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Congestion Controlled d-Adapt-OR for Adhoc Networks

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***Abstract*:** *Opportunistic routing scheme is used to route data packet from source to destination. Broadcasting nature of the wireless networks is utilized here to send data packets. A suitable forwarder node is selected from the neighboring node based on the rank ordering of the nodes. The nodes are ranked according to a score called Estimated Best Score (EBS). This score is calculated by considering the network congestion which is one of the major problems in adhoc networks. Probability of unsuccessful delivery of the packet become very less. Different types of packets are used to communicate between different nodes. A distributed and asynchronous routing scheme is introduced to route the packet. The proposed routing scheme doesn't require any initial knowledge about the network topology. Another problem with adhoc wireless networks is the presence of selfish nodes. For the successful delivery of the packet at the destination we have to avoid the presence of selfish nodes in the networks. So each node calculate the selfishness of its neighboring nodes. The data packet is forwarded by considering the selfishness of the node.*
Keywords: *opportunistic routing,wireless adhoc networks.*

I. Introduction

Wireless adhoc networks are decentralized type of networks. A node in wireless adhoc networks communicate with the node which is in the range of the node. Wireless adhoc networks are considered in this work. Routing in adhoc networks is very important in order to communicate with the node which is not directly reachable. Different conventional routing scheme is now used to direct packet from source to destination. But most of them is not deal with the network congestion. They always result in unnecessary packet retransmission. Conventional routing scheme always find a fixed path along source to destination. So it always requires maintaining the knowledge about the network topology and statistics to find a path.

Here a routing scheme called opportunistic routing is used. Opportunistic routing scheme doesn't require any previous knowledge about the networks and statistics. It dynamically route the packet from source to destination without any initial knowledge about the networks. This routing scheme exploits the broadcast nature and the opportunities available in the networks. It selects a node from its neighbors as next relay node based on some conditions. According to these conditions order the neighboring nodes and select one node as the relay node. And this process continues until it reaches the destination. The selection of next relay node may based on some geographical location or shortest path etc.

Here proposed a routing framework called d-Adapt-OR that is distributed adaptive, asynchronous opportunistic routing scheme to route the packet. This routing scheme has low complexity and low overhead. While routing the routing scheme considered the congestion in the network and finds a path with less congestion. And it assumes no knowledge about network topology.

One of the major problems in wireless adhoc networks is the presence of selfish nodes. A node is said to be selfish if it doesn't provides its own resources to forward others packet. But it takes the advantage of other node's resources and memory to forward its own packets. The nodes that drop the packet without forwarding it is a selfish node. A node may selfish even if it doing some other tasks at the packet arrival time. So the presence of selfish nodes reduces the packet success probability and deteriorates the performance of the network. So we have to avoid this type of nodes from the networks for improving the probability of successful delivery of the packet.

II. Related works

A large number of routing methods are available for routing packet from source to destination. Traditional routing protocols like table driven and on demand routing protocols are there[2]. The table driven routing protocols maintains a table at each node which gives the topology information of the networks. An up-to-date view of the network topology is available at each node every time. Whenever a table changes its content it sends an update message to all other nodes in order to update its own table based on the update message. So the network topology information is needed to maintain at every node. It utilizes a large amount memory. And the update message may flood on the network which causes network congestion. Versions of table driven routing protocols are RIP, OSPF etc[9].

Another traditional routing protocol is on-demand routing schemes. In this routing scheme the table is updated whenever a new packet arrives. It maintains old routing information as long as the path to destination is available. And it starts to find new path when the existing path fails. So it keeps the old path even if other better paths are available. These protocols are cost effective but these routing protocols not found to be optimal. TORA, DSR, AODV, ZRP etc are different versions of on-demand routing protocols[9].

Opportunistic routing is a routing scheme provided for wireless networks. It doesn't maintain the topology information in updated table at every node. It uses the broadcast nature of the network. Select a neighboring node as next relay node based on the rank ordering of the nodes. That is it opportunistically selects the next relay node without initial knowledge of the network. It maintains only local topology information. Different versions of opportunistic routing schemes are SDF, GeRaF [19] and EXOR [3].EXOR is a protocol which always tries to minimize the expected number of transmissions. In Geographical random forwarding routing is based on the smallest geographical distance from the destination.

III. System Model

In the proposed work a considering a problem of routing packet from source to destination in a wireless adhoc networks. Here considering a number of nodes which consist of source and destination. So here want to find a path from source to destination. If the destination is not direct neighbor of the source then the path consist of number of nodes from source to destination. The time is slotted from 0 to n. The transmission of a packet is in any of the time slots.

