ISSN No. 0976-5697

Volume 7, No. 4, July-August 2016

International Journal of Advanced Research in Computer Science

REVIEW ARTICLE

Available Online at www.ijarcs.info

Routing Protocol in Mobile Ad-Hoc Networks: A Review

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Abstract: Failure of wireless link is considered as one of popular challenges faced by Mobile Ad-Hoc Networks (MANETs). Whereas this type of networks does not have any fixed routers or any pre-exist infrastructure. Also, every node is capable of movement and can be connected to other nodes dynamically. Therefore, the network topology will be changed frequently and unpredictably according to continuous interaction between nodes that simultaneously affect network topology in the basis of dynamic ad-hoc nature. This factor puts routing operation in critical area of research under mobile ad-hoc network field due to highly dynamic environment. To adapt this nature, MANETs demand new routing strategies to occupy these challenges. Thereafter, huge amount of protocols are proposed to argue with ad-hoc requirements. Thus, it is quite difficult to specify which protocols perform better under different mobile ad-hoc scenarios. This paper examines the prominent routing protocols that are designed for mobile ad-hoc networks by describing their structures, operations, features and then comparing their various characteristics.

***Keywords*:** Proactive Routing, Reactive Routing, Hybrid Routing.

I. INTRODUCTION

Mobile ad hoc network is collection of wireless computers (or nodes) establishing a special type of networks in which nodes communicate with each directly if the pair within the range of each other by single hop connection or using multiple hops if there is no direct connection between connection parties. This type of networks does not require any pre-exist infrastructure or any centralized point of control such as base station or access point, where it can be established as a consequence to the demand anywhere and anytime as required [5]. In MANET, every node operates not only as a host, it also operates as a router to increase the range of transmission to give the source node the desire link to the destination node without direct transmission range between them. Thus, designing efficient routing protocol is a challenging problem that routing protocol designers face during designing routing protocol for this kind of networks due to dynamic changing topology, cooperation between nodes, lack of centralized management, source of power, and scalability. Accordingly, routing protocol in mobile ad hoc network play the main role in the network establishment.

As this type of networks relies on multi-hop techniques in its communications, different challenges are appear to determine the multi-hop route over which data packets can be exchanged between source and destination mobile nodes. The origin
point of measuring the quality of routing protocols in ad-hoc networks is identified by its ability of adapting the variations of network topology dynamically. Accordingly, several types of routing protocols for mobile ad-hoc network can be broadly classified into three main groups: 1) proactive routing protocols, 2) reactive routing protocols, and 3) hybrid routing protocols. Figure 1 shows main classifications of routing protocols classes that can be used in MANET. This paper will emphasize one protocol of each category in routing protocols in MANETs.

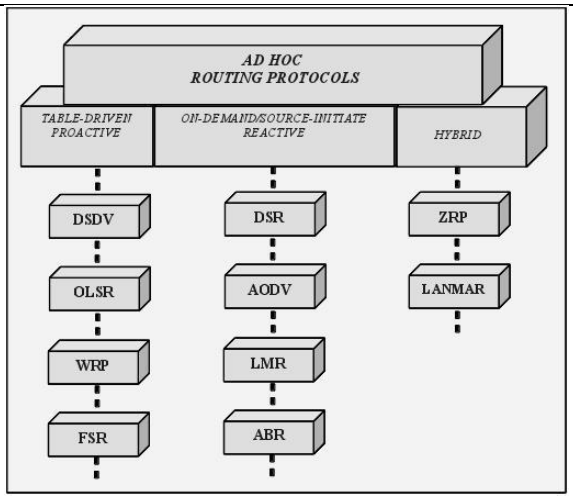

Fig 1: Routing Protocols in MANET

II. PROACTIVE ROUTING PROTOCOLS

Pro-active routing protocols seek each node to manipulate and maintain up-to-date routing information to all remaining nodes in the network. Vast variety routing protocols in the category differ in the way the topology changes are detected, how routing information being updated, and what type of information is processed at each node. The core implementation of pro-active routing protocols is based on two poplar routing algorithms that used in wired networks. These are known as *link-state routing* and *distance vector routing*.

In the link-state technique, every node manipulates complete view of the whole network topology, even though the node may not need it. To obtain this, each node periodically floods link-state information (i.e. link activity and delay of its links) to the entire network. Accordingly, every node receives this information, it updates its view of the network topology and directly tries to calculate the shortest-path for all nodes.

On the other side, each single node in distance vector routing periodically observes the cost of its interface links and sends its routing table information to all surrounding nodes. Thus, through repeated observations to the outgoing links, and updating of the routing information in routing table, every node calculates the shortest distance to every node in the network. Distributed Bellman Ford (**DBF)** [3] and Routing Information Protocol (**RIP**) [1] are the classical examples of distance vector of routing algorithms.

