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Routing Convenant For Mobile Ad-Hoc Networks based on Pragmatic Cluster

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Abstract— As a large-scale, high-density multi-hop network becomes desirable in many applications, there exists a greater demand for scalable mobile ad hoc network (MANET) architecture. This paper proposes a new routing protocol for mobile adhoc networks. The idea is to significantly reduce the control overheads such as route query packets as well as the flooding time for collecting the network topology information at a destination. Clustering algorithms select master nodes and maintain the cluster structure dynamically as nodes move. Routing protocols utilize the underlying cluster structure to maintain routing and location information in an efficient manner. This paper discusses the various issues in scalable clustered network architectures for MANETs. This includes a classification of link-clustered architectures, an overview of clustering algorithms focusing on master selection, and a survey of cluster-based routing protocols. A disconnected route can be replaced by backup route, if available. Our simulation results show that terminode routing performs well in networks of various sizes. In smaller networks, the performance is comparable to MANET routing protocols. In larger networks that are not uniformly populated with nodes, terminode routing outperforms existing location-based or MANET routing protocols. No additional computational overheads are increased for computing the backup route.. It exhibits all these desirable characteristics without compromising on other important performance measures.

Keywords: Cluster, Ad-Hoc Networks, Routing Protocol, Location monitoring,

I. INTRODUCTION

Mobile ad hoc networks (MANETs) are collection of mobile nodes that intercommunicate on shared wireless channels. The topology of the network changes with time due to mobility of nodes. Nodes may also enter or leave the network. These nodes have routing capabilities which allow them to create multi hop paths connecting node which are not within radio range. A network is a collection of two or more computing devices connected by a communication medium. Figure 1 shows a simple network with three computing devices. When a computing device wishes to send information to another device, it may do so by transmitting the information along a shared communication medium. any computing device actively participating in a network is called a *node*. Nodes are connected by a communication medium or *link*. Nodes exchange information over links in discrete blocks called *packets*. In Figure 1, any node can communicate with any other node along the single shared link. In this case, no special steps are needed for any two nodes in the network to exchange information. If, however, nodes in a network do not share a common link, this no longer holds true. Figure.2 shows a network where different nodes share different links.

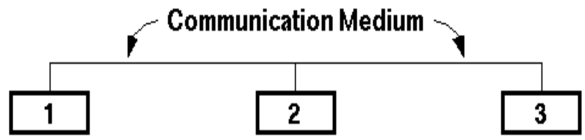

Figure 1: Simple network with three nodes

For example, in Figure 2, for node 1 to send a packet to node 8, the packet must first be sent to node 3. Node 3 must subsequently be willing and able to forward the packet on to node 8. The links and nodes a packet traverses along its journey from source to destination is called the packet's path. Whenever a packet is transmitted from one node to another, it is said to have made a hop. In the above example, a packet sent from node 1 to node 3 requires one hop, whereas a packet sent from node 1 to node 8 requires two hops (one hop from node 1 to node 3, and a second hop from node 3 to node 8). In the above example, the various nodes along the packet's path from node 1 to node 8 must cooperate in order to make the information exchange successful. This cooperation process is called routing.

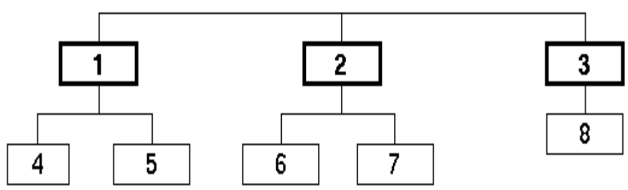

Figure 2: Network with eight nodes connected by four separate links.

