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Comparative Analysis of Routing in MANET

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Abstract: **Mobile ad-hoc network is one of the most encouraging research areas. However due to high mobility involved, routing becomes of the most critical factor and need to be improved in terms of communication. Being a stand alone network, infrastructure less that includes collection of mobile devices communicating over wireless links need proper route for transferring of data packets. This paper just presents the impact of comparison of different routing protocol in terms of different parameters.**

***Keywords*— Routing, security, flooding, DBF, unicast, multicast.**

I. INTRODUCTION

Mobile ad hoc network is collection of wireless computers (or nodes) establishing a network in which nodes communicate with each other by forwarding packets within and outside range of direct wireless transmission. Such type of networks also known as Mobile Ad Hoc multi-hop wireless networks does not have any requisite for fixed infrastructure or central control such as base station or access point, and can be set up according to the demand anywhere as required [1].Routing is one of the centralized problem in wireless networks that attracts the attention of researchers. It uses point-to-point multi-hop routing instead of a static network infrastructure to provide network connectivity. Flowchart shown in figure 1 depicts working of general ad-hoc network. They have several salient characteristics: 1) Dynamic topologies 2) Bandwidth-constrained, 3) variable capacity links 4) Energy-constrained operation 5) Limited physical security etc. Therefore the protocols for wired networks cannot be directly used for wireless networks [2].

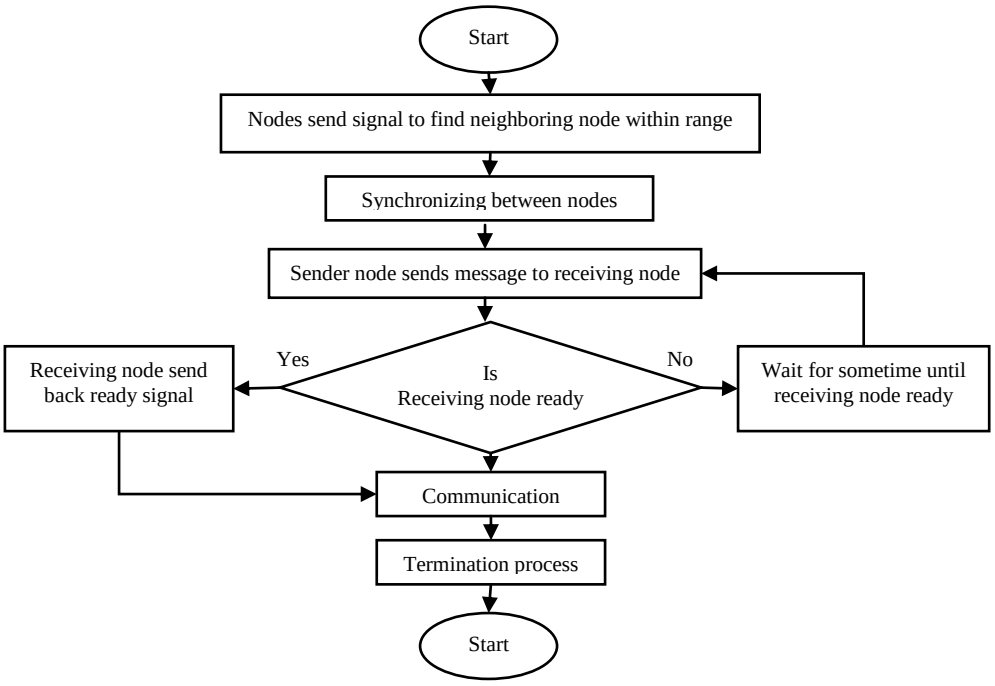

Figure 1: Working of a general Ad-Hoc Network

II. ROUTING PROTOCOLS TERMINOLOGY

A routing protocol maintains a routing table to keep information about the linking node and neighbours. Researchers have proposed several routing protocols for both wired and wireless networks [3]. They lie into four distinct categories depending on their properties: -

A. Centralized Vs. Distributed

In centralized algorithms, all route selection are made at a central node, while in distributed algorithms, the evaluation of route is shared among the network nodes.

B. Static Vs. Adaptive

In static algorithms, the route used by source-destination pairs is fixed being independent of traffic conditions. Here route for transitions change only in response to a node or a link failure. Such types of algorithms cannot achieve high throughput under a wide variety of traffic input patterns. Most major packet networks use some form of adaptive routing which in response to congestion may change the route between the source and destination.

