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Study of load balancing protocols in MANET

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Abstract
Mobile ad hoc network is a collection of wireless mobile nodes, such devices as PDAs, mobile phones, laptops etc. that are connected over a wireless medium. There is no pre-existing communication infrastructure (no access points, no base stations) and the nodes can freely move and self-organize into a network topology. Such a network can contain two or more nodes. Hence, balancing the load in a MANET is important because the nodes in MANET have limited communication resources such as bandwidth, buffer space, and battery power. Most current routing protocols for mobile Ad-hoc networks consider the shortest path with minimum hop count as optimal route without any consideration of any particular node's traffic and thus degrading the performance by causing serious problems in mobile node like congestion, power depletion and queuing delay. Therefore it is very attractive to investigate Routing protocols which use a Routing Metric to Balance Load in Ad-hoc networks. This paper discusses various load metric and various load balancing routing protocols for efficient data transmission in MANETs.
Keywords: Load Balancing, Mobile Ad hoc Networks, Routing

I. Introduction

MANET is a temporary wireless network formed by a group of mobile nodes which may not be within the transmission range of each other. The nodes in MANET are self organizing, Self-configuring, Self-maintaining and characterized by multi-hop wireless connectivity and frequently changing topology. Mobile nodes in MANET are connected by wireless links and each node act as host end router in the network. It is a collection of mobile nodes, such devices as PDAs, mobile phones, laptops etc. that are connected over a wireless medium The routing protocols in MANET can be categorized in to three different groups: Table Driven/Proactive, On-demand/Reactive and Hybrid routing protocols. In Table Driven routing protocols, each node stores and maintains routing information to every other node in the network. These are done by periodically exchanging routing table throughout the networks. These protocols maintain tables at each node which store updated routing information for every node to every another node within the network. In on-demand routing protocols, routes are created when required by the source node, rather than storing up-to-date routing tables. Hybrid routing protocols combine the basic properties of the two classes of protocols.

This paper is organized as follows. In section 2, we described the characteristics of Ad-hoc networks and existing routing protocols. Section 3 provides considerable insight into various Load Balanced routing protocols, finally we include the comparison of the protocols and conclude the paper.

II. Previous Works

2.1 Ad-Hoc Network

In recent, the proliferation of portable devices like PDAs and Laptop computers with diverse wireless communication capabilities has made a mobility support on the Internet an important issue. A mobile computing Environment includes both infrastructure wireless network and novel infrastructure-less mobile ad-hoc networks. A MANET [1] is a self organizing system of mobile nodes connected by multi-hop wireless links forming a temporary network which is based on Radio to Radio multi-hoping and has neither fixed base station nor a wired backbone infrastructure. Since this network can communicate without a base station and a fixed cable network, the network can be configured dynamically and are deployed in applications such as search and rescue, automated battle fields, disaster recovery, crowd control, sensor networks, military settings, mine site operations and wireless classrooms or meeting rooms in which participants wish to share information or to acquire data. Major challenge in such a network is that nodes can freely move, hence the network topology continuously change. In addition, the characteristics of wireless channel such as limited data transmission range, low bandwidth ,high error rate, limited battery power, frequent mobility, high interference, link failure due to mobility[2] make routing on ad-hoc network a difficult problem to deal with. The routing issues in infrastructure-based networks are very different from routing in infrastructure-less networks. Each intermediate host between source and target node acts as router in an ad-hoc network and the topology of the network changes frequently. Therefore distribution of up-to-date information about the nodes can saturate the network. Also, late arrival of the information can drive the network into instability. Besides this, another problem is that link failure due to mobility is usually very high. Thus for efficient data transmission in MANETs a lot of research effort has been dedicated to the development of efficient routing protocols.

2.2 Routing Protocols for MANETs

Routing protocols for ad hoc wireless networks can be classified into several types based on different criteria [3].

These protocols can be broadly classified into four categories based on:

1. Routing information update mechanism
2. Use of temporal information for routing
3. Routing topology
4. Utilization of specific resources.

A classification tree is shown in the figure below.

