Routing Protocols in Wireless Local Area Networks (WLANs)

Mr. Sachin D. Latkar * and Dr. S. A. Patil **
* Electronics & Telecommunication Engineering Department, Gharda Institute of Technology, Khed, India.
Email: latkarsachin@gmail.com
** Professor, Electronics & Telecommunication Engineering Department, Gharda Institute of Technology, Khed, India.
Email: sapatil.mah@gmail.com

Abstract: This work surveys routing protocols employed in Wireless local area Network. There are many applications of wireless LANS. The applications embrace in-home networks, campus-sized networks, complete mobile networks on airplanes and trains. Wireless local area Network (WLAN) hot-spots are created in restaurants and hotels and users can access the web from these hot-spots. Most of the time these public networks do not need a password to join the network. Different WLAN hot spots need registration and/or registration fee to access the network. The state of the system in such cases is not static and can change which ends into an amendment in physical and logical topologies used. The convergence by a typical routing protocol is required to handle the problem. This work reviews a number of the quality routing protocols in terms of their characteristic, practicality, economical route discovery mechanisms and comparison of their several merits and demerits in Wireless local area Network. The protocols are classified as a table driven (proactive), reactive (on-demand), power aware, hierarchical and geographical multicast routing protocols.

Keywords: Wireless local area Network (WLAN), Routing Protocols, Proactive, Reactive, Hybrid.

Introduction

A routing protocol is a standard which is used for communication between computer units, exchange packets and discover routes to destination hosts. Routing protocol distributes information in the network. [2] It uses wireless transceiver at the interface. The functions performed by routing protocol are route discovery; route keeping; convergence of network topology; harmonized exchange of packets.

Wireless LANs became popular within the home [1] thanks to simple installation and use, and in business complexes providing wireless access to their customers; usually for free. New York town, for example, has begun a pilot program to supply town employees in all 5 boroughs of the town with wireless web access. The wireless network is classified into two types viz. infrastructure network and ad hoc network.

Infrastructure network is a network with a stable and wired gateway. There is a centralized controlling agency in the infrastructure network. Typical applications [2] of this type include office wireless local area networks (WLANs). In ad hoc network there is no centralized controlling agency, all the nodes are capable of movement and can be connected dynamically. Ad hoc networks are useful in the emergency type of applications which include search-and-rescue operations, meeting and conventions which share information and data acquisition operation in hospital terrain.

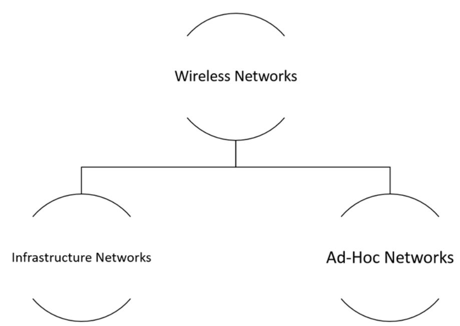

Figure 1: Types of Wireless Networks

Problem Statement

Limited and inadequate resources available in Mobile Ad hoc Network (MANET) build the planning of efficient and reliable routing protocol tough task. It is necessary to use these restricted resources. Intelligent routing algorithmic rule [3] is required that uses these restricted resources whereas at the same time being adaptable to propellant network conditions like network size, traffic density, a mobility of nodes and broken routes.

Quantitative properties embrace throughput, delay in routing, route discovery time, packet delivery ratio, jitter etc... Most of the routing protocols are quantitatively and qualitatively enabled.

Hence, it is to visualize fully totally different routing protocols so as that it will enable and aid the researcher or engineer to select best routing protocol in step along with his or her work. This work evaluates major routing protocols used in WLAN. The performance analysis of routing protocols is meted out.

Review of Related Research Efforts

In ad hoc Network cluster communication is a lot of vital, during which routing protocols play an important role for data transmission. Using or not using central server or access point, the Wireless network form a short-lived network with a collection of wireless nodes during which, every node changes indiscriminately at completely different times. So as to ascertain data transmission between nodes, multiple hops are required due to restricted range i.e. transmission rate.

Mobile Ad hoc network (MANET) routing protocols are classified according to several criteria, reflecting fundamental design and selection choice for implementation [2]. Numerous routing protocols have been proposed and developed for wireless local area networks.

