Congestion and stability-aware multipath routing protocol in MANETs

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Abstract

Objectives: In mobile ad hoc networks (MANETs), congestion is a main factor while packets transmitted from the source to the destination. The high packet loss, high delay and waste of resource utilization time are occurring due to the congestion. By using the average queue length, the CSAMR (Congestion and Stability-aware Multipath Routing) detects the present congestion level and packets are transmitted through congestion free path.
Methods: Congestion aware technique is introduced for detecting the congestion along the routing path. In this method, the average queue length at the node level is computed based on the estimations. Here the node detects the present congestion stage and sends a warning information message to its neighboring nodes. Finally the packets are transmitting from source to destination along with congestion free path.
Results: The proposed method achieves high performance in terms of packet delivery ratio and end-to-end delay.
Conclusion: The congestion aware method is used to reduce the delay and buffer overflow caused by network congestion and hence it facilitates the network to perform better. In this method, dynamic congestion aware routing method is used for detects the congestion level according to the estimations of the average queue length.

Keyword: Mobile ad hoc networks, congestion, queue length, Node disjoint, packet transmission.

1. Introduction

Communication facilitates for information exchange among people anywhere at any time. In MANET, the number of mobile nodes is grouped to form a network which is independent of any centralized management. The mobile devices are battery operated; extending lifetime is a main factor. Most of the researchers have recently started to think power-aware improvement of efficient protocols for MANETs. Each and every mobile node in a MANETs performs the routing operation for establishing communication among several mobile nodes the “death'' of even a few of the nodes due to power exhaustion might cause disconnect of services in the entire MANET [1]. Mobile nodes in MANETs are battery driven. Mobile nodes are suffered from limited energy level problems.

The nodes are moving out from the transmission range of network the link between them is broken.
There are two major situations for link breakage:

- Node falls due to energy drop [2]
- Node moves away from the transmission range

The numbers of mobile nodes are grouped to form a mobile Adhoc networks. They do not have any predefined infrastructure. In mobile ad hoc network the packets are transmitted from source to destination through multiple routes by using routing protocols. In ad hoc network routing protocols are mainly categorised into Proactive/table driven routing protocol, Optimized Link State Routing (OLSR) routing protocol, Reactive/On-demand and Hybrid routing protocol.
The some routing protocols are
Destination Sequenced Distance Vector (DSDV) [3]
Optimized Link State Routing (OLSR)[4]

Dynamic Source Routing Protocol (DSR) [5]
Ad hoc On-Demand Distance Vector routing protocol (AODV) [6]
Temporally Ordered Routing Algorithm (TORA)[4]
Zone Routing Protocol (ZRP) [7]
Hybrid Ad hoc Routing Protocol (HARP) [8]

Application of MANET

Military Scenarios: MANET supports for military applications and automated battle fields.

Rescue Operations: It gives Disaster recovery, means substitute of stable infrastructure network in case of environmental disaster.

Data Networks: This network gives support to the net- work for the swapping of data among mobile devices.

Device Networks: Device Networks supports the wireless connection among various mobile devices so that they can communicate.

Free Internet Connection Sharing: It also allows us to share the internet with other mobile devices.

Sensor Network: It consists of devices that have capability of sensing, computation and wireless networking [9]. Wireless sensor network combines the power of all three of them, like smoke detectors, electricity, and gas and water meters.

Most of the system investigates the Quality of service, multipath routing; malicious node detection. Energy is an important issue in MANETs. To solve the single path routing problem of huge route discovery latency, frequent route discovery effort and possible development of data transfer throughput, AODV [6] and DSR [5] Protocols are used. The system presented TCP flow control technique. To improve the network performance the system combines RED with TCP window adjustment. Finally the system produced huge network stability, low packet dropping rate [10]. It fully utilizes the network resources. This system addresses energy issues, a primary issue of paramount importance in mobile ad hoc networks (MANETs) which include of powerful nodes and normal nodes. The system propose a cross-layer designed Device-Energy-Load Aware Relaying framework, named *DELAR*, which is used for reduce energy consumption, consider power-aware routing, scheduling and control of power [11].

MANETs is a dynamic network. Quality of Service (QoS) routing is major issues due to node mobility or energy dissipation of the mobile nodes. To complete confident quality parameters, attendance of multiple node-disjoint paths development is necessary. That system aims the best traffic distribution and reliability in case of path break down. Thus, to provide a lot of challenges in QoS routing in Mobile Ad hoc Networks, a Node Disjoint Multipath Routing allowing for Link and Node Stability (NDMLNR) protocol. The proposed metric is used to choose the paths according to the stability of the nodes and the corresponding links [12].

