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A Fault Tolerant Power Constraint AODV Protocol for MANET

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ABSTRACT

The rapid development in the wireless technology, enormous availability of mobile devices make the people expectation of their communication with each other without any interruption. Mobile Adhoc Network is a collection of mobile devices which communicate with each other without any infrastructure. The communication networks suffer due to frequent changes in topology because of mobility and scalability. The main objective of this protocol is to resoleve this issue by proposing an enhanced reliable,fault tolerant routing protocol for MANET based on the reactive routing protocol AODV, and is called Fault Tolerant Power Constraint Adhoc On Demand Distance Vector Routing (FTPC-AODV). The proposed FTPC-AODV deals with how the mechanism adapt to topology changes due to mobility induced link break by building back up paths between the source and destination by considering battery power as a constraint. If the primary path fails, it automatically switches to the backup path and improves the data transfer rate. The protocol is implemented using Network Simulator (NS-2) and simulation results are analyzed based on the quantitative metrics. The derived results shows that the performance of Adhoc Newtork significantly improved by means of good packet delivery ratio, through put and reduced packet loss, and delay.

Keywords: MANET, NS-2, AODV, FTPC-AODV, Quantitative Metrics.

INTRODUCTION

Mobile Adhoc Network(MANET)[1] is a collection of mobile nodes, which communicates with each other without need of any infrastructure. These nodes uses transmission medium radio waves for forwarding packets. If source and destination nodes exist within the transmission range, they communicate with each other directly. If source and destination nodes exist outside of the transmission range, they uses intermediate nodes to communicate with each other. Fig.1. shows an example of MANET.

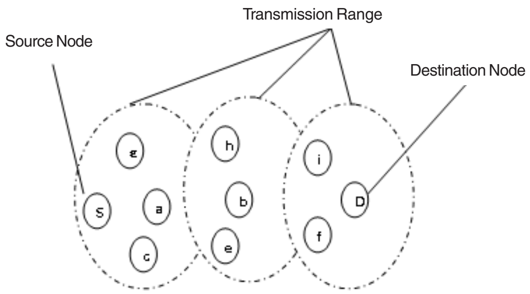

Fig. 1: Mobile Adhoc Network

Routing protocols are necessary for forwarding packets through the number of intermediate nodes. There are different routing protocols available for MANET. Fig.2 shows the categories of routing Protocols in MANET. They are

1. Proactive Routing Protocol
2. Reactive Routing Protocol
3. Hybrid Routing Protocol

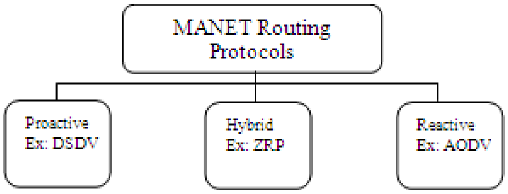

Fig. 2: Categories of MANET Routing Protocols

The main functionality of routing protocols are discovering path to the correct destinaton and forwarding packets through the path and deliver the packets to the appropriate destination. Proactive Routing Protocols maintains routing tables in every node and periodically exchanges topological informations among the mobile nodes throughout the network. Reactive Routing Protocols establishes routes to the destination only when there is a need. These protocols do not exchange information periodically. Hybrid Routing Protocols are the combination of reactive and proactive protocols which gives better solution when compared to a particular routing protocol.

A link (physical if wired, logical if wireless) is a connection between two nodes. A route is a sequence of links in a multihop network. Routing uses multihops from source to destination makes the routing as a more challenging one. The nodes mobility may cause link/route failure. If anyone of the node or link fails, the route no longer functions. Hence fault tolerant routing protocol is necessary to resolve this routing problem in MANET. The proposed efficient and effective routing algorithm called Fault tolerant Power Constraint AODV (FTPC-AODV) to provide vitality to the routing protocol in the presence of link failure in Adhoc Network. This FTPC-AODV protocol is used to provide certain packet delivery fraction guarantee and low delay in the presence of route failure or node failure in Adhoc network.

The rest of the paper is organized as follows: Section II briefly describes the related works and deals with link failures in AODV algorithms. The Proposed FTPC-AODV is introduced in section III. The performance of network is evaluated using NS-2 in Section IV. And finally conclusion with future reseach work is designed in Section V.

Related Work

Traditional Reactive Routing Protocols in MANETs are DSDV[1], DSR[2], AODV which are single Path Source initiated Routing Protocols. In DSR[2] Route Reply (RR) packet includes the complete route information, and it is returned to the source once the Route Request packet reaches the destination. And all routes expire or be explicitly deleted after a Route Error (RE) packet is received. Among these Reactive Routing Protocol, AODV[3] is the prominent protocol. AODV which combines DSDV and DSR to establish an end-to-end route between the source and destination, and the link failure notification is propagated to the source during route maintenance. TORA is based on link reversal techniques, obtains multiple routes for any desired source/destination pair after route discovery and broadcasts the route control packet near the occurrence of topology changes for route maintenance.