C. Flat Vs. Hierarchical

A flat addressing is one of the pre-requisite for the flat routing approach. Each underlying node participating in routing plays an important role and all nodes have same responsibilities means no special gateway nodes are present. In contrast, hierarchical routing usually assigns different roles to network nodes.

D. Proactive (Table-Driven) Vs. Reactive (On-Demand-Driven) Vs. Hybrid

Proactive protocols continuously check the routes within the network so that when a packet needs to be forwarded, the information about routes is already known. The proactive protocols maintain consistent, up-to-date routing information about each other. These protocols force each node to maintain routing tables and respond to changes in network topology. The updates are transmitted throughout the network in order to maintain a consistent view. The family of Distance-Vector protocols is an example of proactive scheme. Reactive protocols, on the other hand, invoke route determination procedure on demand only. Thus, when the route is needed, some sort of global search procedure is employed. This type of routing creates routes only when desired by the source node, i.e., when a node requires routing a data packet to destination, it initiates a route discovery process within the network. This process examines all possible route permutations and selects an optimal route. Once the route is established, the data packets are sent over the designated path. However, a route maintenance procedure maintains the path until the destination becomes either inaccessible along the path from the source or the route is no longer desired. The family of classical flooding algorithms use reactive scheme.

Proactive schemes have an inch of figure over other protocols whenever information about routes is required; the delay before actual packets can be sent is quite insignificant. On the other side, proactive schemes need time to converge to a steady state which can cause problems if topology is changing frequently. Therefore, the proactive strategies are appropriate for a network with low mobility. Since reactive routing protocols flood the network to discover the route, these are not optimal in terms of bandwidth utilization, but scale well for frequent changing network topology.

In addition to proactive and reactive protocols, there also exist hybrid protocols which combine merits of both proactive and reactive approaches. Such hybrid protocols offer means to switch dynamically between proactive and reactive parts of protocol. For instance, proactive protocols could be used between networks and reactive protocols inside the networks or vice versa.

III. PROPERTIES OF AD HOC ROUTING PROTOCOLS

The desirable properties of ad hoc routing protocols are discussed below [1]:

A. Distributed Operation

Here each node maintains a set of values in its routing table. As ad-hoc networks are self-dependent and autonomous systems, they demand for a routing protocol that may be able to maintain the required criterion.

B. Quality of Service Support

Some sort of Quality of service is necessary to incorporate into the routing protocol. This helps to find what these networks will be used for. It could be for instance real time traffic support.

C. Efficient Bandwidth Utilization

The available network bandwidth will be consumed by control traffic as routing protocols incurs excessive control traffic. This may affect communication performance of the network as the bandwidth of the wireless network is moderately limited; reduction of control overhead becomes an important design factor.

D. Manageable Resource:

In a cellular network, reduction in the number of active mobile nodes reduces the amount of signal interference and channel contentions where as the ad hoc mobile nodes transmit their messages via other nodes toward their intended destinations i.e. a decrease in the number of mobile users can also degrade performance of networks. Unlike cellular networks, the ad hoc network performance deeply impacts the lifetime of mobile nodes. Therefore, as the number of available nodes decreases, it may be further noted that the network may also be partitioned into smaller networks and to prolong the lifetime of each node, ad hoc routing protocols should consider power consumption.

E. Optimization of metrics

The bandwidth and battery power are important metrics in ad hoc networks besides end-to-end throughput and delay, the widely used performance metrics in wired and wireless networks. Though the existing metrics influence the design of routing

protocols, the designer must optimize the following metrics:

- Maximum end-to-end throughput.
- Minimum end-to-end delay.
- Minimum total power (battery capacity).
- Minimum overhead (bandwidth).
- Load balancing (least congested path).
- Shortest path/minimum number of hops.

F. Freedom from loops

Sometimes, a fraction of packets start revolving around the network because of temporary loops. Since, looping of packets can cause a considerable overhead in terms of bandwidth and power consumption. Therefore, it is desirable for routing to have acyclic route i.e. may not have loops.

G. Security

The radio environment is especially vulnerable to impersonation attacks so to ensure the wanted behaviour of the routing protocol we need some sort of security measures. Authentication and encryption is the way to go and problem here lies within distributing the keys among the nodes in the ad-hoc network.