Conventional networks tend to change infrequently, relaxing the burden on the routing protocol to return to a stable state in response to a topology change. The process of returning to a stable state after a topology change is called convergence. The time required for a routing protocol to converge is called its convergence time. As will be seen in later sections, many routing protocols (in both ad hoc and conventional networks) can form temporary routing loops when the topology changes. These routing loops may persist until the routing protocol converges. Sensors are generally equipped with data processing and communication capabilities. The sensing circuitry measures parameters from the environment surrounding the sensor and transforms them into an electric signal[4]. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. In this paper, we propose a new hybrid routing algorithm for MANET called Cluster based Routing Protocol (CRP) algorithm. The most popular HRP protocol is the ZRP [9], in which the cluster is called a *routing zone* [2],[9]. HRP significantly improves both the delay and control overhead performances, within the constraints imposed by PRP and RRP. This is the motivation for proposing the *Virtual Cluster-based Routing Protocol* (VCRP). It works on the basis of a virtual cluster in mobile ad-hoc networks. The aim is to somehow garner the benefits accruing from the short packet transfer delay of PRP and the small overheads performance of RRP. The delay performance is further enhanced by a backup route for uninterrupted transmission of data packets even when a route is disconnected. The corresponding scheme is called a *Virtual Cluster-based Routing Protocol* (VCRP).

It uses clustering's structure to decrease routing control overhead and improve the networks scalability. Results show that the packet delivery ratio increases greatly and packet delay decreases significantly, when compared with other routing algorithms such as ad hoc on-demand Distance Vector (AODV).

II. Related Work

Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad-hoc networks[1,2,5,6].

- It is not possible to build global addressing scheme for the deployment of sheer number of sensor nodes. Thus classical Internet Protocol based routing protocols cannot be applied to sensor networks.
- In contrary to typical communication networks almost all applications of sensor networks require the flow of sensed data from multiple regions (sources) to a particular sink.
- Generated traffic has significant redundancy in it since multiple sensors may generate same data within the vicinity of a phenomenon. Such redundancy needs to be exploited by the routing protocol to improve energy and bandwidth utilization.
- Sensor nodes are tightly constrained in terms of transmission power, on-board energy, processing capacity and storage and thus require careful resource management.

MANETs generally do not rely on fixed infrastructure for communication and dissemination of information. VANETs follow the same principle and apply it to the highly dynamic environment of surface transportation. The architecture of VANETs falls within three categories: pure cellular/WLAN, pure ad hoc, and hybrid. VANETs may use fixed cellular gateways and WLAN access points at traffic intersections to connect to the Internet, gather traffic information or for routing purposes. The network architecture under this scenario is a pure cellular or WLAN structure. VANETs can combine both cellular network and WLAN to form the networks so that a WLAN is used where an access point is available and a 3G connection otherwise. Stationary or fixed gateways around the sides of roads could provide connectivity to mobile nodes (vehicles) but are eventually unfeasible considering the infrastructure costs involved. In such a scenario, all vehicles and roadside wireless devices can form a mobile ad hoc network to perform vehicle-to-vehicle communications and achieve certain goals, such as blind crossing (a crossing without light control. VANETs comprise of radio-enabled vehicles which act as mobile nodes as well as routers for other nodes.

III. Review Of Routing Protocols

Because of the dynamic nature of the mobile nodes in the network, finding and maintaining routes is very challenging in VANETs. Routing in VANETs (with pure ad hoc architectures) has been studied recently and many different protocols were proposed. We classify them into five categories as follows: ad hoc, position-based, cluster-based, broadcast, and geocast routing.

Ad Hoc Routing

As mentioned earlier, VANET and MANET share the same principle: not relying on fixed infrastructure for communication, and have many similarities, *e.g.*, self organization, self-management, low bandwidth and short radio transmission range. Thus, most ad hoc routing

protocols are still applicable, such as AODV (*Ad-hoc On-demand Distance Vector*) [6] and DSR (*Dynamic Source Routing*) [7]. AODV and DSR are designed for general purpose mobile ad hoc networks and do not maintain routes unless they are needed. Hence, they can reduce overhead, especially in scenarios with a small number of network flows. However, VANET differs from MANET by its highly dynamic topology. A number of studies have been done to simulate and compare the performance of routing protocols in various traffic conditions in VANETs [8]– [11]. The simulation results showed that most ad hoc routing protocols (*e.g.*, AODV and DSR) suffer from highly dynamic nature of node mobility because they tend to have poor route convergence and low communication throughput. In [11], AODV is evaluated with six sedan vehicles. It showed that AODV is unable to quickly find, maintain, and update long routes in a VANET. Also in their real-world experiment, because packets are excessively lost due to route failures under AODV, it is almost impossible for a TCP connection to finish its three-way handshake to establish a connection. Thus, certain modification of the existing ad hoc routing protocols to deal with highly dynamic mobility or new routing protocols need to be developed.