Reference [21] analyses and simulates a planned Wireless local area Network (WLAN) using different routing protocols. The performances of various protocols are compared and analyzed using Optimum Network Performance (OPNET) simulator tool during which metrics like delay, throughput, packet delivery, load, Ethernet delay, are measured.

Reference [2] carries out the overview of routing protocol for wireless local area network. This work takes an overview of some important routing protocols used in WLAN by classifying them in terms of their characteristics and functionality, efficient route discovery mechanisms, and comparison of their particular advantages and disadvantages in a wireless local area network (WLAN).

Reference [3] presents review and a comparison of the typical representatives of MANETS (Mobile Ad Hoc Networks) routing protocols. An Ad hoc network is an assembly of wireless mobile nodes forming a temporary network without the aid of any centralized control or infrastructure. Such networks have no permanent topology due to the high degree of node movement. Hence, efficient and reliable routing is one of the key challenges in mobile ad hoc networks. Many routing algorithms have been proposed and evolved for accomplishing this task. Therefore, it is difficult to decide which protocol performs best under a number of dissimilar scenarios. Hence, the work undertakes the selection of routing protocol for MANETs.

The IEEE 802.11e is developed to supply (Quality of Service) QoS capabilities to WLAN, giving revelatory enhancements to multimedia system traffic. Since the widest deployed and used wireless interfaces are IEEE 802.11 based. Reference [22] expose results relative to the correlation of reactive routing protocols for MANETs and also the IEEE 802.11e technology. It is found that substantial enhancements in terms of throughput and normalized routing overhead are achieved because of enlarged routing responsiveness. The relation between the behavior experienced in every case and also the internal mechanisms of the routing protocol getting used are elaborated giving a holistic read of the phenomena. It is an insight into the interaction of routing protocols and also the MAC implementations of IEEE 802.11 and IEEE 802.11e.

Wireless Mesh Networks (WMNs) will offer wide range Wireless local area Networks (WLANs) area by connecting Access Points (APs) of WLANs with one another using radio communications. A routing protocol is extremely vital to stay communication quality over radio multi-hop communications as a result of radio waves are impacted a lot of by close surroundings. Once multi-user distributed applications like a video conference and an IP phone are used, it is foreseen that a large quantity of traffic flows on the network. Therefore, it is necessary to take into account network masses to use these applications. Reference [23] proposes a multicast routing protocol for WMNs that considers network loads and hop count. Moreover, the performance of the algorithm is assessed via simulation. It is shown via simulation results that the proposed algorithm has higher performance than a traditional multicast ad-hoc on demand protocol (MAODV) at the high loaded state of affairs.

Reference [24] surveys regarding IEEE 802.11 Wireless local area Networks thoroughly. Wireless Local Area network physical layer deals with transmission and reception of signals. The reference incorporates IEEE 802.11 standards, Wireless Local Area network protocol design, its benefits and its limitations.

Reference [25] is curious about developing a rapidly workable model of 802.11's result on network behavior. The interest is derived from investigations into routing algorithms for large scale ad-hoc networks, executing on parallel architectures. As their curiosity is not in the MAC layer but in the routing, they anticipate that a rapidly executed model of 802.11 can accelerate simulations targeted on routing problems whereas giving “good enough” estimates of packet latency, throughput, and loss here are vital performance advantages to simulating a wireless network's mac layer with a model that is easier than true 802.11. For serial simulation, the key performance the benefit is due to reduction of events required. For parallel simulation, the overwhelming performance benefit is from better look ahead. The key contributions of this reference are to report on the implementation of 802.11 within the DaSSF (high-performance simulation kernel) framework, the recognition of 802.11 model simplification as a worthy goal, and preliminary results that ensure their intuition that such a simplification will yield the necessary performance gain.