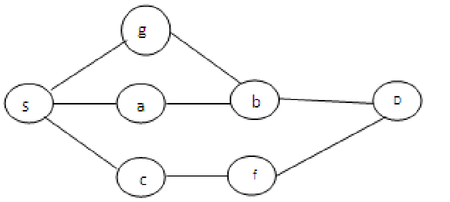

Fig. 3: Initial Topology : Route from Source S to Destination D through S-a-b-D

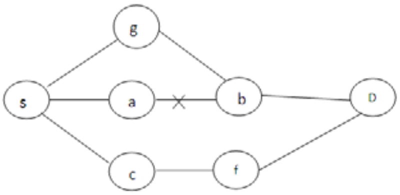

Fig. 4: Topology with link break between a & b

The above Fig.3 shows simple MANET initial topology and Fig.4 shows link break in the topology respectively.

AODV and Link Faliure

Adhoc On-demand Distance Vector (AODV)[7] is a combination of both DSR and DSDV. It follows the basic on-demand mechanism of Route Discovery and Route Maintenance from DSR, plus the use of hop-by-hop routing, sequence numbers, and periodic beacons from DSDV. It uses destination sequence numbers to ensure loop freedom at all times and by avoiding the Bellman-Ford "count-to-infinity" problem offers quick convergence when the adhoc network topology changes. AODV finds routes only when required and hence is reactive in nature.

When a source node desires to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. It broadcasts a route request (RREQ) control packet to its neighbors, which then forward the request to their neighbors, and so on, until either the destination or an intermediate node with a "fresh enough" route to the destination is located.

The AODV protocol utilizes destination sequence numbers to ensure that all routes contain the most recent route information. Each node maintains its own sequence number. During the process of forwarding the RREQ, intermediate nodes record in their route tables the address of the neighbor from which the first copy of the broadcast packet is received, thereby establishing a reverse path. Once the RREQ reaches the destination or an intermediate node with a fresh enough route, the destination or the intermediate node responds by unicasting a route reply (RREP) control packet back to the neighbor from which it first received the RREQ.

Route Maintenance

An active route is defined as a route which has recently been used to transmit data packets. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform the unreachable destination. After receiving the RERR, if the source node still desires the route, it can reinitiate route discovery. Alternatively, the algorithm may initiate a local repair mechanism[9] when a link failure happens on an active route and the first node upstream of that break (the predecessor) chooses to repair the link locally if the destination is not too far away.

In such case, the node increments the sequence numbers for the destination and then broadcasts a RREQ for that destination. Thus, local repair attempts often invisible to the source node. The node that initiates the repair then waits the discovery period to receive RREP in response to the RREQ.

During local repair, data packets should be buffered. If, at the end of the discovery period, the repairing node has not received a RREP (or other control message creating or updating the route) for that destination, the node propagates a RERR . When it happens, long delays and huge losses of packets due to exhaustion of the queues will occur. However, if the repairing node receives a RREP, it ensures lower overhead and delay.

Proposed FTPC-AODV

Node failure significantly affect the performance of routing in an adhoc network. For example, if there is a faulty node participating in the routing operation, drops data packets, then a large number of packets will be lost. If there is a link faillure, the upstream node sends the data packets till it knows the route is not available. So data loss occur.

To resolve this issues, multiple paths introduced between the source and destinaiton, which improve the performance of the fault tolerance of the network. In the proposed fault tolerant[11] technique, one route is considered as a primary route and the other routes are the alternate routes, that can be used when the primary route is invalid.

FTPC-AODV has two phases

1. Route Discovery Phase (Flooding BP-RREQ)
2. Route Maintenance Phase

In Proposed protocol, source Node checks the routing table for any available paths when it needs a route to the destination. The source node performs Route Discovery Process by flooding BP-RREQ when the path is not available.

When the nodes receives BP-RREQ, it verifies wether it is the destination node, and has the cabaple battery power to forward packets and whether it has available routes to the destination node initially. If nodes battery power is equal or lesser than the Minimum Battery Power (MBP), the node is not considered to form path from source to destination. If nodes battery power is greater than the Minimum Battery Power (MBP), the node is considered to form path from source to destination.

Otherwise the entire process proceeded as like traditional AODV Protocol but it checks the battery power. If the current node is the destination, it store the first received BP-RREQ in the buffer and simultaneously starts the timer. The node also receive other copies of BP-RREQ at the same time. Primary path has been choosen to forward data packets. If there is link break, alternate paths are selected automatically for forwarding data packets.