III. AODV

AODV [4,5] is an on-demand, single path, loop-free distance vector protocol. It combines the on-demand route discovery mechanism in DSR [1] with the concept of destination sequence numbers from DSDV [6]. However, unlike DSR which uses source routing,

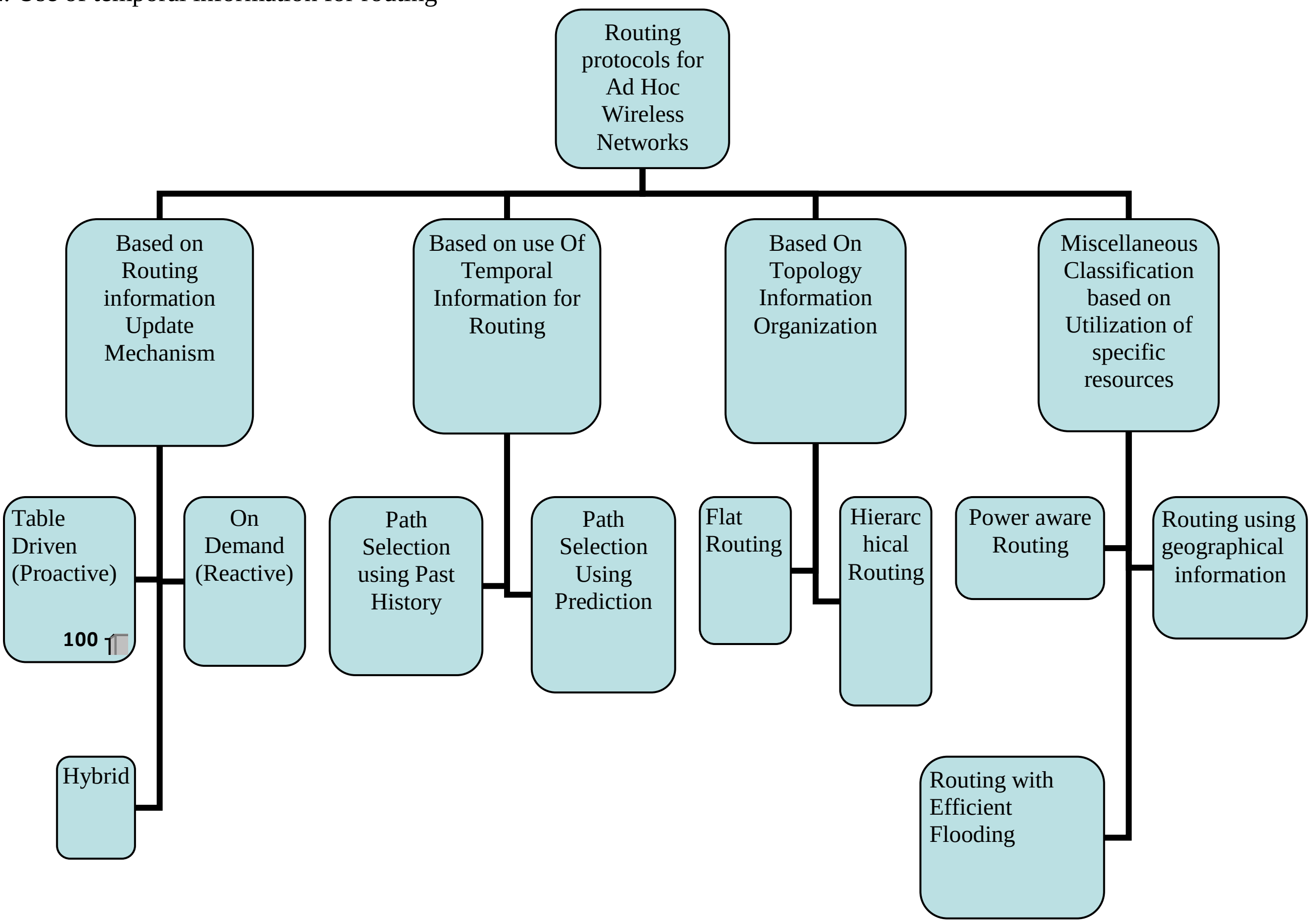

Fig 1: Classifications of Ad hoc Routing protocols

AODV takes a hop-by-hop routing approach. Below we give an overview of some key features of the AODV.