A growing need to have ubiquitous connectivity has intended reference [26] to research to supply a nonstop association between varied wireless platforms like cellular networks, WLANs, and MANETs. Reference think about integration at the routing layer and suggest two adaptable routing protocols viz. Integrated Routing Protocol with reactive gateway discovery (IRP-RD) and with proactive gateway discovery(IRP-PD). The protocols exploit topology information stored at the fixed network elements (cellular Base Stations and WLAN Access Points) for the route discovery and maintenance processes. The proposed protocols can give connectivity to the cellular network and/or WLAN hotspots through multi-hop routing whereas disagree within the gateway discovery approach used. In IRP-RD, multi-hop routes to gateways to the cellular network or a WLAN hot spots are discovered on demand, whereas in IRP-PD out of coverage users proactively maintain routes to the gateways. Moreover, planned protocols will be utilized in any heterogeneous state of affairs, combining a cellular network and WLANs operative in infrastructure or ad-hoc (MANET) mode. They give simulation results that demonstrate the effectiveness of the planned integrated routing protocols and show the benefits and disadvantages of every gateway discovery approach in several heterogeneous situations.

Classification of Routing Protocols in WLANs

The routing protocols are essential in a wireless network. Many routing protocols have been designed to nullify the effect of topological changes that may result because of dynamic and random nature of MANETs. Every routing protocol is intended with specific functions and characteristics with improvement to existing protocol. Many studies have been carried out in wireless LAN routing protocols in order to define a set of protocols that will enhance bandwidth utilization, minimize energy consumption, higher throughput, less overhead, cost etc...

The routing protocol classification [2] is given below with their nomenclatures described in actual theory.

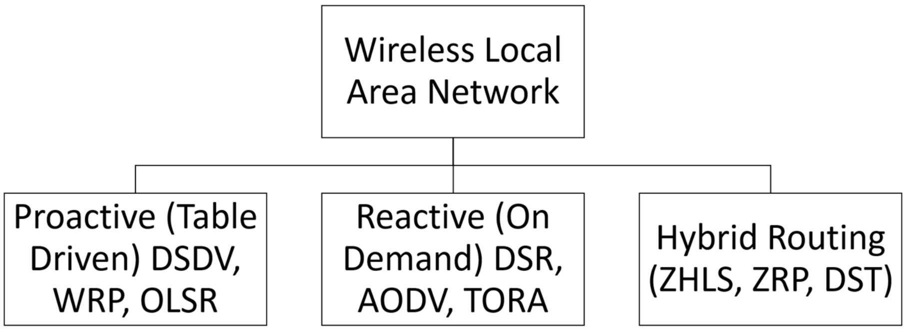

Figure 2: Classification of WLAN Routing Protocols

Proactive Routing Protocol (Table-Driven)

In table driven Routing Protocols [4] each node maintains routing tables. The tables contain routing information to other nodes in the network. All the nodes update these tables so as to maintain up-to-date and harmonies view of the network. The nodes propagate broadcast update messages when the network topology changes. The protocols differ across a number of tables and how the routing information is propagated. But it incurs additional overhead in propagating routing information.

Destination Sequenced Distance Vector Routing Protocol (DSDV)

The protocol [5] is inherited from Routing Information Protocol (RIP). Each node maintains a table which keeps distance or cost information. The routing table gives optimized distance to each destination and track to get there. The routing information is periodically updated to keep routing tables up to date. This protocol addresses poor looping properties of RIP when the links are broken. The modification adopted makes it suitable routing protocol for ad hoc networks.

DSDV protocol [27] guarantees loop-free methods. The protocol reduces the count to infinity problem. The extra traffic will be avoided with progressive updates rather than full dump updates. DSDV maintains solely the most effective path rather than maintaining multiple ways to each destination. With this, space in routing table is reduced.

The inessential advertising of routing data [27] results in wastage of bandwidth albeit there is no amendment within the topology. DSDV does not support Multipath Routing. It is troublesome to work out a time delay for the advertisement of routes. It is very tough to take care of the routing table’s advertisement for a bigger network. Every and each host within the network ought to maintain a routing table for advertising. Except for the larger network, this might result in overhead, that consumes additional bandwidth.

Wireless Routing Protocol (WRP)

It is table driven distance vector routing protocol [7]. Each node in the network maintains following tables

1. Distance Table (DT)
2. Routing Table (RT)
3. Link Cost Table (LCT)
4. Message Retransmission List (MRL)

Distance table (DT) contains matrix where each element contains distance and neighbor for a particular destination. The Routing Table (RT) contains up to date view of the network for all known destinations. The Least Cost table (LCT) contains the cost of percolating information through each link. The cost is calculated in terms number of hops to reach the destination.

