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Survey on Routing Protocols for Wireless Communication

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ABSTRACT: Wireless networks is growing at exponential growth, each day there are thousands of nodes in form of mobile phones, or in other forms are created or deployed around the worlds. Protocols are rules which govern these systems; in following paper there is the comparison between proactive and reactive protocols.

KEYWORDS: Wireless protocols, Proactive protocols, Reactive protocols.

I. INTRODUCTION

Wireless networks are increasingly motivating new players for innovation and opening new horizons of networking. There are traditionally two known types of wireless networks; the first one is “infrastructure network”. Base stations are bridges and a mobile unit is known as its node which communicates with the nearest base station which is in the radius of the node. Wireless local area network is one of the prominent examples of this type of network which have wired gateways but wireless nodes. An Ad-hoc network is infrastructure-less connection of devices i.e. they are connected without wires through air as a medium of communication which makes this as a second type of wireless network. The nodes are mobile which arranges dynamically and arbitrarily in a region. One of the example applications is data aggregation in varied typography i.e. data aggregation in difficult terrain such as mountains or deep valleys. [1]

Protocols:

Protocols are set of rules which govern the communication between these nodes, with the help of routing protocols they facilitate the communication inside the network. The main task of the protocol is to deliver the packet or message in timely manner after establishing correct and coherent routes, and the construction of routes should have minimal overhead and minimum consumption of bandwidth.

This article examines routing protocols designed for these ad hoc networks by first describing the operation of each of the protocols and then comparing their various characteristics.

Types of Protocols

1.) Proactive or Table Driven routing protocols:

Proactive protocols works in a very consistent way by adopting a table in which all the routing information from one node to another in a network is stored which is updated after a regular time interval to make it consistent network view. [1] . The following illustrates existing proactive protocols:

A.) **Destination-Sequenced Distance-Vector Routing (DSDV)-** The Destination-Sequenced Distance-Vector Routing protocol (DSDV) described in [2] which is based on Bellman-Ford routing mechanism [3] is a proactive protocol. Freedom from loops in routing table is one of the major leap in improvement of the above mechanism, in this every mobile node is needed to maintain a routing table with the number of hopes to the destination. Destination node marks a sequence number on each entry, these numbers helps to distinguish the new from old ones which in turn forbids loops. To maintain consistency routing table is updated timely, but this can generate large amount of traffic in the network. In order to stop this unwanted congestion route update hire mainly two types of packets. “Full Dump” [1] is one of the packets, which requires multiple network protocol data units which carries all routing information and sometimes are transmitted infrequently. Further, Smaller incremental packets are used to carefully update only those information which has changed since last full dump, this decreases the amount of traffic.

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Mobile nodes have additional table that contains the data sent in sequence routing information packets. Information such as number of hopes, sequence number of the information received, new unique sequence number and address to reach the destination is contained in new route broadcast [2]. Mobiles can easily reduce traffic and optimize routes by eliminating broadcasts by delaying it by length of the settling time, if a better route was discovered in the very near future.[1]

B.) **Cluster head Gateway Switch Routing (CGSR)** – Type of addressing and network organization are two key points on which it differs with above protocol[1]. It is a clustered multihop wireless network with various heuristic routing schemes unlike a "flat" network [4]. If cluster head controls group of nodes i.e. cluster members then framework for code separation, bandwidth allocation, routing, and channel access can be controlled easily. In this algorithm a cluster head is chosen from within the cluster but the main disadvantage is the frequent change of head which directly affects the performance and energy of the network. Due to this drawback, Least Cluster Change algorithm is used, in which the cluster head changed only when there are two or more than two cluster heads in the same zone or when a node moves out of all other cluster heads. Underlying algorithm of CGSR is DSDV but it modifies according to the needs. It uses hierarchical cluster-head-to-gateway routing approach [1]. In this algorithm, when a packet is sent by the node it is received by the cluster head and from here it is delivered to the gateway. Gateway sends it to another cluster head and this continues till it reaches to the destination.

2.) Reactive or Source-Initiated On-Demand Routing:

In contrast with the proactive protocol, the reactive protocol creates route only when desired i.e. when source want to send a packet to a node. When a source node wants to send a packet then route discovery mechanism is initiated within the network, and completes when the route is found or all possibilities are considered. Route maintenance procedure is initiated as soon a route has been established until the destination is no longer desired or it becomes inaccessible.

A.) **Ad Hoc On-Demand Distance Vector Routing (AODV)** [5]– AODV is the built on DSDV, it is an improvement because it doesn't keep the routing information which minimizes the number of required broadcasts, creating it on demand, which is in contrast with DSDV which maintained a complete list of routes. When a source node want to send a message then route discovery process is initiated to locate destination node, it broadcasts a route request (RREQ) packet to its neighbors which forwards to theirs and so on until the destination node is found and AODV ensures that all routes are loop free and routes contain most updated path [1][5]. Once it reaches to the destination, the node responds by sending RREP which is a unicast route reply to the neighbor from which it got the RREP and it reaches to the source along the reverse path.

