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Design of a Delay-aware Routing Protocol for Multi-hop Mobile Ad-hoc Networks Required

Pankaj Jain, Dr.Vijay Kumar, Richa Jain
Department of Computer Science and Engineering
Rajasthan Technical University, Kota, India

Abstract— As we know that a MANET is a collection of wireless mobile nodes creating a highly dynamic and temporary network without the help of any established fixed infrastructure or centralized administration. The tradition MANETs routing protocols have no support provided to provisioning any type of QoS support for any applications. So, to provide the required delay guarantees we proposed the delay aware routing protocol, which is based on the ad-hoc distance vector (AODV) routing protocol therefore we named it DARP protocol. This protocol is useful for transmission of traffic that is generated by applications which are critical and stringent requirements for end-to-end delay values. We present the simulation results to show the effectiveness and correctness of proposed admission control based delay-aware routing protocol (DARP) based on AODV routing protocol.

Keywords— Mobile Ad-hoc Network, QoS, AODV, Delay aware routing, DARP, Route discovery process

I. INTRODUCTION

An ad hoc network is a collection of wireless mobile nodes creating a highly dynamic and temporary network without the help of any established fixed infrastructure or centralized administration [1]. In such an environment, each node can act as a router to forward packets for intermediate nodes or destination node and a MANET routing protocol should be able to adapt fast and effectively to sudden changes in network layout. Mobile ad hoc networks (MANETs) do not rely on any fixed infrastructure but communicate in a self-organized way. Quality of Service guaranty in a MANET is very challenging due to the dynamic and uncertain nature of networks.

Types of MANET

There are three types of MANETs [2] including:

- Intelligent vehicular ad hoc (InVANETs) – It use to handle unexpected situation like vehicle accident and collision by providing them artificial intelligence through network.
- Vehicular ad hoc networks (VANETs) – It creates effective and efficient environment to communicate or help other vehicles by roadside equipment's.
- Internet Based Mobile Ad hoc Networks (iMANET) – It used to fix static as well as mobile nodes

II. QOS IN MANETS

Quality of Service (QoS) is a set of mechanisms which allow to share reasonably various resources offered by the network to every application as needed, to present, if possible, to every application the desired standards (or the network's ability to provide a service) [6]. The QoS is featured by a certain number of parameters like network throughput, jitter, latency and packet loss, etc. and it can be defined as the degree of user satisfaction. In MANETs, the arrangement of quality of service (QoS) guarantees is very tough compared to wired networks, mainly due to multihop communications, contention for channel access, node mobility, and a lack of central coordination. QoS model defines architecture that will provide the best possible service. This model should considered all the challenges enforced by Ad-hoc networks like, constraints of reliability, changed network topology due to the mobility of its nodes and energy consumption, so it provides a set of services that allow service users to select a number of safe-modes that govern such properties as power, time, reliability, etc.. [3][4]. Multimedia and real-time applications require less delay and high data rates which require the facility of new routing protocols supporting QoS [5] [6]. QoS can be implemented into different layers of network like MAC Layer at channel access functions, Network layer at routing protocols [7].

QoS parameters

QoS parameters are changed from application to application. For example, for multimedia applications, the delay and data rate are the key factors, whereas, in military application, security and reliability are big concern. For emergency cases such as earthquake, flood etc. the key factor should be the availability of network. Battery life and energy conservation becomes prime factor in sensor networks. In real time applications, QoS requests can be expressed in term of many metrics in routing protocols. The most important metrics are delay and data rate. To provide QoS requirements, we have to calculate available data rate and delay for each route and check which route could be used with satisfying QoS.

III.BASIC AODV

Ad_hoc on Demand Distance Vector Routing (AODV) was introduced by Charles E_ Perkins and Elizabeth M Royer [8][9]. They presented a new algorithm which, called as AODV, brings a loop free routes even while reconstruction of collapsed links. Because AVOD doesn't need global periodic routing announcements, the requirement on the total bandwidth usable to the mobile nodes is substantially low than in those protocols that do necessitate such announcements. This algorithm covers to large number of mobile nodes preparing to form ad hoc networks. AODV is type of reactive routing protocol. It uses hop count as metric for route selection. Each node saves only info of the next hop in a route to a destination. For route discovery and maintenance, AODV uses three message mechanisms as Route Reply (RREP), Route Request (RREQ), and Route Errors (RERR) messages. It broadcast a RREQ message, when a node demands a route to other node, this message propagated through the networks until it reaches the final destination node, or an intermediate node, which have correct route to the destination. Later a RREP message passes by one of these via the discovered route. Whenever a link collapse occurs, any nodes which detect it inform all nodes about the link, that it no longer exists. This is managed by sending a RERR message to all those nodes and again a route discovery phase starts. Whenever a node finds out a new route to a particular destination node, it evaluates the new information through the following route updated rule:

```
if(seq_nrdi<seq_nrdj) or ((seq_nrdi=seq_nrdj) and (hop_countdi > hop_countdj))
then
   seq_nrdi:= seq_nrdj;
   hop_countdi:= hop_countdj + 1;
   next_hopdi := j;
endif
```

The notation applies for:
node I : receives routing information to destination d from neighbor j.
seq_nrdi : The destination sequence number,
hop_count di : hop count
next_hopdi : next hop for a destination d at node i is represented

When a node is part of one or more active routes, it broadcasts a Hello message locally every HELLO_ INTERVAL to offer connectivity info.