The MRL contains a record for every update message that is to be retransmitted and has a counter for each entry. The counter is decremented by one for each retransmission. Each update message contains updates that need to be carried out. Each node marks node in the RT table which needs to acknowledge the update for the message transmitted to that node. Once the counter reaches zero, the updates for which acknowledgments have not been received are to be retransmitted again. After successful transmission of the update message, the message needs to be deleted. After receiving update distance from update message, it also checks distance for its neighbors and hence achieves faster convergence.

WRP [28] has a similar advantage as that of DSDV. Additionally, it has quicker convergence and involves fewer table updates. however, the complexness of maintenance of multiple tables demands a bigger memory and larger process power from nodes within the ad hoc wireless network. At high mobility, the control overhead concerned in updating table entries is sort of a similar as that of DSDV and thus is not appropriate for extremely dynamic and also for a really large ad hoc wireless network. WRP demands large memory storage and resources in maintaining its tables. The protocol is not appropriate for large mobile ad hoc networks because it suffers from restricted scalability.

Optimized Link State Routing Protocol (OLSR)

It is a routing protocol [8] for mobile ad-hoc networks and is proactive in nature. It derives the stability from the original link state algorithm. Due to proactive nature it has the advantage of roots becoming available when needed. In the all the link state protocols, all the links with the neighbor nodes are declared and flooded in the entire network. OLSR is an optimization of pure link state protocol. First, it reduces the size of control packets. It only declares a subset of links with its neighbor nodes who are its multipoint relays. This reduces the number of retransmissions in flooding or broadcast procedure.

The protocol does not create extra control traffic in response to link failures and additions. The protocols keep routes for all the destinations in the network and hence are suitable for networks where large subsets of nodes are communicating with each other. It is also suitable for networks where source and destinations are changing with time. The protocol is suitable for large and dense networks where a selection of multipoint relays achieves more optimization.

The advantage of OLSR [30] is that it lowers control information and expeditiously minimizes broadcast traffic bandwidth usage. Though OLSR provides a path from supply to the destination, it is not essentially the shortest path, as a result of each route involves forwarding through an MPR (Multipoint Relay) node. An extra disadvantage is that OLSR additionally has routing waiting period and bandwidth overhead at the MPR nodes as they act as localized forwarding routers.

The protocol does not require reliable transmission of its control messages as nodes transmit their control messages periodically and hence can sustain a loss of packets. The protocol does not need in order delivery of messages as each control message contains the sequence number of recent information.

Source tree Adaptive Routing Protocol (STAR)

The protocol [6] uses least overhead approach compared to optimum routing approach. If a node 1 wants to communicate with node N and does not have a path in its source tree it sends an update message to all neighbors that there is no path to N. Neighbors that have path responds with update messages. Node 1 updates its source tree and may start transmission. In STAR, topology of network is modeled as directed graph

G (V, E); where V=set of nodes

E=set of links connecting edges.

A neighbor who has the path to destination sends its own tree in response. If the path is not available, then the node forwards the message until the alternate path is found. This is called link break maintenance mechanism in STAR.

Global State Routing Protocol (GSR)

It is similar to (Destination Sequence Distance Vector) DSDV protocol [7]. It uses link state routing but keeps away flooding of routing messages. Each node maintains Neighbor List, Topology table, Next Hop Table and Distance Table. The neighbor list contains the list of neighbors.

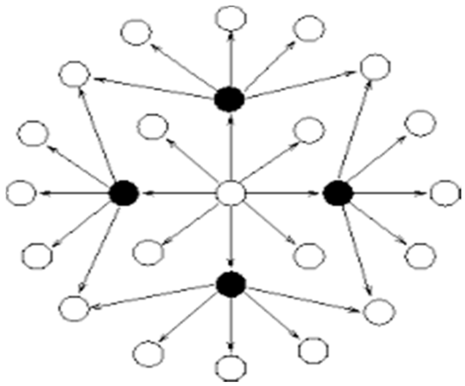

Figure 3: Multipoint Relay

For each Destination node, topology table contains link state information as announced by the destination and time stamp of the information. For each destination, the next hop table contains the address of next hop to which packets must be forwarded to reach the destination. The distance table contains the minimum distance to every node.
The drawbacks of GSR [31] are an out sized update message that consumes a substantial quantity of bandwidth and therefore the latency of the link phase change propagation, that depends on the update period.