2.1 Fisheye State Routing Protocol (FSR)

FSR is one of the novel proactive (table-driven) routing protocols [7]. It is based on the link state routing protocol which is adapted to the wireless ad-hoc environment. It is considered as implicit hierarchical routing protocol. Its implementation is based on "fisheye" technique which is proposed by [6]. It takes the advantages of the eye of a fish that can captures with high detail near to the focal point, where the detail decreases as the distance from the focal point increases. This is translated in FSR to maintain an accurate distance and path quality information about the immediate neighborhood of a node, with progressively less detail as the distance increases. This technique improves routing process in ad-hoc environment since it reduces the routing update overhead in large networks. The level of fish-eye is defined as a set of nodes that can be reached within particular number of hops. This implement the hierarchical structure in this type of routing technique as shown in figure 2, the number of levels, and the radius of each level will depend on the density of the network. All nodes belong to the inner level communicate and exchange information more frequent than outer level.

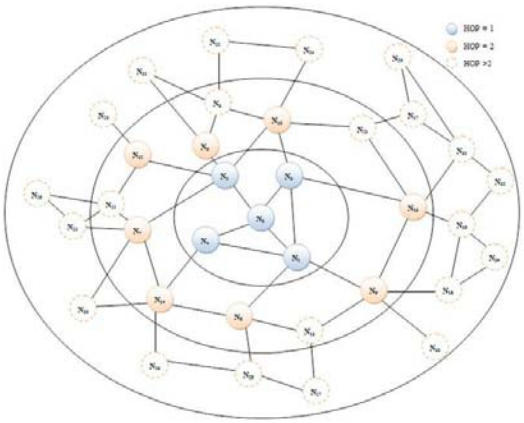

Fig 2: Fisheye Scope

In contrast to link state where the packets are generated and flooded into the network whenever a node detects a topology change. While in FSR the link state packets are not flooded, each node updates its link state table according to information received from neighboring nodes, and it periodically exchanges this information only with their local neighbors. Accordingly, flooding process is not required. Also, FSR avoid a link state updates by applying periodic update rather than event driven for exchanging the topology layout, this process reduces the control message overhead. More precisely, the data will be propagated to neighbors with highest frequency is what implements the actual links with neighbors for that node, the remaining information will be propagated with low frequency. This strategy produces timely updates from near nodes, while it creates large latencies from those far nodes.

III. REACTIVE ROUTING PROTOCOLS

In contrast to pro-active routing, reactive routing protocols search for routes when needed, this technique reduce the amount of control packet to maintain routing topology. Reactive routing protocols perform two main operations;

Route Discovery and *Route Maintenance*. Route discovery process initiated by the source node as it has data for specified destination, the source flood route request packets through the network. Route replay packet is sent back to the source by the destination itself or by any intermediate node has fresh and valid route to that destination. While route maintenance used to recover any link failure between source and destination in case the designated route still required between source and destination.

3.1 Lightweight Mobile Routing Protocol (LMR)

LMR routing protocol is one of the reactive on-demand routing protocols that is applied on mobile ad-hoc networks [2]. It based on heuristic value for particular destination which can be calculated by any intermediate node that resides between Source Node and Destination Node. This can be done when a source broadcast Query Packet to determine all possible set of paths for particular destination. Accordingly, intermediate nodes have information about how much it is far from that destination will reply for those queries and appending the distance for that destination in the reply packet. Figure 3, shows the network before source node broadcast Query Packet. Thus, According to passing reply packets to the node upstream toward the source, after that, all nodes will know the distance to the designated destination, which gives the source the ability to choose the shortest path toward the destination as shown in figure 4.

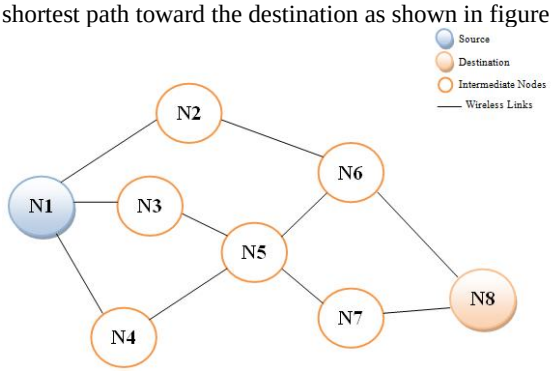

Fig 3: LMR before Initiate Route Request

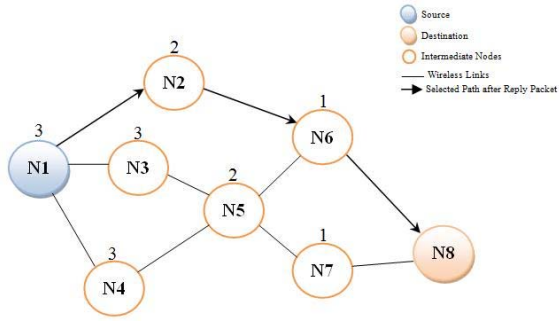

Fig 4: LMR after Reply Propagation

LMR updates routing information when any intermediate node (say N6) in the path detects link failure in the path as shown in figure 5. N6 will use link reversal technique to find alternative path to that destination, as LMR algorithm find out multiple path. Accordingly, N2 and N5 will notice there is link failure where N5 has alternative path to the destination, both N2 and N5 will proceed link reversal upstream until they reach source node. At this moment, all nodes update their information about the distance to the destination according to the current situation of the network as shown in figure 6.