IV.PROPOSED PROTOCOL

In this paper, we propose a delay aware routing protocol (DARP)which is based on a reactive routing protocol called Ad hoc On-demand Distance Vector (AODV). AODV is a reactive routing protocol build specially for routing in wireless networks. As, we know that the traditional MANETs routing protocols have no support provided to provisioning any type of QoS support for any applications. So, to provide the required delay guarantees we proposed this delay aware routing protocol. The proposed DARP uses a cross-layer technique to identify the delay requirements of a transmitting application. The cross-layer technique takes the delay values of each transmission requesting application from application layer and send it to network layer so that the network layer routing protocol (in this case AODV) can then find a route towards the destination that satisfy these delay requirements of the requesting application. The delay-aware routing process will try to discover routes during the route discovery phase. The routes are selected based on the delay requirements given by the application for which this route is being searched. If a route that has total delay less than the delay requirements is found then the application is admitted into the network and its data is transmitted through the discovered route. On the other hand, if such a route is not available the session admission process at the source node will stop the application from being admitted into the network. The admission control process will assign a timer to such applications that when these applications expires can try again to admit into the network.

A. *Flow chart for route discovery process of proposed protocol*

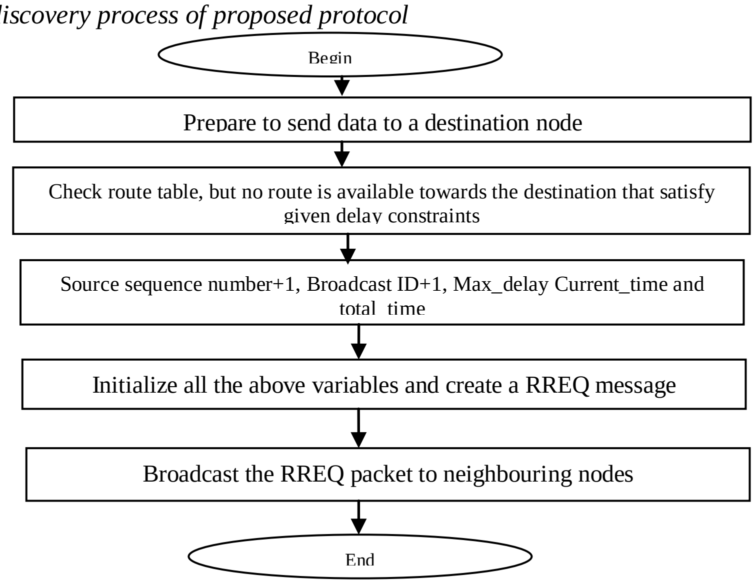

Fig. 1 Flow Chart of initiating a delay-aware discovery process

B. *Proposed Algorithm*
Variables Used:
S = Source nodes
D= Destination nodes
I = Intermediate nodes
DP = Data packet

BEGIN ALGORITHM
IF(S got a data packet)
Call the cross-layer process to get the delay requirements of the application
Check routing table for routes **IF** (S has route with specified delay for D)
Send the packet to next-hop towards destination
ELSE Initiate route discovery process by broadcasting a RREQ
IF(S or I got a RREQ)
Check the received RREQ for duplicity **IF** (duplicate) Discard the RREQ
ELSE Calculate the PATH_OFFSET value and **IF** (PATH_OFFSET is greater than MAX_DELAY)
Rebroadcast the RREQ **ELSE** Discard the RREQ
IF (D got a RREQ && PATH_OFFSET is less than MAX_DELAY)
Initiates the RREP and ignore further RREQs with the same flooding ID
ELSE discard the RREP and wait for another RREQ
IF (S didn't have a RREP for three consecutive RREQs)
S call the CAC process
CAC reject the applications transmission request and give a timer to it (the application can retry to enter into network)
ELSE Data session is admitted in the network
END ALGORITHM

V. SIMULATION RESULTS

Qualnet [28] is used to create different scenarios of wireless ad hoc networks using different values of many scenario parameters. The Simulation parameters to build the scenarios are given in the Table 1. All the simulation results are calculated by taking the average of five different runs.