There is a transmission cost for each node for packet transmission. This cost indicates the hop count to reach the destination. Here assumes no duplicate copies of the packet and each node is responsible for the packet transmission at any time. The number of neighboring nodes of a particular node is considered as a set. If node i transmit a packet then the number of nodes that is directly in the range of node i will receive the packet if there is no congestion in the network. This set of nodes is set S. Then the node I takes the next routing decision, that is select a node from these set S as next relay node. The node selected by node i will relay the packet all other nodes in the set expunge the packet.

Here defines an event called termination for the packet. After sent the packet from the source node i at a particular time slot either it reaches the destination or the packet will drop in between source and destination. The both events are called as termination. If the packet is successfully delivered at the destination it is the termination at destination. If the packet is terminated at the destination a positive reward R is obtained. And if the packet is terminated before reaching the destination no reward is obtained. The reward is zero if no successful delivery of the packet; otherwise a positive reward R is obtained. Considering a problem of multiple source destination pair. That is the problem of multiple source destination pair try to send the packet at the same time. Here assumes this problem is decomposed in to single source destination problem.

IV. Distributed Algorithm

Let $N(i)$ denotes the set of neighboring nodes that accept the packet broadcasted by the node I including node i itself. The set of nodes which receive the data packet send back an acknowledgement to the node i. According to this node i will take an action a from the set of actions $A(S)$.That is selecting the next relay node. $A(S)$ denotes all possible set of actions. $A(S)$ can be defined as $A(S)=S \cup \{T\}$.that is $A(S)$ denotes all allowable actions when the packet sent by node I is successfully received at S. For each node i defines a reward function R such that

$$g(S,a) = \begin{cases} R \text{ if } a = T \text{ and } d \epsilon S \\ 0 \text{ if } a \neq T \text{ and } d \in S \end{cases} \qquad (1)$$

A. Overview of d-Adapt-OR

The proposed scheme take the routing decision based on the reception outcomes of each node. Based on these reception outcomes it selects the next relay node or take a termination decision.

Table I Notations Used In the Description of the Algorithm

Symbol	Definition
S_n^i	Nodes receiving packet from node I at time n
a_n^i	Decision taken by node i at time n
$N(i)$	Neighbours of node i including node i
$v_n(i, S.a)$	Number of times up to n node S have received the packet and decision a is taken
$A_n(i, S.a)$	Score for node i at time n, when nodes S have received the packet and decision a is taken

This routing method is worked as a three way handshake model as follows. Three way handshake between node i and its neighbors which accept the packet sent by the node i

1) At a particular time slot node i transmit a packet.
2) The set neighbouring nodes which accepts the packet sent by the node i replies to node I with an ACK packet.This ACK packet contains the node identity and the control message estimated best score(EBS).
3) After receiving the ACK message from all neighboring nodes which accepts the data packet the node i announces a routing decision.that is node I selects a node from its neighboura as next relay node based on the EBS of the nodes or it indicate a termination decision T in a FO packet.
4) After taking the routing decision the node i updates its ebs score for future acknowledgement.
5) If the packet terminated before reaches the destination then the node that terminated the packet will send a negative Acknowledgement to the source.after receiving this negative acknowledgemnent the source node reestablish the route to destination without considering the node that is previously selected.
6) If the system is busy,then it will not receive data packet and not send acknowledgement back to node i. Each node set a threshold value for its percentage of CPU utilization.If the percentage utilization of the CPU is abouve that threshold the system wil not respond to node i with acknowledgement.The system will respond only after reduces the CPU utilization by stopping one or more processes until the utilization reaches a level below the threshold value.