Route Discovery and Route Maintenance

In on-demand protocols, route discovery procedure is used by nodes to obtain routes on an ‘as needed’ basis. In AODV, route discovery works as follows. Whenever a traffic source needs a route to a destination, it initiates a route discovery by flooding a route request (RREQ) for the destination in the network and then waits for a route reply (RREP). When an intermediate node receives the first copy of a RREQ packet, it sets up a reverse path to the source using the previous hop of the RREQ as the next hop on the rever path. In addition, if there is a valid route available for the destination, it unicasts a RREP back to the source via the reverse path; otherwise, it re-broadcasts the RREQ packet. Duplicate copies of the RREQ are immediately discarded upon reception at every node. The destination on receiving the first copy of a RREQ packet forms a reverse path in the same way as the intermediate nodes; it also unicasts a RREP back to the source along the reverse path. As the RREP proceeds towards the source, it establishes a forward path to the destination at each hop. Route maintenance is done by means of route error (RERR) packets. When an intermediate node detects a link failure (via a link-layer feedback, e.g.), it generates a RERR packet. The RERR propagates towards all traffic sources having a route via the failed link, and erases all broken routes on the way. A source upon receiving the RERR initiates a new route discovery if it still needs the route. Apart from this route maintenance mechanism, AODV also has a timer-based mechanism to purge stale routes.

IV. Ad hoc On-Demand Multipath Distance Vector Routing

Our objective in this section is to extend the AODV protocol to compute multiple disjoint loop-free paths in a route discovery.

AOMDV shares several characteristics with AODV. It is based on the distance vector concept and uses hop-by-hop routing approach. Moreover, AOMDV also finds routes on demand using a route discovery procedure. The main difference lies in the number of routes found in each route discovery. In AOMDV RREQ propagation from the source towards the destination establishes multiple reverse paths both at intermediate nodes as well as the destination. Multiple RREPs traverse these reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. Note that AOMDV also provides intermediate nodes with alternate paths as they are found to be useful in reducing route discovery frequency [7]. The core of the AOMDV protocol lies in ensuring that multiple paths discovered are loop-free and disjoint, and in efficiently finding such paths using a flood-based route discovery. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop-freedom and disjointness properties.

Here we discuss the main ideas to achieve these two desired properties. Next subsection deals with incorporating those ideas into the AOMDV protocol including detailed description of route update rules used at each node and the multipath route discovery procedure.

AOMDV relies as much as possible on the routing information already available in the underlying AODV protocol, thereby limiting the overhead incurred in discovering multiple paths. In particular, it does not employ any special control packets. In fact, extra RREPs and RERRs for multipath discovery and maintenance along with a few extra fields in routing control packets (i.e., RREQs, RREPs, and RERRs) constitute the only additional overhead in AOMDV relative to AODV.

Figure 2 shows the difference in the routing table entry structure between AODV and AOMDV. AOMDV route table entry has a new field for the advertised hop count. Besides a route list is used in AOMDV to store additional information for each alternate path including: next hop, last hop, hop count, and expiration timeout.

Consider a destination d and a node i. whenever the destination sequence number for d at i is updated, the corresponding advertised hop count is initialized. For a given destination sequence number, let hop_count denote the hop count of k_{th} path (for some k) in the routing table entry for d at i.

Route discovery

As in AODV, when a traffic source needs a route to a destination, the source initiates a route discovery process by generating a RREQ. Since the RREQ is flooded network-wide, a node may receive several copies of the same RREQ. In AODV, only the first copy of the RREQ is used to form reverse paths; the duplicate copies that arrive later are simply discarded. Note that some of these duplicate copies can be gainfully used to form alternate reverse paths. Thus, all duplicate copies are examined in AOMDV for potential alternate reverse paths, but reverse paths are formed only using those copies that preserve loop-freedom and disjointness among the resulting set of paths to the source. When an intermediate node obtains a reverse path via a RREQ copy, it checks whether there are one or more valid forward paths to the destination. If so, the node generates a RREP and sends it back to the source along the reverse path; the RREP includes a forward path that was not used in any previous RREPs for this route discovery. In this case, the intermediate node does not propagate the RREQ further. Otherwise, the node re-broadcasts the RREQ copy if it has not previously forwarded any other copy of this RREQ and this copy resulted in the formation/updation of a reverse path.