Simulator	Qualnet 5.0
Simulation time	1000 Sec
Application layer protocol	Constant bit rate (CBR)
Transport layer Protocol	UDP
Routing protocols	AODV, DARP
MAC layer protocol	802.11
Data rate	11 Mbps
Mobility model	Random way point
Packet Size	512 Bytes
Number of packets	5000 per flow
Inter packet time	33 ms
Mobility speed	0-15 m/s
Path-loss model	Two ray
Node pause time	20 Seconds

We present results obtained from different simulations on a variety of scenarios to prove the correctness and effectiveness of the proposed routing protocol i.e. DARP. We compare the traditional AODV routing protocol to over proposed DARP protocol in terms of end-to-end delay (EED) over wireless networks with increasing mobility and network load.

A. *Average End –to – End Delay*
Figure 2 shows the effect on EED with increases in number of CBR sessions in the network for both DARP and AODV routing protocols. Figure 2 show that the proposed DARP outperforms the tradition AODV routing protocol by always providing the delay values which is less than the applications specified delay constraints. This is because the Call Admission Control (CAC) process will on admit those applications traffic for which proposed route discovery process is able to find suitable routes. In Figure 3, we can see the results obtained for EED for AC-DARP and AODV routing protocols with increase in network mobility. As we can observe from Figure 3 that EED of both routing protocols is low

when the mobility in network is very low. But as the network mobility increases the delay of both protocol increases but the increase in DARP is low and smooth as compared AODV. This is because in DARP the CAC process will only find the routes that satisfy the delay requirements of the requesting application after each route break due to high mobility in network.

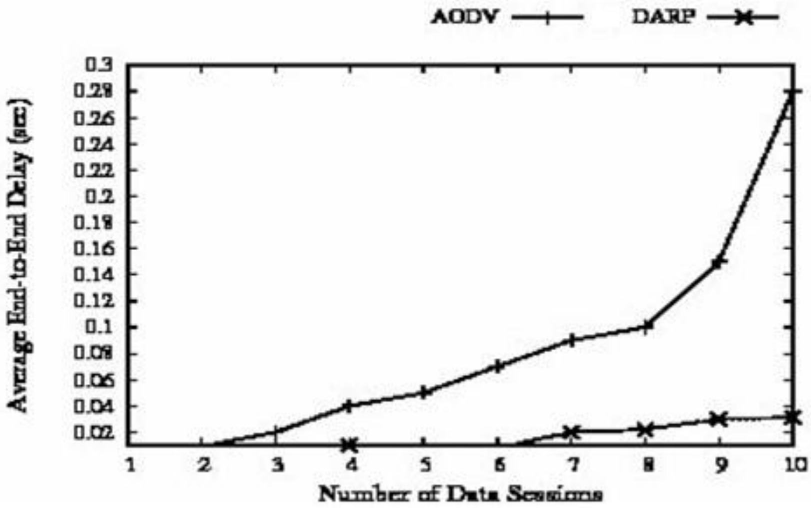

Fig. 2 Effect of increase in CBR session on average EED

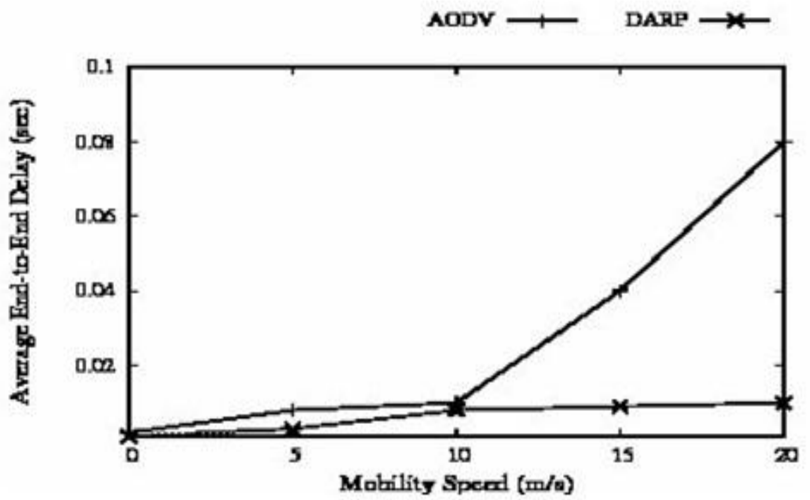

Fig.3 Effect of increase in node's mobility on average EED

VI. CONCLUSION

We have presented the results and performance evolution to show the effectiveness and correctness of our proposed admission control based delay-aware routing protocol (DARP) based on AODV routing protocol. This protocol is developed for reliable and efficient transmission of multimedia application over mobile ad hoc networks. The results show that DARP is able to handle the CBR sessions and its decision to admit a session or reject a session that is based on network layer route discovery process is correct and efficient. We can say that DARP is able to provide the delay guarantees of the applications once they are admitted in the network.

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