B.) **Dynamic Source Routing** - The Dynamic Source Routing (DSR) protocol presented in [6] is an on-demand routing protocol that is based on the concept of source routing. Route caches are required to be maintained by the nodes that contain source routes and the entries are updates as new are discovered. There are two phases of this protocol one of them is route discovery and another one is route maintenance. Whenever a node wants to send a packet to destination it first searches the cache for any available route to destination if it has unexpired route then it will send the packet through this path. Further, if it doesn't have any cached route then the route discovery mechanism is fired having address of the destination, source node's address and a unique identification number [1]. Each node checks whether the path is stored as a cache or not and the process goes on till the destination node is found. [7]

II. COMPARISON

The following are the comparison of algorithms which are discussed in previous sections i.e. proactive and reactive protocols. The number of steps and messages needed for an operation represents Time and Communication complexity respectively [1][8-11]

A. Proactive/Table-Driven Protocols: (Table 1)

Bellman-Ford routing algorithm is modified to form DSDV [1], which guarantees loop-free routes and protocol having updation of simple routes. Further, based on number of hops to destination DSDV selects the shortest path. There are two updates message provided by DSDV, one is smaller than other which can be easily used for incremental updates that helps in transmitting only the changes and not the whole routing table [1]. DSDV limits number of nodes which

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can connect to the network because it cannot provide periodic update transmissions and the overhead grows at a rate of $O(n^2)$ [1]. Cluster Head and Gateways are important components of CGSR and cluster head is necessary. To improve performance of CGSR various heuristic methods can be applied. Some of the methods include path reservation, scheduling, gateway code, and priority token [1][4].

B. Reactive/Source-initiated On-Demand Protocols: (Table 2)

AODV and DSR show similarities and differences on various occasions. One of the similarities is their route discovery procedure; on the other hand overhead which is larger in case of DSR is the difference as it carries complete routing information in contrast with AODV which only carries address of the destination. Further, reply of DSR is also bigger than AODV as former carries address of every node of the route unlike later which carries only the IP address of sequence number. AODV carries only information of the next hope which gives an edge over DSR which remembers complete routes which results in larger memory overhead [1]. Multicast functionality is only supported in AODV, however it cannot use asymmetric nodes, but DSR can work on both symmetric as well as asymmetric links.

Table: 1 Comparison of the characteristics of proactive routing protocols [1]

Parameters [1]	**DSDV** [1]	**CGSR** [1]
Time Complexity (Link addition/Failure)	**O(d)**	**O(d)**
Communication Complexity (link addition/failure)	**O(x = N)**	**O(x = N)**
Philosophy of Routing	**Flat**	**Hierarchical**
Loop-Free	**Yes**	**Yes**
Multicast Capability	**No**	**No****
Number of Tables required	**Two**	**Two**
Frequency of Update transmissions	**Periodically and as required**	**Periodically**
Transmission of updates to	**Neighbors**	**Neighbors and C.H.**
Utilizes sequence numbers	**Yes**	**Yes**
Utilizes hello messages	**Yes**	**No**
Critical Nodes	**No**	**Yes (C.H.)**
Routing Metric	**Shortest Path**	**Shortest Path**

Abbreviations:
N = Number of nodes in the network
d = Network Diameter
X = Number of nodes affected by a topological change
C.H. = Cluster Head
** The Protocol doesn't own capabilities of multicast but a wrapper runs which provides this ability.

III. APPLICATIONS AND CHALLENGES

Ad-Hoc networks are widely used in military where they have mobile soldiers equipped with mobile communicators or other machines which requires communication and the fixed infrastructure is not feasible [1]. It plays important role during wartime when all infrastructure systems fails in the affected areas. Also, now-a-days sensors are deployed on fishing boats where they get information about present condition of weather and it alerts them about any disturbance in the ocean, or river such as tsunami etc. There are many commercial applications of ad-hoc networks which includes conferences, meetings, law enforcement, emergency services etc. Today, mobiles, laptops are used as nodes for faster and better communication and more and more people are now dependent on these devices. Quality of Service support, Power-aware routing, location aided routing and Multicast are some of the important challenges of ad-hoc networks [1][13][14][15].

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Table: 2 Comparison of the characteristics of reactive protocols [1]		
Parameters [1]	**AODV** [1]	**DSR** [1]
Time Complexity (initialization)	**O(2d)**	**O(2d)**
Time Complexity (postfailure)	**O(2d)**	**O(2d) or 0***
Communication Complexity (initialization)	**O(2N)**	**O(2N)**
Communication Complexity (postfailure)	**O(2N)**	**O(2N)**
Philosophy of Routing	**Flat**	**Flat**
Loop-Free	**Yes**	**Yes**
Multicast Capability	**Yes**	**No**
Beaconing requirements	**No**	**No**
Multiple Route possibilities	**No**	**Yes**
Routes maintained in	**Route Table**	**Route Cache**
Utilizes route cache/table expiration timers	**Yes**	**No**
Route reconfiguration methodology	**Erase Route & Notify Source**	**Erase Route & Notify Source**
Routing Metric	**Freshest & Shortest Path**	**Shortest Path**
Abbreviations: N = Number of nodes in the network d = Network Diameter *Cache Hit		

IV. CONCLUSION

This article describes four routing protocols, two of them are proactive and the rest are reactive protocols. Also this article contains highlighted characteristics, features, and some differences. Further there has been a research on the application and challenges of ad-hoc networks. There is no cleared superiority of one algorithm over another, they are used in different use-case, and also it depends on the nature of communication. Ad-hoc as has been stated above is growing exponentially and there are improvements but challenges needs to be covered and definitely this field will advance in years to come.

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