In [12], AODV is modified to only forward the route requests within the *Zone of Relevance* (ZOR). The basic idea is the same as the *location-aided routing* (LAR) [13]. ZOR is usually specified as a rectangular or circular range, it is determined by the particular application [14]. For example, for the road model of the divided highway, the ZOR covers the region behind the accident on the side of the highway where the accident happens.

Position-Based Routing

Node movement in VANETs is usually restricted in just bidirectional movements constrained along roads and streets. So routing strategies that use geographical location information obtained from street maps, traffic models or even more prevalent navigational systems onboard the vehicles make sense. This fact receives support from a number of studies that compare the performance of topology-based routing (such as AODV and DSR) against position-based routing strategies in urban as well highway traffic scenarios [8], [9]. Therefore, geographic routing (position-based routing) has been identified as a more promising routing paradigm for VANETs.

Even though vehicular nodes in a network can make use of position information in routing decisions, such algorithms still have some challenges to overcome. Most position based routing algorithms base forwarding decisions on location information. For example, greedy routing always forwards the packet to the node that is geographically closest to the destination. GPSR (*Greedy Perimeter Stateless Routing*) [15] is one of the best known position-based protocols in literature. It combined the greedy routing with face routing by using face routing to get out of the local minimum where greedy fails. It works best in a free open space scenario with evenly distributed nodes. GPSR is used to perform simulations in [9] and its results were compared to DSR in a highway scenario. It is argued that geographic routing achieves better results because there are fewer obstacles compared to city conditions and is fairly suited to network requirements.

Cluster-Based Routing

In cluster-based routing, a virtual network infrastructure must be created through the clustering of nodes in order to provide scalability. Each cluster can have a cluster head, which is responsible for intra- and inter-cluster coordination in the network management functions. Nodes inside a cluster communicate via direct links. Inter-cluster communication is performed via the cluster heads. The creation of a virtual network infrastructure is crucial for the scalability of media access protocols, routing protocols, and the security infrastructure. The stable clustering of nodes is the key to create this infrastructure. Many cluster-based routing protocols [20]–[22] have been studied in MANETs. However, VANETs behave in different ways than the models that predominate in MANETs research, due to driver behavior, constraints on mobility, and high speeds. Consequently, current MANETs clustering techniques are unstable in vehicular networks. The clusters created by these techniques are too short-lived to provide scalability with low communications overhead. The connectivity graphs of wireless networks typically contain many crossing edges. Face routing must run on a planar sub graph.

IV. HYPOTHESIS

LCA for Routing Backbone

One important design problem in constructing an LCA for routing backbone is to select master nodes so that they can form an efficient routing infrastructure. The master selection and cluster maintenance algorithms for LSG and LNG in a MANET.

4.1 Clustering Algorithms

Designing a clustering algorithm is not trivial due to the following reasons. First, electing a master node among a set of directly connected nodes is not straightforward because each candidate has a different set of nodes depending on the spatial location and the radio transmission range. Second, a clustering algorithm must be a distributed algorithm and be able to resolve conflicts when multiple mutually exclusive candidates compete to become a master. Third, the clustering algorithm must be able to dynamically reconfigure the cluster structure when either some nodes move or some masters need to be replaced due to overloading. Finally, another difficulty is that, in the presence of mobility, it must preserve its cluster structure as much as possible and reduces the communication overhead to reconstruct clusters [7]. Below we will discuss the cluster construction problem involving the first two issues, and then explain the cluster maintenance algorithm that must deal with the last two issues.

