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Review of Different Criteria for Designing Routing Protocols

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Abstract— Routing is the process of finding optimal path between source and destination. Because of the fact that packet may be necessary to hop or several hops before a packet reach the target, a routing protocol is needed. Routing protocols allow routers to dynamically advertise and discover routes, decide which routes are available and which are the most efficient routes to a target. In this paper we review different existing protocols and their applicability in current scenario.

Keywords— MANET, Routing, Performance, Qualitative, Quantitative Characteristics

I. INTRODUCTION

Mobile environment differs from the stationary environment in many respects. Computers in stationary environments are usually very reliable and efficient during data transfer from one host to another host. A stationary environment can distribute an application's components and rely upon the use of high-bandwidth, small latency networks to provide excellent interactive application performance[1].

Various methods in the past have been developed to optimize the quality of service over wireless communications network. These methods have been developed in order to optimize the operation in standalone node itself. But the development was not focused on optimizing the network performance based on full observation in a network. The advantage of optimizing the network performance based on observations of the full network is to maximize the network throughput. In order to achieve the throughput requirements various methods were developed.

II. ROUTING PROTOCOL

A routing protocol is the mechanism by which user traffic is directed and transported through the network from the source node to the destination node. Objectives comprise maximizing network performance and minimizing the cost of network in accordance with its capacity. The network performance depends upon hop count, delay, throughput, loss rate, stability, cost, etc; and the network capacity is a function of available resources resides at each node and number of nodes in the network as well as its density, frequency of communication, frequency of change in topology. Routing in Ad hoc environment is diverse compared to normal wired networks[2]. This is chiefly due to following two factors:

1. The bandwidth restriction
2. Rapid change in network topology

The basic routing functionality for mobile ad hoc networks is as follows:

- **Path generation Mechanism:** which generates paths according to the assembled and distributed state information of the network and of the application; assembling and distributing network and user traffic state information,
- **Path selection Mechanism:** which selects appropriate paths based on network and application state information.
- **Data Forwarding Mechanism:** which forwards user traffic along the selected route forwarding user traffic along the selected route.
- **Path Maintenance Mechanism:** maintaining of the selected route.

III. PROPERTIES OF PROFICIENT ROUTING ALGORITHM

Some common desirable properties that any routing protocol for an ad hoc network should possess are as follows:

A. Qualitative Characteristics

Several qualitative properties for designing a routing protocol are desired for a mobile ad hoc network.

- Loop free: Presence of loops in the path from the source to the destination result in inefficient routing. In the worst-case situation, the packets may keep traversing the loop indefinitely and never reach their destination.
- Distributed control: In a centralized routing scheme, one node stores all the topological information and makes all routing decisions; therefore, it is neither robust, nor scalable. The central router can be a single point of failure; also, the network in the vicinity of the central router may get congested with routing queries

and responses.

- Fast routing: The quicker the routing decisions are made, the sooner the packets can be routed towards the destination, as the probability that the packets take the chosen route before it gets disrupted because of node mobility is quite high.
- Localized reaction to topological changes: Topological changes in one part of the network should lead to minimal changes in routing strategy in other distant parts of the network. This will keep the routing update overheads in check and make the algorithm scalable.
- Multiplicity of routes: Even if node mobility results in disruption of some routes, other routes should be available for packet delivery.
- Power efficient: A routing protocol should be power efficient. That is the protocol should distribute the load otherwise shut-off nodes may cause partitioned topologies that may result in inaccessible routes.
- Secure: A routing protocol should be secure. We need authentication for communicating nodes, non-repudiation and encryption for private networking to avoid routing deceptions.
- QoS aware: A routing protocol should also be aware of Quality of Service. It should know about the delay and throughput for a source destination pair, and must be able to verify its longevity so that a real-time application may rely on it.

B. *Quantitative Characteristics*

There are several quantitative performance metrics that can be used to assess the performance of routing protocols within a mobile ad hoc network. First, throughput and end-to-end delay are typical performance measures that show a routing protocol's effectiveness in doing its job (i.e. delivering data packets). Second, for certain protocols that acquire routes on-demand the amount of time it takes to acquire a route or route discovery latency is also an important performance measure. This measurement more simply conforms to those protocols that are of a demand-base property and thus should be attained. Third, bandwidth utilization should be observed to notice, how effectual the protocol is if both routing packets and data packets share the same channel. One such measure would be to attain the number of bytes (or packets) of routing packets transmitted per number of bytes (or packets) of data packets delivered. Another such measurement may be the amount of data bits transmitted per data bit delivered to show the efficiency of data delivery throughout the network.

IV. CLASSIFICATION OF ROUTING PROTOCOLS

There are different criteria [3] for designing and classifying routing protocols for wireless Ad hoc networks as shown in table 2.1 below.

Table 2.1: Classification of Routing Protocols

Classification	Criteria used
Pre-Computed Routing Vs. On-Demand Routing	Depending on when the route is computed
Periodical Update vs. Event-Driven Up-Date	Based on when the routing information will be disseminated
Flat Structure vs. Hierarchical Structure	Based on the number of levels (clusters) used
Decentralized Computation vs. Distributed Computation	Based on how (or where) a route is computed
Source Routing Vs. Hop-By-Hop Routing	Based on routing information available in packet header
Single Path (unipath) Vs. Multiple Paths (multipath)	Based on number of paths established

A. *Pre-Computed Routing Vs. On-Demand Routing [4]*

Depending on when the route is computed, routing protocols can be divided into two categories: Pre-computed routing and On-demand routing. Pre-computed routing is also called proactive routing or table driven routing [5]. In Proactive routing, routes to all destinations are computed a priori and link states are maintained in node's routing tables in order to compute routes in advance. To keep the information up to date, nodes require to update their information periodically. The major benefit of proactive routing is when a source needs to send packets to a destination, the route is already available, i.e., and there is no latency. The drawback of proactive routing are some routes may never be used and dissemination of routing information will consume a lot of the scarce wireless network bandwidth when the link state and network topology change fast.

