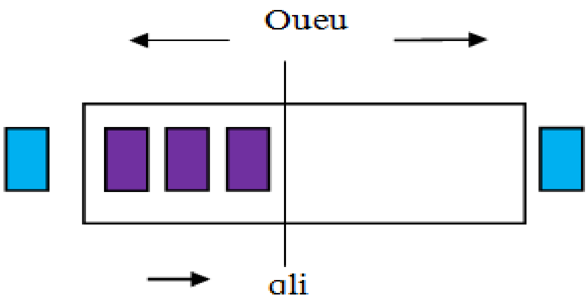

Fig 3. Forwarding packets in FIFO order

If the hop count of the arriving packet is less than two, then the packet is enqueued normally fig 6. Otherwise if the hop count of the arrivng packet is greater than two, then the packet is transmitted immediately fig 7. Thus Joint Scheduling has FIFO in the first half of the queue and Priority Scheduling in the second half of the queue.

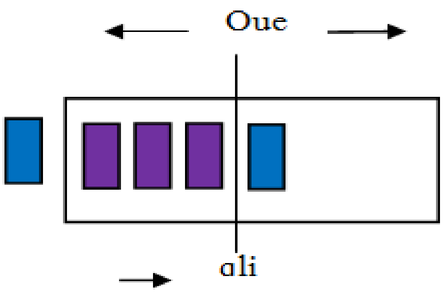

Fig 4. Forwarding Packets with 2 or more hop counts in the second half of the queue

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IV. RESULTS AND IMPLEMENTATION

The source nodes searches for the best path using AODV Buffer Routing. In AODV Buffer Routing, the optimal path is chosen based on the shortest path and the buffer size of the intermediate nodes.

Transmission of Packets from Source to Sink :

After routing, source nodes transmit the packets to the destination node through the optimal path.

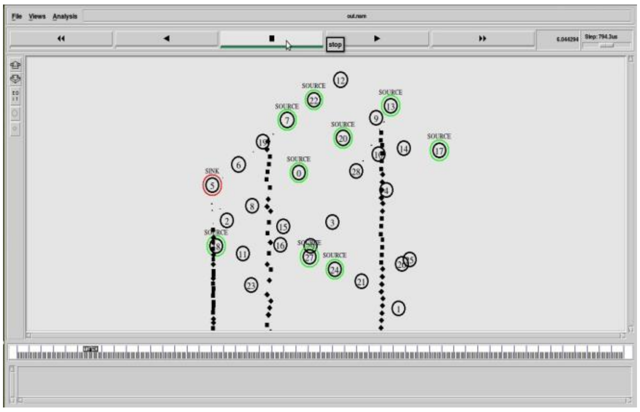

Fig 6. Transmission of Packets from Source to Sink

During packet transmission through intermediate nodes, some new packets may be dropped due to unavailability of space in the buffer.

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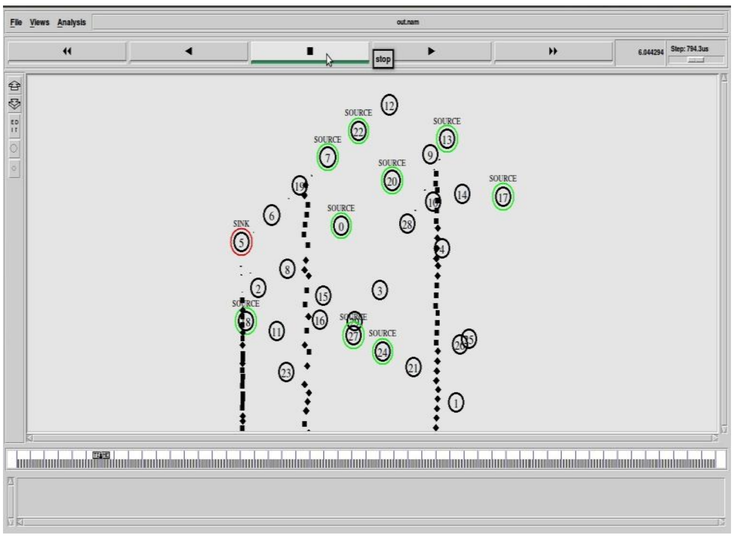