Summary of Table-Driven Routing Protocols
Table-driven routing protocols keep routing table at each node [8]. The table is updated periodically. Routing Procedure is based on this data. Basically, Table-Driven Routing protocol has the main advantage [2] is that routing information is available to each node to initiate a session. As a result, nodes encounter higher overhead cost in order to maintain routing tables and convergence takes much time when there is link failure.

a. Link State Algorithms: Each node keeps a view of network topology with a cost for each link [8]. Link costs are broadcasted. Each node updates its topology and applies shortest path algorithm to find next hop to reach the destination.
b. Distance Vector Algorithms: Each node keeps for each destination a set of distances to get that destination [8]. The neighbor with minimum distance is selected for that destination. The node periodically broadcasts its routing table containing the best next node for each destination to each of its neighbors.

The comparison of proactive routing protocols is given below [11]

Table 1: Proactive Routing Protocols Comparison

Parameters	**DSDV**	**WRP**	**OLSR**
Routing Updates	Periodic	Periodic	Periodic
Loop- Free	Yes	Yes	Yes
Routing Overhead	High	High	Low
Caching Overhead	Medium	High	High
Throughput	Low	Low	Medium
Routing Tables	2	4	4

The proactive protocols [27] are not appropriate for bigger networks, as they have to keep up node entries for every and each node within the routing table of each node. This causes a lot of overhead within the routing table resulting in the consumption of a lot of bandwidths.

Reactive Routing Protocols (On Demand)
In Reactive Routing Protocols [9] route information for routes is maintained for active nodes only. Route discovery occurs by flooding route request packet within the entire network. Reactive routing protocols are classified into source routing and hop by hop routing. In source routing, each data packet carries complete source to a destination address. In Hop by Hop routing, nodes need not maintain neighborhood connectivity through periodic beacon messages.

Dynamic Source Routing (DSR)
It is a source based loop-free routing protocol [10]. Each node maintains route cache where it keeps the source routes learned by the node. The route discovery process is initiated when the source node does not have a valid route to the destination in

the route cache. The DSR protocol works well in small to medium size network with moderate mobility. It is beacon less protocol [2]. No HELLO messages are exchanged between nodes to notify neighbors in the network.

This protocol [32] employs a reactive approach that eliminates the necessity to periodically flood the network with table update messages that are needed in an exceedingly table-driven approach. The intermediate nodes conjointly utilize the route cache information with efficiency to scale back the control overhead. The disadvantage of this protocol is that the route maintenance mechanism does not regionally repair a broken link. Stale route cache information might additionally end in inconsistencies during the route reconstruction phase. The connection setup delay is more than in table-driven protocols. Even if the protocol performs well in static and low mobility environments. The performance degrades quickly with increasing mobility. Also, considerable routing overhead is involved owing to the source routing mechanism utilized in DSR. This routing overhead has directly proportionality with the path length.

Ad Hoc on-Demand Distance Vector Routing Rule (AODV)

It is the mix of each (Dynamic supply Routing) DSR and Destination Sequence Distance Vector (DSDV) routing protocol [11]. It ensures destination sequence number to ensure loop freedom at all times. AODV does not offer any kind of security rather than source routing [2], it depends on dynamically creating route table entries at Intermediate nodes.

AODV [27] can handle extremely dynamic behavior owing to its reactive nature. The protocol is used for each unicasts and multicasts communication.

The algorithm [27] expects that the nodes within the broadcast medium will observe every others' broadcasts. Overhead on bandwidth are going to be occurred compared to DSR, when a (Route Request) RREQ travels from node to node. While discovering the route information on demand, with the addresses of all the nodes through which it is passing, it sets up the reverse path in itself and it carries all this information all its way. AODV lacks an economical route maintenance technique. The routing information is usually obtained on demand, together with for common cause traffic. The messages are exploited for insider attacks together with route upset, route takeover, node isolation, and resource consumption. AODV is intended to support the shortest hop count metric. This metric is kind to long, low bandwidth links over short, high-bandwidth links. The AODV does not find a route until a flow is initiated. This route discovery latency result is high in large-scale mesh networks.

