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Routing Strategies in Adhoc Network

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Abstract

Wireless Communication is the transfer of information over long distances without the use of wires. The connectivity of wireless communication is nearly everywhere and becoming highly affordable even for people who are in the pyramid's bottom. Wireless networking is slowly pushing out wired networking and ideal solution for a user that wants the ability and freedom to roam without having a fixed cable determining the distance that user can go before having to stop due to a cable. – "connect anytime, anywhere, anyhow" promising ubiquitous network access at high speed to the end users, has been a topic of great interest especially for the wireless telecom industry. An ad hoc network has certain characteristics, which imposes new demand on routing protocols. The most important characteristics is the dynamic topology, which is the consequence of node mobility. Nodes can change position quite frequently, which means that we need a routing protocol that quickly adapts to topology changes. This means that routing protocol should try to minimize control traffic, such as periodic update messages, instead the routing protocols should be reactive, thus only calculate routes upon receiving a specific request.

Keywords: DSR, Uniform Routing, FSR, CGSR& DSDV etc.

Introduction

With the advance of the wireless communication technologies, small size and high performance computing communication devices have been increasingly used in daily life and computing industry (e.g., commercial laptops and personal digital assistants equipped with radios). In this paper, we consider a large population of such devices wishing to communicate. While the infrastructure cellular system is a traditional model for mobile wireless network, here we focus on a network that does not rely on a fixed infrastructure and works in a shared wireless media. Such a network, called a mobile ad hoc network (MANET), is a self-organizing and self-configuring multi-hop wireless network, where the network structure changes dynamically due to member mobility. Ad hoc networks are very attractive for tactical communication in military and law enforcement. They are also expected to play an important role in civilian forums such as convention centers, conferences, and electronic classrooms. Nodes in this network model share the same random access wireless channel. They cooperate friendly to engage in multiple-hop forwarding. Each node functions not only as a host but also as a router that maintains routes to and forwards data packets for other nodes in the network that may not be within direct wireless transmission range. Routing in ad hoc networks faces extreme challenges from node mobility/dynamics, potentially very large number of nodes, and limited communication resources (e.g., bandwidth and energy).The routing protocols for ad hoc wireless networks have to adapt quickly to frequent and unpredictable topology changes and must be parsimonious of communications and processing resources. Due to the fact that bandwidth is scarce in MANET nodes and that the population in a MANET is small, as compared to the wire line Internet, the scalability issue for wireless multi hop routing protocols is mostly concerned with excessive route. A considerable body of literature has addressed research on routing and architecture of ad hoc networks. Relating to the problem describe above, we present a survey with focus on solutions towards scalability in large populations that are able to handle mobility. Different from that, we provide here a classification according to the network structure underlying routing protocols. Different structures affect the design and operation of the routing protocols. Different structures also determine the performance within message overhead caused by the increase of network population and mobility. Routing table size is also a concern in MANETs because large routing tables imply large control packet size hence large link overhead. Routing protocols generally use either distance-vector or link-state routing algorithms. Both types find shortest paths to destinations. In distance-vector routing (DV), a vector containing the cost (e.g., hop distance) and path (next hop) to all the destinations is kept and exchanged at each node. DV protocols are generally known to suffer from slow route convergence and tendency of creating loops in mobile environments. In large networks, the transmission of routing information will ultimately consume most of the bandwidth and consequently block applications, rendering it unfeasible for bandwidth limited wireless ad hoc networks. Thus, reducing routing control overhead becomes a key issue in achieving routing scalability. In some application domains (e.g., digitized battlefield) scalability is realized by designing a hierarchical architecture with physically distinct layers (e.g., point-to-point wireless backbone) . However, such physical hierarchy is not cost-effective for many other applications (e.g., sensor networks). Thus, it is important to find solutions to the scalability problem of a homogeneous ad hoc network strictly using scalable routing protocols. Classification according to routing strategy, Different from that, we provide here a classification according to the network structure underlying routing protocols. Different structures affect the design and operation of the routing protocols.

Properties of Routing Protocols

a) Distributed operation: Even for stationary networks, the protocol should not be dependent on a centralized controlling node. Ad-hoc network nodes can very easily enter or leave the network and the network can be partitioned because of mobility.
b) Demand based operation: The protocol should be reactive to minimize the control overhead in the network and not waste the network resources. The protocol should react only when needed and it should not periodically broadcast control information.
c) Loop free: The routing protocol should guarantee that the routes supplied are loop free to improve the overall performance avoiding any wastage of bandwidth or CPU consumption.
d) Multiple routes: The topological changes and congestion multiple routes can be used to reduce the number of reactions. Hence if one of the routes becomes invalid, there is a possibility of another stored route to be valid and hence saving the routing protocol from initiating another route discovery procedure.
e) Quality of Service Support: Quality of service is necessary to some extend incorporate into the routing protocol. This helps to find usage of these networks, which could be for instance real time traffic support. None of the proposed protocols have all these properties, but the protocols are still under development and are probably extended with more functionality.
f) Security: The radio environment is especially liable to enactment attacks so as to ensure the required behavior of the routing protocol, we need some sort of security measures. Authentication and encryption is the way to ensure security.
g) Power conservation: The nodes in the ad-hoc network can be laptops or computers and thin clients such as PDA"s which are limited in battery power and hence uses some standby mode power saving, Hence it is important for the routing protocol to support these sleep modes.
h) Unidirectional link support: Unidirectional links are formed by the radio environment. The performance can be improved by proper utilization of these links, not only the bi-directional links.