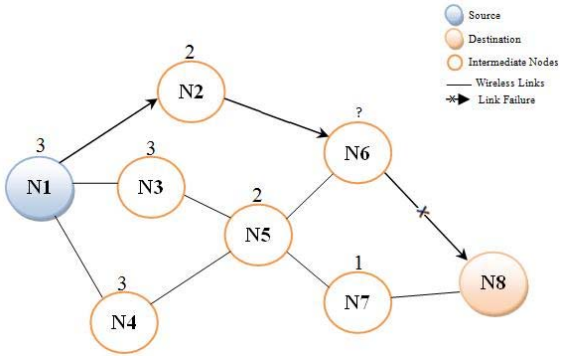

Fig 5: Link Failure in LMR

LMR has low computation and communication overhead, because routing is done through multiple paths where the congestion of traffic is avoided. But routing is not optimal since it chooses the routes without any cost consideration.

IV. HYBRID ROUTING PROTOCOLS

Hybrid routing protocols combine both features of pro-active and reactive routing techniques to scale up the network size and increase node density in the network. This can be achieved by maintaining nearby nodes routes using a pro-active routing techniques where the far away nodes route can be determined using a reactive routing strategies.

4.1 Zone Routing Protocol (ZRP)

ZRP [4] adopts both pro-active and reactive routing techniques in order to taking the advantages of both types. Every node in ZRP define a special zone around it, the radius of the zone can expressed by the terms of n-hops can be reached from that node. node within the same zone use pro-active routing protocols to maintain their routing information. While other nodes compute their routing information using reactive routing protocols. if a source node has data for designated destination, it check first its routing table to find out any relevant information in its routing zone. If so, the packet can be routed using one of pro-active routing protocols. Otherwise, the source uses a *Route Discovery* process defined by any reactive routing protocol to determine a valid route to the required destination.

ZRP has special nodes in the zone borders called *border nodes*. They used to propagate the route discovery process for any source node in their zone. Also, they utilize delivering incoming and outgoing packets in their zone.

V. PROACTIVE VS. REACTIVE VS. HYBRID ROUTING

The trade-offs of routing strategies in MANET are quite complex. Table 1, shows some parameters which can be taken into account to distinguish routing protocols in MANET as mentioned in figure 1 before. Accordingly, to identify which approach is better depends on many factors, such as the node density, size of the network, the mobility, the data traffic and so on. Most of proactive protocols attempt to maintain routes to all possible destinations, whether they are needed or not. Thus, it is continuously propagates and maintains routing information.

Table 1. Protocols Configuration Parameters

Parameter	FSR	LMR	ZRP
Route Selection Metric	Shortest Path	Link Reversal	Shortest Path
Routing Uniformity	Uniform	Uniform	Nonuniform
Multiple Route	May be	Yes	No
Topology Structure	Hierarchical	Flat	Hierarchical
Routing Update Time	Periodic	Event Driven	Hybrid
Update Information Metric	Link State	Route Error	Hybrid
Beacon	Yes	No	Yes
Loop Free	Yes	Yes	Yes
Critical Nodes	No	No	No
Control Overhead	Low	Low	Medium

On the other hand, reactive routing protocols define route discovery on the demand of availability of data to be send. The only routes desired to those required destinations. This routing approach reduces routing overhead when a network is almost static and the active traffic is not heavy. However, the source node has to wait for routing discovery process to discover valid fresh route to the designated destination, accordingly, increasing the response time.

The hybrid routing approach can adjust its routing strategies that adapt both proactive and reactive techniques according to a network's characteristics and thus provides an attractive method for routing in MANETs. However, a network's characteristics, such as the mobility pattern and the traffic pattern, can be expected to be dynamic.

VI. CONCLUSIONS AND FUTURE WORKS

Wireless Ad Hoc technologies able to change dynamically. Also, its performance where the wireless link can change unpredictably. Therefore, routing in mobile ad hoc networks are more complex than the conventional networks. This paper discusses three types of routing protocols that can be applied for ad-hoc networks. The paper shows that there is no single routing technique is fixed for mobile ad hoc network where it cannot cover all scenarios founded in mobile ad hoc networks.

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