Temporally- Ordered Routing Algorithm (TORA)

It is an adaptive distributed algorithmic rule for multihop ad hoc networks. [12] It is purposely engineered for quick dynamical network topologies. It has 3 parts that are construction phase, maintenance phase, and destruction phase. It uses link reversal procedure.

Link reversal routing (LRR) protocols [13] are developed for fast changing topology networks where conventional routing protocols are not working anymore. But at the same time it is used for the networks where change is not so fast that it will flooding will be the only possibility. LRR protocols do not necessarily give optimal route from source to destination, but it does not matter in this kind of situations.

One of the merits of TORA [29]is that the more than one routes between any source-destination pair are supported by this protocol. Therefore, removal or failure of any of the nodes is quickly resolved while not source intervention by a change to an alternate route. TORA is additionally not free from disadvantages. One in every of them is that it depends on synchronic clocks among nodes within the ad hoc network. The dependence of this protocol on intermediate lower layers for certain practicality presumes that the link status sensing, neighbor discovery, in order packet delivery and address resolution are all readily offered. The solution is to run the web MANET Encapsulation Protocol at the layer now below TORA.This can create the overhead for this protocol tough to break away that obligatory by the lower layer.

Associatively-Based Routing (ABR)

It is bandwidth efficient distributed routing protocols [14]. It is source initiated on-demand routing protocol. ABR uses point to point and broadcast routing. The destination node in the ABR chooses the route based on associability. The ABR has three phases route discovery, route reconstruction, and route deletion.

ABR routing protocol defines a new kind of routing metric known as, "Degree of Association stability" [15]. In this protocol, the route is chosen based on "degree of association stability" of mobile nodes. every node periodically creates a beacon to announce its existence. Upon receiving the beacon, a neighbor node updates its own associativity table. For every received beacon, the associativity of the beaconing node with the neighboring node is increased. A high value of associativity tick for any beaconing node means the node is comparatively static. Associativity tick is reset once the neighboring node moves out of the neighborhood of the other node.

The ABR [33] avoids packet duplications. The route reconstructions are absent in the protocol. The protocol is complex in terms of operation and communication.

Signal Stability–Based Adaptive Routing Protocol (SSA)

The protocol performs on-demand route discovery by choosing longer lived routes [16]. The route discovery is predicated on signal strength and site stability. The signal strength criterion permits the protocol to form a distinction between robust and weak channels. Every channel is characterized by average signal strength at that packets are interchanged between hosts at either end of the channel. The location stability criteria select a channel that has existed for the longer amount of time. Along these 2 ideas select robust channels and exist for the longer period greater than some threshold. The protocol [34] reduces path failure by signal stability but the overhead is more.

Summary of Reactive Routing Protocols

The source node sends the request packet in order to find a route to destination node [2]. The source node floods the packet to all the nodes in the network. The route path followed by the request packet is saved and sends back to source node by the destination node. As the request packet is flooded it generates multiple reply packets and hence multiple routes. The shortest route is used. It is dynamic strategy since each node can update its routing table when topology information is received.

Fresh routes require fewer calculations for data transmission. The disadvantage in the method is that each route each intermediate node must store and maintain routing information for each route. Each node may be aware of its surrounding neighbors through the use of beaconing messages. As it is reactive (on-demand) routing protocol routing information is provided as per need and periodic updates are not required.

The reactive routing protocols comparison [11] is given below

Table 2: Reactive Routing Protocols Comparison

Parameters	**AODV**	**DSR**	**TORA**
Route Generation	By Source	By Source	Locally
Periodic Updating	No	No	No
Performance Metrics	Speed	Shortness	Speed
Routing Overhead	High	High	High
Caching Overhead	Low	High	Medium
Throughput	High	Low	Low
Multipath	No	Yes	Yes
Route Updating	Non -Periodic in nature	Non -Periodic in nature	High Routing Overhead

Hybrid Routing Protocols

Hybrid routing protocol is a combination of proactive and reactive routing protocols. Proactive and reactive techniques are used to route packets. The route is established with proactive techniques and uses reactive flooding for mobile nodes. Sometimes these protocols are also referred to as hierarchical routing protocols. The protocol divides the networks into clusters. Each cluster has a cluster head. Cluster head keeps information about other clusters. Other nodes maintain information about their own clusters. A collection of clusters is called as a supercluster. Such types of protocols have the advantage of both tables driven and on demand approaches. [17]