Uniform Routing

Dynamic Source Routing (DSR): It is a reactive and uniform routing protocol that uses a concept of source routing. Each node lists the complete routes to all destinations for which the routes are known in a route cache. A source node has the routes leading a data packet in its header, which are discovered on demand by a route discovery process. When a node does not have a route cache entry for the destination of the data packet, it initiates a route discovery by broadcasting a route QUERY message seeking a route to the destination. The REQUEST packet has the source identities and the aimed destination. Every node which receives a REQUEST packet firstly checks its route cache for an existing entry to the desired destination. If it doesn't have such an entry, the node adds its identity to the header of the REQUEST packet and transmits it. Finally the REQUEST packet will flood the whole network by traversing nodes tracing all possible paths. When it reaches the destination, that has a known route, a REPLY is sent back to the source following the same route that was traversed by that QUERY packet in the reverse direction by simply copying the sequence of identities obtained from the header of REQUEST packet. The REPLY packet contains the entire route to the destination, which is recorded in the source node's route cache. When an existing route breaks, it is detected by the failure of forwarding data packets on the route. Such a failure is observed by the absence of the link layer acknowledgement expected by the node where the link failure has occurred. On the detection of the failure of

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link, it sends this information from an ERROR packet to the source, now the nodes receiving the ERROR packet, delete all of the routes from their respective caches that contain the stated link. If it is still needed, a fresh route discovery is initiated. Some other uniform routing protocols are OSR, AODV, DSDV, TORA and ABR.

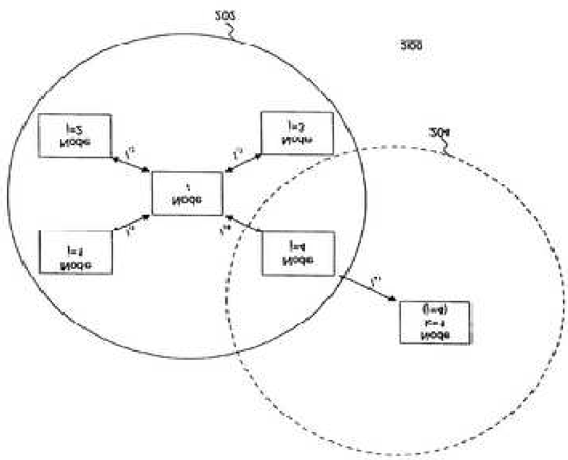

Fig 1: Dynamic Source Routing

NON Uniform Routing

Fisheye State Routing (FSR): The enhancement of GSR is FSR. The large sized updated messages in GSR consume a continual amount of network bandwidth. For overcoming this problem, FSR uses a method in which each updated messages would not includes information about all nodes. Alternatively, it swaps information about neighboring nodes usually than it does about farther nodes, hence reducing the updated message size. Each node gets accurate information about near neighbors and information accuracy decreases with the increase in distance from the node. A node does not have accurate information about the far nodes, the packets are routed accurately as the route information becomes more and more precise as the packet moves closer to the destination. Some other protocols are ZRP, OSLR, CEDAR, DST, HSR and LANMAR.

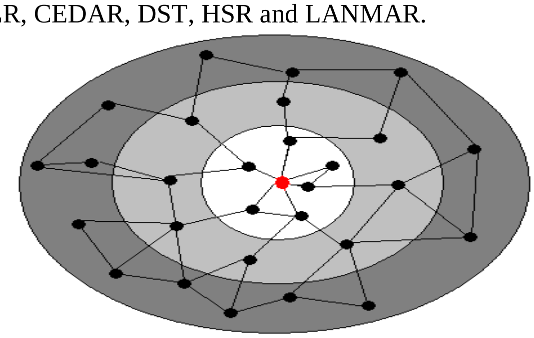

Fig 2: Non Uniform Routing

Single Channel Routing

Optimized Link State Routing Protocol (OLSR):