Fig 7. Dropping of Packets during transmission

Finally, at the end of the simulation time, packets will be dropped by the destination node

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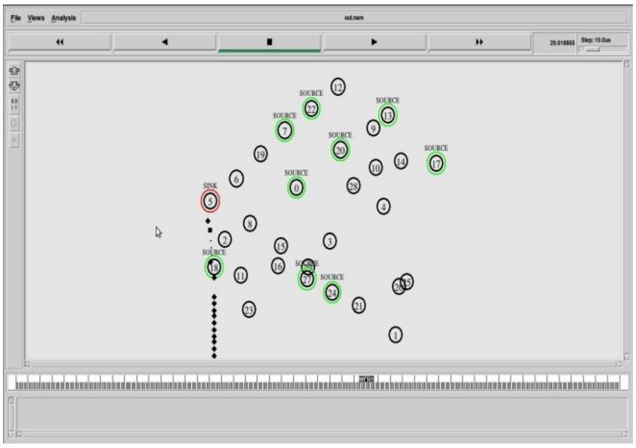

Fig 8. Dropping of Packets at the end of the transmission

The trace files for basic communication, existing scheme and proposed schemes are shown below. Trace file consists of event type(t), receive(r), send(s), forward(f), drop(d), timestamp of the event. Packet types are AGT and RTR. AGT refers to data packets and RTR refers to control packets or router packets.

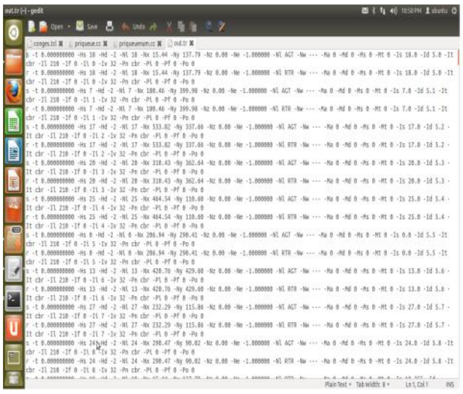

Fig 9. Trace file for Simple Scheduling

The following graph depicts the comparison of Drop counts maintaining the sending rate as constant. The number of nodes are plotted in the x axis and the drop counts are plotted in the y axis. The values are tabulated in Table 1.

Number of Nodes	Simple Scheduling	Joint Scheduling
30	27414	26446
40	29265	29157
50	19844	17543
60	31157	27532

TABLE 1 Number of Nodes - Simple Scheduling Vs Joint Scheduling

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Sending Rate	Simple Scheduling	Joint Scheduling
0.25 Mb	4698	3458
0.50 Mb	10356	10283
0.75 Mb	19000	18912
1.00 Mb	27414	26446

TABLE 2 Sending Rate - Simple Scheduling Vs Joint Scheduling

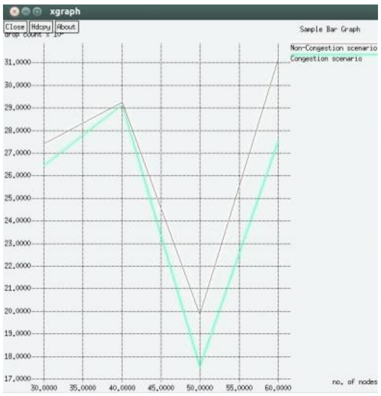

Fig 10. Number of Nodes - Simple Scheduling Vs Joint Scheduling

This graph, fig 14, depicts the comparison of Drop counts maintaining the number of nodes as constant. The sending rates are plotted in the x axis and the drop counts are plotted in the y axis. The values are tabulated in Table 2.

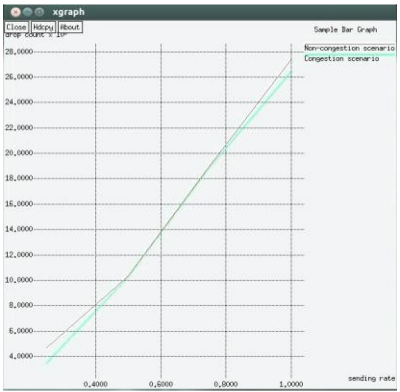

Fig11. Sending Rate - Simple Scheduling Vs Joint Scheduling

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