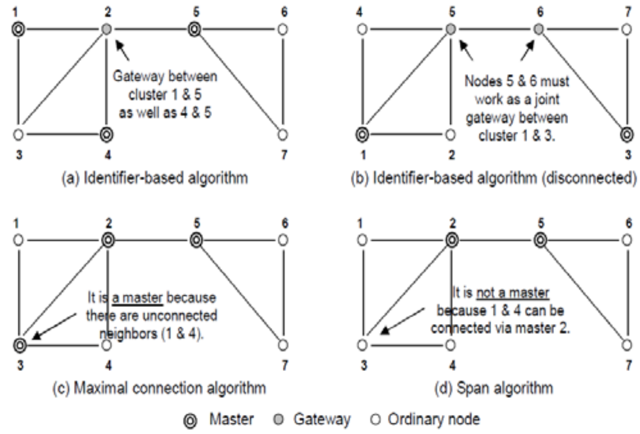

Fig. 3. Master selection algorithms

There are various clustering algorithms used to construct a LSG. In the *identifier-based algorithm* [6], a node elects itself as a master if it has the lowest-numbered identifier in its uncovered neighbors, where any node that has not yet elected its master is said to be uncovered. Fig. 3(a) shows the process of master selection based on this algorithm. Nodes 1 and 4 elect themselves as masters and nodes 2 and 3 are covered by those masters. Among uncovered nodes (nodes 5, 6 and 7), node 5 elect itself as a master because it has the lowest identifier. By definition, a master node cannot have another master as a neighboring node and thus, this algorithm produces an single-gateway structure..

V. ANALYSIS RESULTS

We evaluate the proposed routing protocol and compare it with AODV routing protocol via simulation. For this purpose, we implemented the proposed algorithm on the NS-2 [9] simulator. The performance of the CRP and AODV protocol is evaluated in terms of packet delivery ratio and average end-to-end delay. The packet delivery ratio is defined as the percentage of packets that successfully reach the receiver nodes each second. The average end-to-end delay is defined as the average time between a packet being sent and being received. Figure 4 compares the packet delivery ratio (PDR) for AODV and CRP. As the number of nodes increases the packet delivery ratio decreases. We can see that the packet delivery ratio of CRP is clearly higher than the AODV protocol and our algorithm can scale up to larger network. The comparison of the end-to-end delay is show in Figure 5. We can see that as the total number of nodes increases, the average end-to-end delay increases, because more connections and congestions appear in higher density network. It can also be concluded from this study (Figure 5) that the average end-to-end delay for proposed approach is better than the AODV protocol. When the source node wants to send a message to the destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the destination.

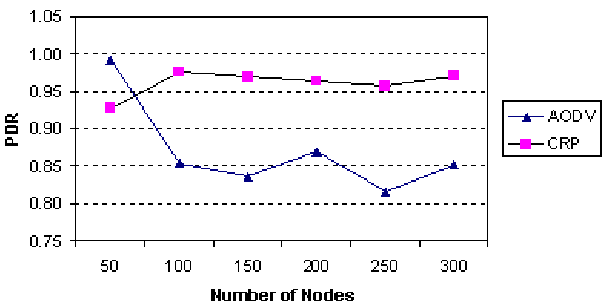

Figure 4: PDR vs. number of nodes

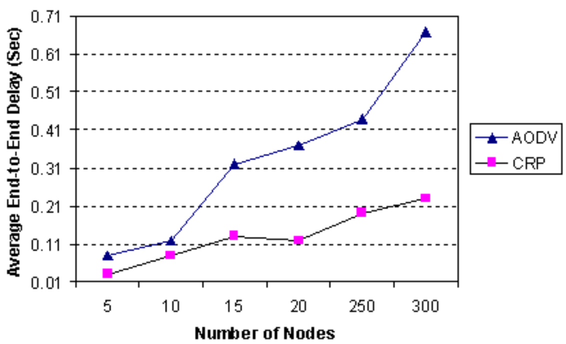

Figure 5: Average end-to-end delay vs. number of nodes

VI.CONCLUSIONS

Our proposed algorithm is a cluster based routing protocol for ad hoc network. In our method, due to the weight group, the cluster creation speed increases, and causes the network services to be more accessible. Recreating of clusters is rarely executed, and when two clusters locate in the same range, one of them becomes the gateway of other node. This causes to prevent the creation of most constructions. In the proposed protocol the routing is also done quickly. Due to the increased path length between two end nodes in a multi-hop MANET, scalability is a challenging issue. Further, it introduces the concept of anchors, which are geographical points imagined by sources for routing to specific destinations, and proposes low overhead methods for computing anchors. A large-scale MANET is feasible only when the task of route search is localized so that the corresponding overhead does not increase as network grows. As one of the promising architectural choices for a scalable MANET, the *link cluster architecture* (*LCA*) was discussed, where mobile nodes are logically partitioned into clusters that are independently controlled and dynamically reconfigured with node mobility.

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