It is a new proactive routing protocol [9]. It is conventional LS routing in which each node tries to maintain information about the network topology. Each node determines the link costs to each of its neighbors by broadcasting HELLO messages periodically. Whenever there is a change in the link costs, the node broadcasts this information to all other nodes. In classical link-state algorithms, this is done by each node overwhelming the whole network with the update packets consisting of the updated link costs. Nodes use information for applying a shortest path algorithm (such as Dijkstra-s shortest path algorithm [6] to determine the best route to a specific destination. OLSR optimizes the link-state protocol in two ways. First, it reduces the size of the update packets sent during the broadcasts by including only a subset of links to its neighbors. These are the links to a select set of neighbors known as the multipoint relays (MPR). The set of MPRs of a node consist of the minimum set of one hop neighbors of that node so that the node can reach all of its two hop neighbors by using these nodes as relay points. Each node computes its MPR set from the exchange of neighborhood information with all its neighbors. Second, instead of every neighbor broadcasting the update packets sent out by a node, only the MPR nodes participate in broadcasting of these packets in OLSR , which minimizes the control traffic packets during flooding. However, the savings of bandwidth achieved using these two techniques come at a cost of propagating incomplete topology information in the network. The updates include only MPR sets and not the sets of all neighbors of the broadcasting nodes. Therefore , partial topology based information of a shortest path algorithm will generate routes having the MPR nodes only. When the network is dense, i.e. when each node has many neighbors, OLSR will work out to be efficient due to the reduction of control traffic for updates in the network. Some other protocols of single channel are DSR, GSR, DSDV, WRP, AODV, and ABR.

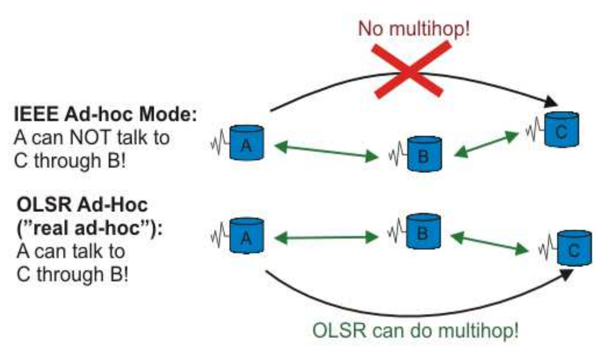

Fig 3: Single Channel Routing

Multi Channel Routing

Cluster head Gateway Switch Routing :

Clusterhead-Gateway Switch Routing (CGSR) [2] is a typical cluster based hierarchical routing. A stable clustering algorithm Least Clusterhead Change (LCC) is used to partition the whole network into clusters and a clusterhead is elected in each cluster. A mobile node that belongs to two or more clusters is a gateway connecting the clusters. Data packets are routed through paths having a format of ”Clusterhead – Gateway – Clusterhead - Gateway ...” between any source and destination pairs. CGSR is a distance vector routing algorithm. Two tables, a cluster member table and a DV routing table, are maintained at each mobile node. The cluster member table records the Clusterhead for each node and is broadcast periodically. A node will update its member table upon receiving such a packet. The routing table only maintains one entry for each cluster recording the path to its clusterhead, no matter how many members it has. To route a data packet, current node first looks up the clusterhead of the destination node from the cluster member table. Then, it consults its routing table to find the next hop to that destination cluster and routes the packet towards the destination clusterhead. The destination clusterhead will finally route the packet to the destination node, which is a member of it and can be directly reached. The major advantage of CGSR is that it can greatly reduce the routing table size comparing to DV protocols.
One entry is needed for all nodes in the same cluster. Thus the broadcast packet size of routing table is reduced. These features make a DV routing scale to large network size. Although an additional cluster member table is required at each node, its size only decided by the number of clusters in the network. The drawback of CGSR is the difficulty to maintain the cluster structure in mobile environment. The LCC clustering algorithm introduces additional overhead and complexity in the formation and maintenance of clusters. Some other protocols of Multi channel are TLR, TRR and TORA.

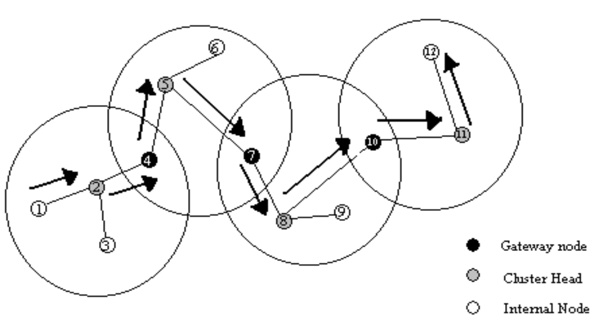

Fig 4:Multiple Channel Routing

Conclusion

In this paper, study of ad hoc networks and its classification is provided. It is a meaningful attempt to clarify the vast field of ad hoc routing protocols. It is so because it tries to reveal the main design and implementation principles behind protocols. The classification is a little bit complicated and it is not always an easy task to classify a protocol according to that taxonomy, but the meaning of classifying is try to get some rough basis for protocol’s performance evaluation.

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