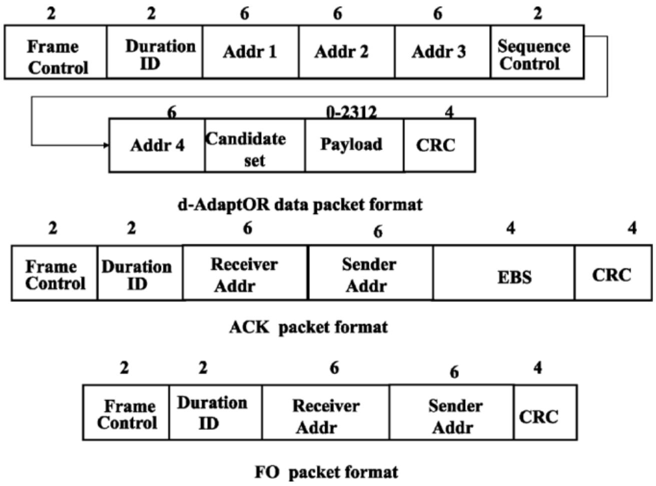

Fig 1. Frame structure of data packets, acknowledgement packets and FO packets

A counting variable is maintained. Its value is incremented when the neighboring nodes receive the data packet initially sent by the node i and node i successfully receives the ACK message from each of its neighbours. That is the value of the counter will be incremented only when every neighbor accepts the packet and successfully acknowledged. Fig 1 shows the structure of different packets used for communication between nodes.

B. Detailed Description of d-Adapt-OR

The distributed adaptive opportunistic routing scheme can be described in four stages of transmission and the initialization stage. Four stages of transmission are reception, Acknowledgement, relay and adaptive computation stage.

TABLE I gives the description of notations used in the algorithm.
0) Initialization

Each node keeps four variables. Reward for the node, counting variable, the EBS value and the score variable. These variables are initialized to zero.

1) Transmission Stage
Transmission occurs at particular time slot at node i if it has a packet to transmit.

2) Reception and Acknowledgement stage

The neighbors which successfully receive the packet acknowledges the packet by an ACK message to node i.the number of neighbor nodes and number of nodes successfully receive the packet from node i may be different.

3) Relay Stage

Up on reception of ACK messages from neighbors the node i selects one of its neighbors as relay node. That is node i selects a routing action.

Node i send an FO packet to the node that is selectd as a relay node. This is a control message. This either indicates the relay node or the termination event at the destination.

After sending the FO packet based on the routing decision the node which receive the FO packet start the packet transmission and all other nodes expunge the packet.

After selecting the routing action the counting variable v_n is updated as

$$v_n(i,s,a) = \begin{cases} v_n(i,s,a) + 1 \text{ if } (S,a) = (S_n^i, a_n^i) \\ v_n(i,s,a) \text{ if } (S,a) \neq (S_n^i, a_n^i) \end{cases} \quad (2)$$

S_n^i is the set of nodes which successfully receive the packet. a_n^i is the set of actions available at nodes which are successfully receive the packet. S is set of neighbors of node i. a actions available at set S.

4) Adaptive Computation Stage

The node I sent the packet at a time slot all neighbors successfully receive the packet and acknowledges to node i then only the counting variable is updated. If any of them not receive or not acknowledges the packet then the counting variable will remain as the previous.

The EBS of each node is updated after selecting the routing action.

Each node maintains a score variable. And the score variable is updated as

If $S = S_n^i$ and $a = a_n^i$

Then the score variable (A_n) is updated as

$$A_{n+1}(i,S,a) = A_n(i,S,a) + \text{count} + R/n \quad (3)$$

Where n is the total number of nodes

Else the score variable is remained as the previous

i.e.

$$A_{n+1}(i,S,a) = A_n(i,S,a) \quad (4)$$

The EBS of the node i is set as the maximum EBS of its neighbors if the score variable is updated. Otherwise the EBS of node i remains as the previous.

If the packet terminated before reaches the destination then the EBS score calculated is discarded and set the previous EBS score, then start the routing process by not considering the node that is previously selected.

C. Selfishness Detection

The nodes which are overloaded with some tasks may not forwarded or respond the packet received by it. So we have to avoid this type of nodes from routing. So the selfishness of such node needs to be defined. Each and every node maintains the neighboring nodes information in the networks. So in the proposed scheme, after broadcasting the packet each node expects the number of acknowledgement from its neighbors. According to this selfishness of the node is calculated as

Percentage of Selfishness= (a-b/a)*100 (5)

a – Expected number of ACK packets

b - Received ACK packets

The CPU utilization of a node is greater than a threshold then the packet will not be processed. If a node wants to process the packets then it have to stop one or more process to reduce the CPU utilization. Then only it can process the packet. The value of threshold needs to be defined.

D.Result Analysis

The time, space complexity and computational overhead of proposed system is very less. Computing different values at each node is simple.

No large space requirements to store the variables used in each node. It is the order of exponential of number of neighbours and the time required for the computation is the order of number of neighbors.

The proposed scheme has no communication overhead because no need to communicate with the neighboring node to exchange routing information and no need to monitor neighbor's transmission for the routing decision.

Whenever a packet arrives at a node it finds a path with less congestion. So the chance of successful delivery of the packet at the destination is high.

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