Proposed Algorithm: FTPC-AODV

i. Set Minimum Battery Power as MBP.
ii. Set BP-RREQ with the parameter MBP and name it as BP-RREQ
1.If Source (S) requires a route to Destination (D), then Its checks in the routing table
 a. If Path is available, path is considered for forwarding packets.
 b. If path is invalid, then
 Source starts route discovery process
 (by flooding BP-RREQ)
End if

2.If node receives BP-RREQ then
 If BP-RREQ is from D and BP-RREQ has route to the D, then Stores the first received BP-RREQ and checks its Battery Power with MBP
 If it is greater
 Starts the timer
 Else
 BP-RREQ treated as like Traditional AODV
 End if
 If timer expires then
 Node drops all copies of BP-RREQ
 End if
3.If Battery Power is Minimum
 The destination node replies for the BP-RREQ
End if
4.If Intermediate node does not have valid route to destination, then
 Forward first BP-RREQ
End if

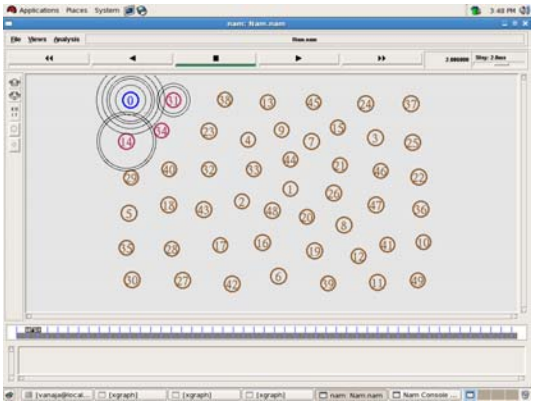

Fig. 5: NAM showing initial topology

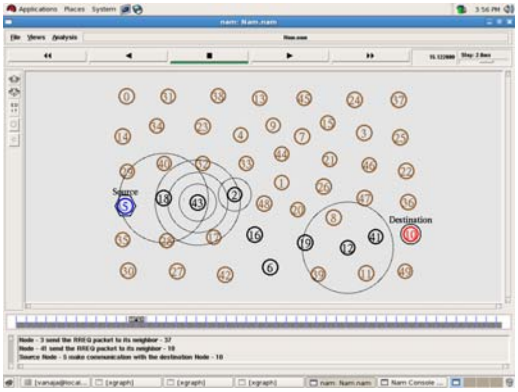

Fig. 6: Data transfer between source(5) and Destination(10) Through s-18-43-2-16-6-19-12-41-10

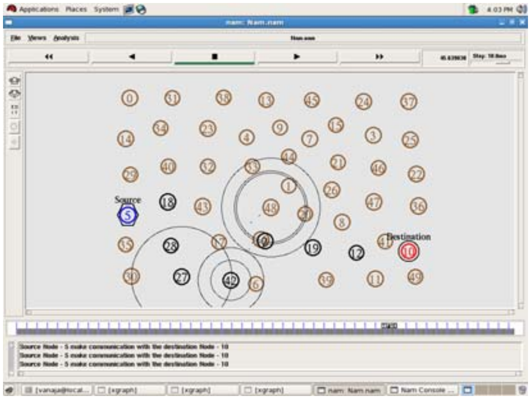

Fig. 7: Data transfer between source (5) and Destination(10) Through s-18-28-27-42-2-19-12-10

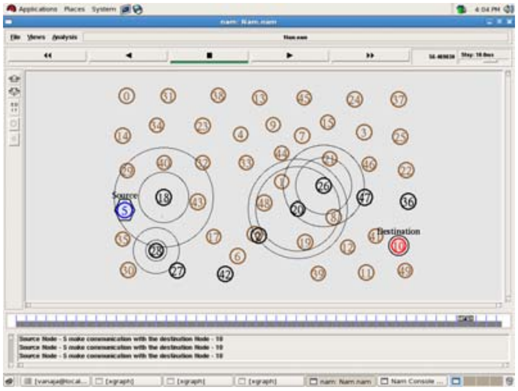

Fig. 8: Data transfer between source (5) and Destination (10) Through s-18-28-27-42-2-20-26-47-36-10

The Fig.5 shows the initial set up of nodes and path generated between the source and destination and Fig.6, Fig.7 & Fig.8 shows communication between source and destination and also automatic alternate path selection among the source and destination.

RESULTS AND DISCUSSION

Simulation Environment

Network Simulator[12] (NS-2) 2.32 is installed on Linux OS. In order to study and analyze the operability and behavior of the routing protocol AODV and proposed FTPC-AODV is implemented in the simulator NS-2.32 and the results are derived. The table below shows the context of simulation (Simulation set up Parameters).