2. Congestion and stability-aware multipath routing

2.1. Network model

An undirected graph G (V, E) here V stands for the mobile nodes and E stands for set of edges which characterizes the physical or logical links among the mobile nodes. Two nodes can exchange the packets directly with each other are connected by an edge in the graph. Let N represents a network of m mobile nodes, $N_1, N_2, \ldots N_m$ and let D stands for collection of n data items $d_1, d_2, \ldots d_n$ dispersed in the network. For each pair of mobile nodes N_i andN_j, let t_{ij} denote the delay of transmitting a data item of unit-size between these two nodes.

2.2. Computation of link expiration time

To compute link and stability of the node the Link Expiration Time and Energy Drain Rate can be calculated. Mobility Factor: By using velocity and node direction ,Link Expiration Time (LET) is calculated. The Link Expiration Time (LET), is determined by using velocity, direction of the nodes. q and r are two nodes, (x_q, y_q) and (x_r, y_r) is the position co-ordinates and (vq, θ_q) and (v $_r$, θ_r) denotes motion of nodes. LET represented

$$\text{LET}= \frac{-(ab+cd)+Q}{(app^{\,2}+c^2)}$$

Where Q= $\sqrt{\{(a^2 + c^2)r^2 - (ad - bc)^2\}}$

a=$v_q \cos\theta_q$-$v_r \cos\theta_r$

b=$x_q - x_r$

c= $v_q \sin\theta_q$- $-v_r \sin\theta_r$

d= $y_q - y_r$

The velocity and directions are changed between nodes at regular interval throughout GPS. The relative mobility among nodes are zero , i.e., v_q=v_r and θ_q= θ_r, the link will remain forever, as LET will be ∞.

2.3. Computation of energy drain rate

Drain rate is defined as the amount of node dissipation energy.Each and Every node compute its total energy consumption at every T secs . By using DR_{old} and DR_{new} values drain rate is computed as follows,

DR_i=αDR_{old} + (1-α) DR_{new}

Where, 0< α <l, can be selected so as to give higher priority to updated information.

The drain rate is high the node has depleted their energy faster.

2.4. Node disjoint multipath routing considering link and node stability (NDMLNR)

Node Disjoint Multipath Routing system is used to determine the several node disjoint routes from source to destination .It calculate the route bandwidth for chooses best routes. From the factors Link Expiration Time (LET) and Drain Rate (DR) it is inferred that the Link Stability:

a) Depends directly on Mobility factor

b) Depends inversely on the energy factor

Hence, Link Stability Degree (LSD) is defined as:

LSD = Mobility factor / Energy factor

The higher value of Link Stability Degree achieves higher stability of the link. Thus, a route having all the links with LSD>LSD_{thr} is the feasible. The system selects Dynamic Source Routing (DSR) protocol as a candidate protocol. Here Route Request (RREQ) and Route Reply (RREP) packets are used for find node disjoint paths. The systems have three stages. There are Route Discovery, Route Selection and Route Maintenance.

2.5. Route discovery

Source node starts the route discovery process while it sends the forwarding RREQ packets to all neighbouring nodes. The source is not approved to continue route cache for a long time, as network changed in terms of position and node energy level. The source node initiates the route request packets that can be broadcasted among all the neighboring nodes. This process is repeated until satisfy the broadcasting condition. Every node has a Neighbour Information Table (NIT).As RREQ reach every neighbouring node it enters its information in the NIT. All requests are mentioned into the table. At the end of the Wait Period, it accepts the packets with the huge value in LSD field.

2.6. Route Maintenance and selection

In route maintenance phase the LSD of a node falls below LSD_{thr}, it indicates node breakdown by sending the NODEOFF message. The node sends ROUTEDISABLE information to destination while node receives the NODEOFF information. Source node can then reroute the packets to the backup routes. If there is no backup routes are there, the source node starts the route discovery process again.

2.7. Congestion aware Method

In that congestion control and detection phase, the RREP packets should carry much information such as queue length. When each intermediate node receives a RREP packet, it can add the queue length of this node to the "queue_ length" field in RREP packet. The source node knows the information of queue length along the path while it receives the RREP message from the destination. With the "queue_ length" field in RREP packet, it can choose the path with the minimum queue length.

$$\text{Avgque} = (1\text{-}w_q)^* \text{ Avg que} + \text{Inst\_ que} *w_q)^*$$

Here, w_q denote weighted value, q denoted as actual queue length in the sampling interval. The node detects the congestion level through the queue length and sends the warning message to the neighbor. The packets transmission is done by using congestion-free alternative path. The system minimise the delay time thus providing higher QoS.