Zonal Routing Protocol (ZRP)

ZRP uses table driven approach inside the zone and on demand approach outside zone [17]. A zone is created based on radius. If the radius is equal to one, then nodes need to maintain a table of routes to reach one hop neighbor alone. If the radius is equal to 2 then concerned nodes need to maintain the table of routes to reach its two-hop neighbors. So, in this case, table driven routing with the distance of two is used inside the zone and on-demand routing is used outside the zone.

Zone-Based Hierarchical Link State Routing Protocol (ZHLS)

It is hierarchical protocol in which network is divided into non-overlapping zones [18]. In addition, mobile nodes are assumed to know their locations through systems like GPS (Global Positioning System). Each node knows the node connectivity within its node and zone connectivity of the entire network. All the nodes in the ZHLS maintain two routing tables viz. namely intra-zone routing table and inter-zone routing table. The protocol uses hierarchical address scheme which contains node ID and zone ID. There are two kinds of link state revisions- the node level LSP (Link State Packet) and Zone Level LSP.

A node periodically broadcasts its node level LSP to all other nodes in the zone in which it resides. Gateway nodes broadcast zone level LSP when a virtual link is broken or created. That is why every node knows the zone level topology of the entire network.

Before sending packets, a source checks its intra-zone routing table. If the destination node is in the same zone as the source the routing information is already present. If this is not the case, then source sends a location request to all other nodes through gateway nodes. The zone in which destination node is situated replies with location response containing zone ID of the destination. During the journey of the packets through zones, inter-zone routing table will be used and when the packet arrives the destination zone then intra-zone routing table will be used.

Sharp Hybrid Adaptive Routing based protocol (SHARP)

This protocol [18] maintains the balance between proactive and reactive routing. It adapts efficiently between proactive and reactive strategies. The protocol defines proactive zones around some nodes. A node specific zone radius determines the number of nodes within given proactive zone. Nodes within a proactive zone maintain pro-actively to a central node. SHARP maintains proactive routing zones around popular destinations and for the nodes that have little or no data traffic it will maintain will rely on purely reactive traffic. By increasing the radius of the proactive zone, the protocol can decrease the loss rate and variance in delay but will increase the packet overhead to maintain the routes in larger zone.

Distributed spanning trees based routing protocol (DST)

The nodes in the network are grouped into a number of trees [11]. Each tree has two types of nodes: route node and an internal node. The root node controls the structure of the tree and decides whether the tree can be merged with other trees. Other nodes serve as regular nodes. Router, merge and configure are the three states of the node and the node can be in one of the three states depending on a type of task it is trying to perform.

DST proposes two strategies to propose route between source and destination pair. The first approach is Hybrid Tree Flooding (HTF) in which source sends control packets to all neighbors and adjoining bridges in the spanning tree. Each packet remains static at these places for a specific holding time. The second approach is Distributed Spanning Tree (DST) shuttling in which source sends control packets to edges till each of them reaches a leaf node. When a packet reaches the leaf node it is forwarded to shuttling level.

The drawback of such architecture is an existence of a single point of failure for the entire tree. If the route node fails, then entire routing structure falls apart. Further holding time used to buffer the packets may introduce an extra delay in the network.

Summary of Hybrid Routing Protocols

Hybrid protocols are a new generation of protocols which is a combination of proactive and reactive routing protocols [11]. The protocols provide scalability and eliminate the single point of failure. Bottleneck node creation in the network is avoided by allowing any number of nodes to perform data forwarding if the path becomes available. The difficulty of hybrid protocols is to organize the network according to required parameters. The protocol attempts to keep down the number of rebroadcasting nodes by defining a zone which allows the node to work together. The best or suitable nodes can perform route discovery. The disadvantage of hybrid routing protocol is that nodes that have high topological information keep more routing information which requires more memory and power consumption.

The comparison of some of the hybrid routing protocols [11] is given in Table III.