On-demand routing is also called reactive routing. In Reactive (on-demand) routing, protocols update routing information when a routing requirement is presented i.e. a route is built only when necessary. The main benefit reactive routing is that the precious bandwidth of wireless Ad hoc networks is greatly saved. And the main disadvantage is if the topology of networks changes quickly, a lot of update packets will be generated and distributed over the network, which will use a lot of

valuable bandwidth, and furthermore, may cause too much fluctuation of routes.

B. Periodical Update Vs Event-Driven Update [4]

Routing information needs to be disseminated to network nodes in order to ensure that the knowledge of link state and network topology remains up-to-date. Based on when the routing information will be disseminated, we can classify routing protocols as periodical update and event-driven update protocols. Periodical update protocols disseminate routing information periodically. Periodical updates will maintain network stability, and most importantly, enable (new) nodes to learn about the topology and the state of the network. However if the period between updates is large, the protocol may not keep the information up-to-date. On the other hand, if the period is small, too many routing packets will be disseminated which consumes the precious bandwidth of a wireless network. In an event-driven update protocol, when events occur, (such as when a link fails or a new link appears), an update packet will be broadcast and the up-to-date status can be disseminated over the network soon. The problem might be that if the topology of networks changes rapidly, a lot of update packets will be generated and disseminated over the network, which will use a lot of valuable bandwidth, and furthermore, may cause too much fluctuation of routes. One solution[6][7] is to use some threshold which imposes maximum limit to update packets.

C. Flat Structure Vs. Hierarchical Structure

In a flat structure, all nodes in a network are at the same level and have the same routing functionality. Flat routing is straightforward and proficient for little networks. The hitch is that when a network becomes bulky, the amount of routing information will be outsized and it will take a extended time for routing information to arrive at remote nodes. For large networks, hierarchical (cluster-based) routing may be used to solve the above problems [7]. In hierarchical routing the nodes in the network are dynamically organized into partitions named as clusters, and then the clusters are combined again into larger partitions called super-clusters and so on. Organizing a network into clusters assist to maintain a comparatively stable network topology. The high dynamics of membership and network topology is restricted within clusters. Only stable and high level information such as the cluster level or the super-cluster level will be propagated across a long distance, thus the control traffic (or routing overhead) may be largely reduced [6]. Within a cluster, the nodes may have complete topology information about its cluster and proactive routing may be used. If the destination is in a different cluster from the source, inter-cluster routing must be utilized. Inter-cluster routing is usually reactive, or a combination of proactive and reactive routing. Alike cellular structure in cellular systems, a hierarchical cluster is readily deployable to achieve some kind of resource reuse such as frequency reuse and code reuse and interference can be reduced when using different spreading codes across clusters.

D. Decentralized Computation Vs. Distributed Computation

Based on how (or where) a route is computed, there are two categories of routing protocols: decentralized computation and distributed computation. In a decentralized computation-based protocol, all node in the network preserve global and complete information about the network topology such that the node can compute the route to a destination itself when desired. The route computation in LSR is a typical example of decentralized computation.

In a distributed computation-based protocol, every node in the network only maintains partial and local information about the network topology. When a route needs to be calculated, many nodes collaborate to compute the route. The route computation in DVR and the route discovery in on demand routing belong to this category.

E. Source Routing Vs. Hop-by-Hop Routing

Some routing protocols place the entire route (i.e., nodes in the route) in the headers of data packets so that the intermediate nodes only forward these packets according to the route in the header. Such a routing is called “source routing”. Source routing has the advantage that intermediate nodes do not need to maintain up-to-date routing information in order to route the packets they forward, because the packets themselves previously contain all the routing decisions. This fact, when coupled with on demand route computation, eradicates the necessity for the periodic route advertisement and neighbour detection packets required in other kinds of protocols [8]. The major difficulty with source routing is that when the network is large and the route is long, placing the whole route in the header of every packet will waste a lot of scarce bandwidth.

In a hop-by-hop routing, the route to a destination is distributed in the “next hop” of the nodes alongside the route. When a node accepts a packet to a target, it forwards the packet to the next hop corresponding to the target. The tribulations are that all nodes need to maintain routing information and there may be a possibility of forming a routing loop.

F. Single Path Vs. Multiple Paths

Some routing protocols will find a single route from a source to a destination, which results in simple protocol

and saves storage. Other routing protocols will find manifold routes, which have the benefits of simple recovery from a route malfunction and being more reliable and robust. Single path routing protocols have been extensively examined in the past[9][10]. A more recent research topic for MANETs is multipath routing protocols. Multipath routing protocols set up numerous disjoint paths from a source to a destination and are thereby improving resilience to network failures and allow for network load balancing. These upshots are principally interesting in networks with high node density (and the corresponding larger choice of disjoint paths) and high network load (due to the ability to load balance the traffic around congested networks).

V. CONCLUSION

Routing is the process of finding optimal path between source and destination. Because of the fact that packet may be necessary to hop or several hops before a packet reach the target, a routing protocol is needed. Routing protocols allow routers to dynamically advertise and discover routes, decide which routes are available and which are the most efficient routes to a target. The routing protocol has two main jobs, selection of routes for various source-target pairs and the deliverance of massages to their correct target. The second function is conceptually straight forward using a verity of protocols and data structures (routing tables). In this research work we focused on selecting and finding various criteria for routing protocols.

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