Table 1. Simulation Parameters

Parameters	Values
No. of Nodes	50
Area	1000 x 1000
MAC	802.11
Radio Range	250m
Simulation Time	50 sec
Traffic Source	CBR
Packet Size	512 B
Mobility Model	Random Way Point
Speed	10, 20, 30, 40, & 50 m/s
Pause time	5 seconds

The performance of FTPC-AODV is evaluated based on the quantitative metrics Packet delivery ratio[10] (Fig.9), Throughput[10] (Fig.10) and **Average Delay**[10] (Fig.11), Packet Loss[11]

Average Delay

The period of time taken for source node sending data till the destination receiving them, which includes the route building time and the data transmit time.

$$\text{Delay (D)} = Tr - Ts$$

Tr → Received Time

Ts → Sent Time

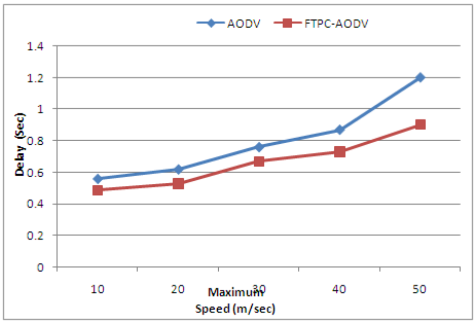

Fig. 9: Delay Vs Speed

The delay is affected by high rate of CBR packets. The buffers become full much quicker, so the packets have to stay in the buffers for longer period of time before they sent. The performance of average end to end delay (Fig.9) is decreased in FTPC-AODV than AODV.

Packet Delivery Ratio

The ratio of the received data amount and the total data source node delivered.

$$PDR = (Pr/Ps)*100$$

Pr → Packet Received

Ps → Packet Sent

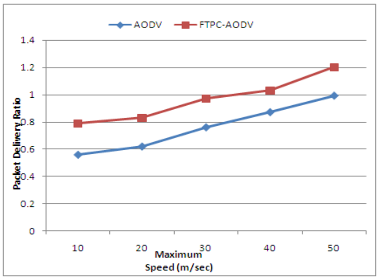

Fig. 10: PDR Vs Speed

PDR is the ratio between the number of packets originated by the application layer sources and the number of packets received by the destination. It describes the loss rate that seen by the transport protocols which in turn affects the throughput of the network. FTPC-AODV gives better packet delivery ratio (Fig.10.) when there is more nodes and on mobility. The performance of AODV is better at the beginning and decreases slightly with increase in number of nodes.

Throughput

The important quality of communication networks is throughput. It is a measure of how fast the data sent from source to destination without loss.

$$\text{Throughput} = Pr/Ps$$

Pr→Total Number of packets received
Ps→Total Number of Packets sent/forwarded

The unit of throughput is bits/sec or packets/sec.

Packet Loss

Packet Loss occurs when one or more packets fail to reach their destination.

$$\text{Packet Loss} = (1\text{-}Pr/Ps)*100$$

Pr→Total Number of packets received
Ps→Total Number of Packets sent/forwarded

Some of the data packets may be lost. Those are the dropped packets. The network performance using AODV is degraded due to more packet loss (Fig.11). As the number of node increases the number of packet dropped also increases. The number of packets dropped is negligible means that almost all the packets reach the destination successfully. The packet drop of FTPC-AODV is less when compared to the performance of AODV

CONCLUSION

The proposed Fault Tolerant Power Constraint AODV (FTPC-AODV) is a source initiated reactive routing Protocol which provides local recovery when the route is partially broken. The main objective of this protocol is to show better adapt to the topology changes due to scalability or mobility. The performance is compared with traditional AODV and it shows significant improvements in packet salvage, throughput, and delay in various scenarios. From the simulation results, it is shown that the proposed protocol achieves better throughput and packet delivery fraction with reduced delay, packet drop. Further this protocol is going to be tested on the metrics control overhead, routing overhead based on CBR and VBR in different scenarios.

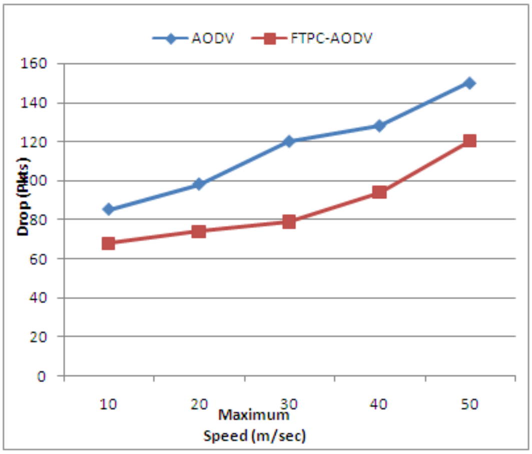

Fig. 11: Packet Drop Vs Speed

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