Destination	Sequence No	Hop count	Next hop	Timeout

(a) AODV

Destination	Sequence No	Advertised Hop count	Route list

(b) AOMDV

Figure 2 Routing table entry structure in (a) AODV and (b) AOMDV

V. Scalable multipath on-demand routing (SMORT)

The principal objective of SMORT is to reduce the amount of routing overhead generated by an unipath on-demand routing protocol, using multipath routing. Alternate paths to destination avoid the overhead generated by the additional routing discoveries and route error transmissions, during route break recovery. Reduction in routing overhead allows the protocol to scale to larger networks. Multiple paths between a source and a destination are of two types, namely node-disjoint and link-disjoint multiple paths. Node-disjoint paths do not have any nodes in common, except the source and destination. Nodes labeled S and D are source and destination nodes, respectively. Node-disjoint multiple paths are used for traffic load-balancing (by dispersing data over multiple paths), and provide fault-tolerance towards route breaks. The advantage of node-disjoint multiple paths is that they fail independent of each other. Breakage of any link on one path can be corrected by resuming the data session through one of the other paths. Link-disjoint paths do not have common links, but may have nodes in common. A set of link-disjoint paths are formed by a series of node-disjoint segments. Each segment is a node-disjoint path between any two nodes.

SMORT is a multipath extension to the well-known unipath ad hoc routing protocol AODV. SMORT has three basic phases; namely route discovery, route reply and route maintenance.

When a node needs a route to some destination, it initiates route discovery process, by flooding a route-request packet into the network. Intermediate nodes receiving the route-request, send a routereply packet back to source if they have a valid path to the destination. Otherwise, they re-broadcast the request. Finally, when the destination receives the request, it initiates route reply process by sending a route-reply packet back to the source node. Unlike AODV, SMORT allows nodes to accept multiple copies of route-request packet, in order to enable computation of multiple fail-safe paths. Also, the destination replies to multiple copies of routerequest for the same reason.

Route reply reaches the source node through the reverse path recorded in a special table, during the route discovery phase. In order to avoid loops in the routes that may form due to the acceptance of multiple copies of route-request, route-reply packets carry the full path to the destination. Although, loops can be avoided in the route discovery phase itself, by carrying the list of nodes traversed in the route-request packet, SMORT does not carry full path in route-request packets as it may increase network wide collisions due to the flooding of large sized route-request packet across the entire network.

On the contrary, the number of route-reply packets communicated are limited when compared to the number of route-request packet transmissions (many copies of the route-request do not generate reply as they move away from destination), and they traverse on the actual routes between source and destination.

Finally, when the source receives the first route, it starts sending data packets to the destination. Intermediate nodes may receive multiple route-reply packets as the destination replies to multiple copies of route-request, but they relay only the first reply. The reply is relayed through multiple neighbors through which nodes received the routerequest packet previously. Extra replies are dropped after nodes copy secondary paths carried in them into their routing tables.

Route maintenance involves two important actions. Firstly, re-establishing the connection between source and destination, if all the routes between them fail in the middle of the session.

Secondly, deleting the expired routes from the routing table.

VI. Conclusion

In this paper we have discussed some important issues related to the load-balanced routing protocols for mobile ad hoc networks Load balanced routing protocols have different load metric as route selection criteria to better use MANET recourses and improves MANET performance. The heavily loaded nodes are also likely to incur high power consumption. MANET can maximize mobile nodes packet delivery ratio, throughput lifetime and load unbalanced as a result end-to-end delay can be minimized.

References

[1] D. B. Johnson, D. A. Maltz, “Dynamic source routing in ad hoc wireless networks,” Mobile Computing, pp. 153–181, 1996.

[2] Josh Broch, David A. Maltz, David B. Johnson, Yih-Chun Hu, Jorjeta Jetcheva. “A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols,” The Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking, pp. 1-13, 1998

[3] Chen, X., H. M. Jones, A .D .S. Jayalath, “Congestion-Aware Routing Protocol for Mobile Ad Hoc Networks,” Vehicular Technology Conference 2007, pp. 21-25, 2007

[4] S. Ramanathan, M. E. Steenstrup, “A survey of routing techniques for mobile communications networks, mobile networks and applications,” Vol. 1, pp. 98–104, 1996.

[5] C. E. Perkins, “Ad hoc on demand distance vector (AODV) routing,” IEFT Internet Draft, November 1998,

[6] H. Raghavendra and D.A. Tran, “Congestion Adaptive Routing in Ad Hoc Networks (Short Version),” Proc. ACM Int’l Conf. Mobile Computing and Networking (MOBI-COM), Oct. 2004. [7] H. Raghavendra and D.A. Tran, “Congestion Adaptive Routing in Ad Hoc Networks” IEEE Transactions on Paral-lel and Distributed Systems, Vol. 17, No. 11, November 2006.

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