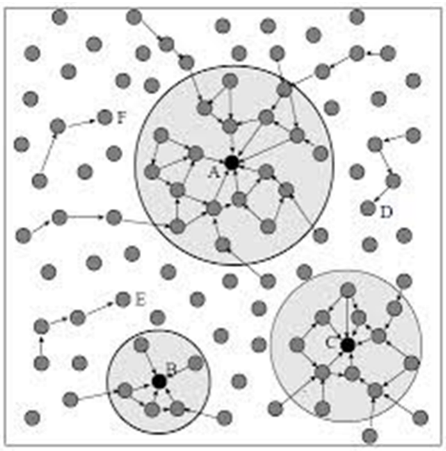

Figure 4: The SHARP Proactive and Reactive Zones

Preview of Other Routing Protocols

Other Routing Protocols

An efficient geographic multicast routing protocol (EGMP) is proposed in [19] which can scale to large group size and network size. The protocol efficiently implements multicasting delivery and management of membership for a group. The network piece of ground is split into geographical non overlapping square zones and a zone elects the leader to take charge of local group membership management. A zone based bidirectional multicast tree is formed to connect those zones having group members and such tree can utilize network resource effectively. The protocol [35] is an efficient multicast protocol which is suitable for dealing with large group size networks.

Geographical routing [20] is another type of routing which uses location information to formulate efficient route search towards a destination. Geographical routing requires propagation of single hop information to find a route towards the destination. The localized approach of the protocol reduces a need for maintaining the routing tables and reduces control overhead. It does not require flooding. The protocol is scalable, supports mobility and introduces minimal overhead.

Power-aware routing protocols [2] refer to set of protocols which are power aware. The nodes in the MANET are typically powered by batteries with limited energy supply. One in every of the foremost difficult issue in MANETs is to how to conserve energy and increase a lifetime of the nodes. It means that to increase the life of the network itself. Some routing protocols have been designed to take these challenges. Power-aware routing protocols are needed to be considered when energy saving is important criteria.

Minimum Net Transmission Power Routing (MTTPR) is a basic power aware routing protocol that forever tries to minimize the total power of the entire network. It does so by selecting the minimum hop count route. The metric “minimize the energy consumed per packet” is executed.

Every individual node battery life is not taken care of by MTTPR algorithm, so Minimum Battery Cost Routing (MBCR) algorithm is suggested by introducing extra battery cost function, that is, the inverse of the remaining battery capacity. This implies that if the remaining battery power decreases, the value operate can rise. This algorithm first finds the battery for each node of the network and then finds the battery cost function.

Table 3: Comparison of Hybrid Routing Protocols

Parameters	**ZRP**	**ZHLS**	**DST**
Routing Formation	Flat	Hierarchical	Hierarchical
Multiple Routes	No	Yes	Yes
Beacons	Yes	No	No
Route Information Stored in	Intra-zone and Inter-Zone Routing Tables	Intra-zone and Inter-Zone Routing Tables	Route Tables
Route Metric	Shortest Path	Shortest Path	Forwarding using Tree Neighbors
Advantages	Reduced Transmissions	Low Control Overhead	Reduced Transmission
Disadvantage	Overlapping Zones	Static Zone Map Required	Root Node

The comparison between three different categories of routing protocols [11] is given below

Table 4: Comparison of Routing Protocols On Classification

Parameters	**Table Driven**	**On Demand**	**Hybrid**
Storage Requirements	Higher	Dependent on number of routes maintained or required	Depends on size of each zone or cluster
Route Availability	Always available	Computed as per need	Depends on location of destination node
Periodic Route Updates	Required Always	Not required	Used inside each zone
Delay	Low	High	for local destinations it is low and high for inter-zone
Scalability	100 nodes	>100	>1000
Control traffic	High	Low	Lower than other two types
Routing Information	Keep stored in table	Does not store	Depends upon requirement.
Routing Philosophy	Mostly flat	Flat	Hierarchical

Conclusion

This work takes an overview of a number of routing protocols used in a wireless network. The protocols are chiefly classified as proactive, reactive and hybrid protocols. Other types like geographical routing and power aware routing are also discussed. Different types of comparisons have been carried out. The principal factor in all these protocols is finding an optimum route between source and destination with given conditions. The overview as presented in this work will go a long way in providing a platform for anyone to choose the best protocol for his/her work and to do necessary innovations if any.

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