2.8. Congestion aware algorithm

1. Initialise source node S
2. Source node generates the RREQ packet with field value
3. S broadcast RREQ packets to neighboring nodes
4. Receives all the paths arriving to it for Wait Period, W.
5. The intermediate receives RREQ packet
6. All RREQs with ID =I and updates the NIT.
7. Intermediate node receives a RREP packet; It contains queue length.
8. S receives RREP packet from destination it knows exact queue length along the path
8. If the node receiving the RREP packets from D
10. Selects the node disjoint paths
11. Creates RREP packets for unicasting to source. The Bandwidth field of the RREP packet is updated.) Destination unicast all node disjoint paths details to S.
12. From NIT, select the node j with highest LSD value
13. Select minimum q length path for packet transmission.

3. Results and discussions

An experimental result shows that the proposed method achieves high performance in terms of packet delivery ratio and end-to-end delay.

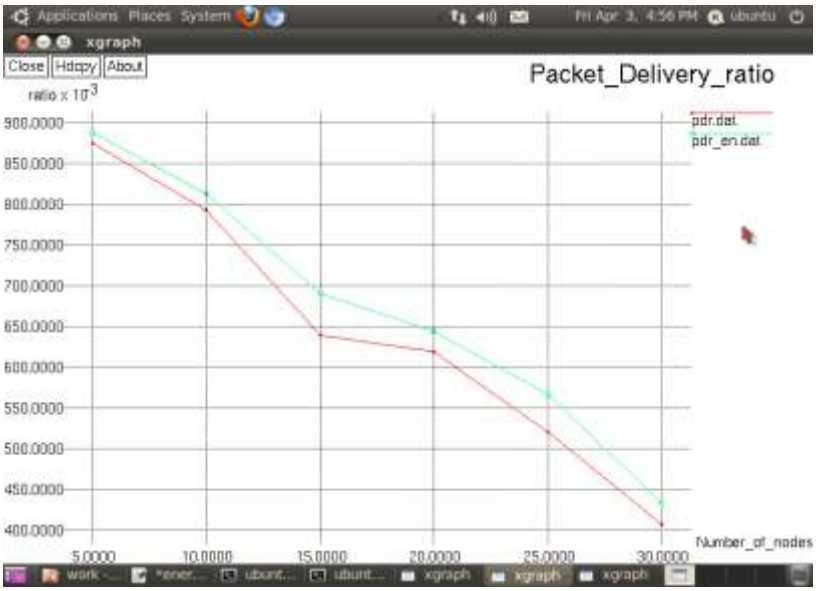
3.1. Packet delivery ratio

The ratio of number of delivered data packet to the destination is defined as packet delivery ratio.

$$\frac{\sum Number\ of\ packet\ receive}{\sum Number\ of\ packet\ send}$$

Figure 1 shows the packet delivery ratio of the network. In the X-axis number of nodes is taken. Y-axis packet delivery ratio of the network is taken. This graph clearly shows that if the number of nodes is increases the packet delivery ratio of the network is decreased. The ratio of the number of delivered data packet to the destination is highly efficient compare to the existing one.

Figure 1. Packet delivery ratio graph



3.2. End to end delay

End-to-end delay or One-way delay refers to the time taken for a packet to be transmitted across a network from source to destination.

Figure 2 shows end to end delay network. In the X-axis number of nodes is taken. Y-axis time is taken. This graph clearly shows that if number of node increases is end to end delay of the network is increased. The delay of proposed system is highly efficient compared to the existing one.

Table 1 represents the Characteristic Evaluation of CSAMR.

Figure 2. End to end delay graph

Table 1. Characteristic evaluation of CSAMR

Method	Mobility factor	Energy factor	Multiple path	node disjoint path	Congestion detection
CSAMR	yes	yes	yes	Yes	Yes
NDMLNR	Yes	Yes	Yes	Yes	No
ECCA	No	Only transmission power. not the individual node energy	yes	Yes	No
QSEL	Yes	No	No	No	No
CLPR	No	Y predicts life time on basis of energy consumed per packet	No	No	No
TDPR	No	Y residual battery power and transmission power is used to calculate traffic load	No	No	No
ENDMR	No	Y residual battery capacity is used as cost function	Yes	Yes	No

4. Conclusion

In Manet an Improving Quality-of-Service is a significant factor**.** The main objective of this system is to improve the Quality-of-Service in terms of packet delivery ratio, end-to-end delay. The main work is to compute the link expiration time and energy drain rate for the nodes in the network and compute multiple node disjoint routes from source to a given destination. In addition to that, the congestion level of the nodes in the network is detected and finds the alternative path for the routing process. An experimental result shows that the proposed method achieves high performance in terms of packet delivery ratio, and end-to-end delay.

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