IV. CLASSIFICATION OF ROUTING PROTOCOL IN MANET

The IP layer is the backbone of communication. The basic operation in IP layer of MANET is to successfully transmit data packets from the source to the destination. Therefore, efficient routing of packets is a primary MANET challenge as it may be necessary to employ several hops i.e. multi-hop before a packet reaches the destination as shown in Fig. 2. Routing protocols for ad hoc networks must deal with limitations such as high power consumption, low bandwidth, high error rates and arbitrary movements of nodes. On the basis of routing information update mechanism routing protocol for ad-hoc wireless network can be classified into three categories [4] Fig. 3 shows basic classification of routing protocol:

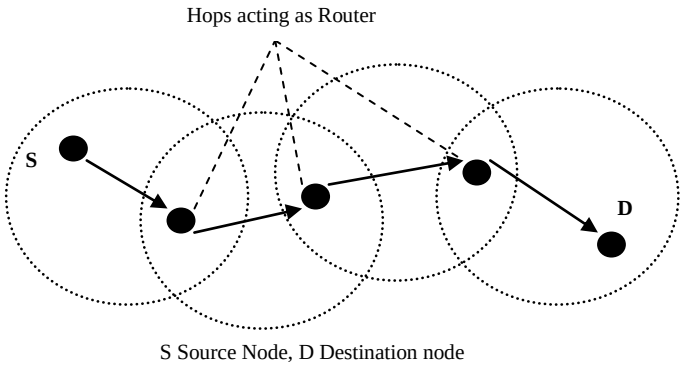

Fig. 2: Routing in Infrastructure less network (MANET)

Routing protocol for MANET is classified as:

1. Table driven (proactive) routing protocol
2. On – demand (reactive) routing protocol
3. Hybrid routing protocol

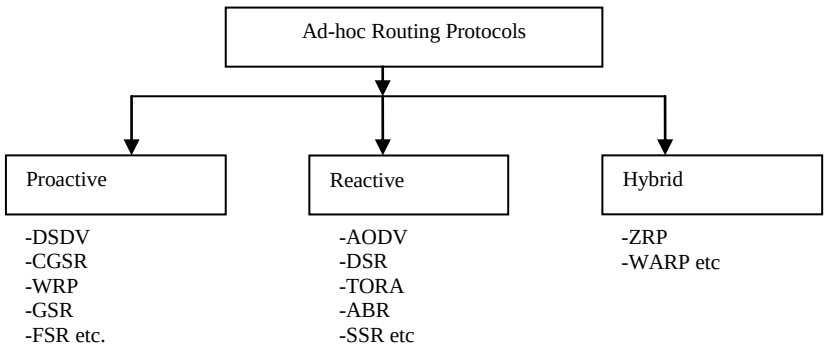

Fig. 3: Classification of ad-hoc routing protocol

1. Table driven routing protocols

The table-driven approach is similar to the connectionless approach of forwarding data packets, with no regard to when and how frequently such routes are desired. It relies on an underlying routing table update mechanism that involves the constant propagation of routing information [4]. Here, a route to every other node in ad hoc network is always available,

regardless of whether or not it is needed. Table I represents proactive protocols which are result of enhancement from their predecessor protocols. The various table driven ad hoc routing protocols are as follows: -

- Destination Sequenced Distance Vector (DSDV)[5]
- Cluster Gateway Switch Routing Protocol (CGSR)[6]
- Wireless Routing Protocol (WRP)[7, 8]
- Fisheye state routing[9]
- Global State Routing (GSR)[10]

TABLE I
PROACTIVE ROUTING PROTOCOLS

Proactive Protocol	**Predecessor Protocol**	**Enhancement regarding predecessor**
DSDV	DBF	Provide single shortest path
CGSR	DSDV	Reduces network traffic load
WRP	DBF	Performance/Count-to-infinity problem
FSR	LS	Improved Flooding
GSR	GSR	Exchange link-state information at different interval for different scope dist.
DBF: Distributed Bellman Ford, LS: Link State Routing		

2. On-demand driven routing protocols

These protocols try to eliminate the conventional routing tables and consequently reduce the need for updating these tables to track changes in the network topology. In the On-Demand approach, when a node desires a route to a new destination, it will have to wait until such a route can be discovered i.e. routes are discovered whenever a source node have packets to send [4] and maintain it until either the route is no longer desired or it becomes inaccessible, and finally remove it by route deletion procedure. Table II represents reactive protocols which are result of enhancement from their predecessor protocols. The various on demand driven unicast based routing protocols are as follows:

- Ad Hoc On Demand Distance Vector Routing (AODV) [11]
- Dynamic Source Routing (DSR)[12]
- Temporally Ordered Routing Algorithm (TORA)[13]
- Associatively Based Routing (ABR)[14]
- Signal stability Routing (SSR)[15]

TABLE II
REACTIVE ROUTING PROTOCOLS

Reactive Protocol	**Predecessor Protocol**	**Enhancement regarding predecessor**
AODV	DSDV	Minimize broadcast message
DSR	-	
TORA	LMR	Converges quicker in portioned network
ABR	-	
SSR	ABR	Enhance stability
LMR: Lightweight Mobile Routing		

3. Hybrid Routing Protocols

Since proactive and reactive protocols [1] each works best in oppositely different scenarios, hybrid method uses both. These protocols combine the best good features of reactive and proactive protocol. It is used to find a balance between both protocols. Proactive operations are restricted to small domain, whereas, reactive protocols are used for locating nodes outside those domains. Examples of hybrid protocols are:

- Zone Routing Protocol, (ZRP)
- Wireless Ad hoc Routing Protocol, (WARP)

TABLE III
SUMMERY OF WIRELESS ADHOC ROUTING PROTOCOL'S CLASSIFICATION

	Proactive	**Reactive**	**Hybrid**
Network organization	Flat / Hierarchical	Flat	Flat Hierarchical
Topology dissemination	Periodical	On-demand	Both
Route Latency	Always available	Available when needed	Both
Communication overhead	High	Low	Medium

V. COMPARISON AMONG ROUTING PROTOCOL

Based on imperative parameters and features of routing protocol, a variety of table-driven (Proactive) routing protocols [7] [4] [8] are compared in Table IV.

TABLE IV
COMPARISON TABLE FOR PROACTIVE ROUTING PROTOCOLS

Parameters	**DSDV**	**CGSR**	**WRP**	**FSR**	**GSR**
Route Selection	Link–State	Shortest Path	Shortest Path	Shortest Path	Shortest Path
Route Computation	Distributed	Distributed	Distributed	Distributed	Distributed
Route	Single	Single or Multiple	Single	Single or Multiple	Single or Multiple
Topology Structure	Flat	Hierarchical	Flat	Hierarchical	Flat
Broadcast	Full	Full	Local	Limited	Local
Source Routing	No	No may be Yes	No	No may be Yes	No may be Yes
Update	Hybrid	Periodic	Hybrid	Periodic	Periodic
Update Information	Distance Vector	Distance Vector	Distance Vector	Link State	Distance Vector
Method	Broadcast	Broadcast	Broadcast	Broadcast	Broadcast
Beacon	Yes	No	Yes	Yes	Yes
Loop Free	Yes	Yes	Yes, but not instantaneous	Yes	Yes
No. of Table	2	2	4	4	4

On the basis of imperative parameters and features on-demand (Reactive) routing protocol [7] [4] [8] [16], are compared in Table V

TABLE V
COMPARISON TABLE FOR REACTIVE ROUTING PROTOCOL

Parameters	**AODV**	**DSR**	**TORA**	**ABR**	**SSR**
Route Selection	Shortest and Updated Path	Shortest and Updated Path	Shortest Path	Signal Strength or Associativity and Shortest Path	Associativity and Stability
Route Computation	Broadcast	Broadcast	Broadcast	Broadcast	Broadcast
Route	Multiple	Multiple	Multiple	Single	Single
Topology Structure	Flat	Flat	Flat	Flat	Flat
Broadcast	Full	Full	Local	Full	-----
Source Routing	Yes	No	No	Yes	Yes
Update	Event Driven	Event Driven	Event Driven	Event Driven	Event Driven
Update Information	Route Error	Route Error	Node's Height	Route Error	Route error
Method	Unicast	Unicast	Broadcast	Bro/ Uni	Broadcast
Beacon	Yes	No	No	Yes	Yes
Loop Free	Yes	Yes	No (short lived loops)	Yes	Yes
Route Reconfiguration	Erase Route, Notify Source	Erase Route, Notify Source	Link Reversal, Route Repair	Localised Broadcast Query	Erase Route, Notify Source

VI. CONCLUSION

Mobile ad hoc network is decentralised, self-organised, "anytime, anywhere" network and provide cheap communications. In this paper author discussed classification of routing protocols on the basis of routing information update mechanism, highlighting their characteristics and done comparative analysis for wireless ad hoc networks routing protocols viz. DSDV, CGSR, DSR, AODV and TORA etc. As there are still many challenges facing wireless ad hoc networks, it is not clear that any particular algorithm or class of algorithm is the best for all scenarios, each protocol has their own merits and demerits and is well suited for certain situations. However because of there advantages, wireless ad hoc networks are becoming more and more prevalent in the world.

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