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Improvement Test – May 2017

Sub:	Ad-hoc Networks	**Code:**	10IS841
Date: -05-17 Duration: 90 mins Max Marks: 50	**Sem:** VIII	**Branch:**	**ISE A&B**

Note: Answer any 5 questions. All questions carry equal marks. Total marks: 50

		Marks	OBE CO	OBE RBT
1.	Explain flow oriented routing protocol in ad-hoc wireless networks.	[10]	CO3	L1
2.	Give the classification of routing protocols in ad-hoc wireless networks with examples of each.	[10]	CO3	L1
3.	Explain zone based hierarchical link state routing protocol with example.	[10]	CO3	L4
4.	Explain the operation of Fisheye State Routing Protocol (FSRP).	[10]	CO5	L3
5	Briefly explain the core extraction distribution Ad-hoc routing protocol by mentioning its advantages and disadvantages.	[10]	CO3	L4
6	Write short note on AODV and DSDV	[10]	CO3	L3
7	Explain preferred link state routing protocol and optimized link state routing protocol.	[10]	CO3	L2
8	Explain Zone Routing Protocol.		CO3	L2

IAT3 Scheme and solutins
Subject:Adhoc Wireless Networks

1.Explain wireless routing protocol in ad-hoc wireless networks.

[Working (5)
Advantages disadvantages (5)
Diagram (1)

WRP is similar to DSDV; it inherits the properties of the distributed bellman-ford algorithm.

To counter the count-to-infinity problem and to enable faster convergence, it employs a unique method of maintaining information regarding the shortest distance to every destination node in the network and penultimate hop node on the path to every destination node.

Maintains an up-to-date view of the network, every node has a readily available route to every destination node in the network.

It differs from DSDV in table maintenance and in the update procedures.

While DSDV maintains only one topology table, WRP uses a set of tables to maintain more accurate information.

The table that are maintained by a node are :

o Distance table (DT): contains the network view of the neighbors of a node. It contains a matrix where each element contains the distance and the penultimate node reported by the neighbor for a particular destination.

o Routing table (RT): contains the up-to-date view of the network for all known destinations. It keeps the shortest distance, the predecessor/penultimate node, the successor node, and a flag indicating the status of the path. The path status may be a simplest (correct) path or a loop (error), or destination node not marked (null).

Link cost table (LCT): contains the cost of relaying messages through each link. The cost of broken link is ∞.it also contains the number of update periods passed since the last successful update was received from that link.

o Message retransmission list (MRL): contains an entry for every update message that is to be retransmitted and maintains a counter for each entry.

After receiving the update message, a node not only updates the distance for transmitted neighbors but also checks the other neighbors' distance, hence convergence is much faster than DSDV.

Consider the example shown in figure below, where the source of the route is node 1 and destination is node 15. As WRP proactively maintains the route to all destinations, the route to any destination node is readily available at the source node.

From the routing table shown, the route from node 1 to node 15 has the next node as node 2. The predecessor node of 15 corresponding to this route is route 12. The predecessor information helps WRP to converge quickly during link breaks.

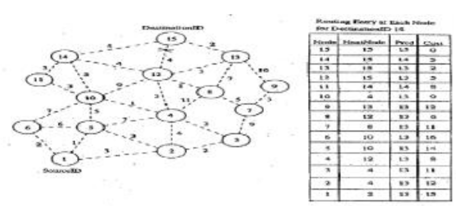
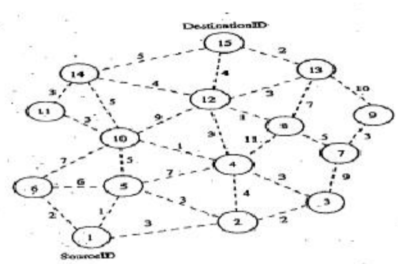


Figure 7.8. Route maintenance in WRP.



Routing Entry at Each Node for DestinationID 15

Node	NextNode	Pred	Cost
15	15	15	0
14	15	14	5
13	15	13	2
12	15	12	4
11	14	14	8
10	4	12	8
9	13	13	12
8	12	12	5
7	8	12	10
6	10	12	15
5	10	12	13
4	12	12	10
3	4	12	7
2	4	12	11
1	2	12	14

Figure 7.7. Route establishment in WRP.

Explain wireless routing protocol in ad-hoc wireless networks.

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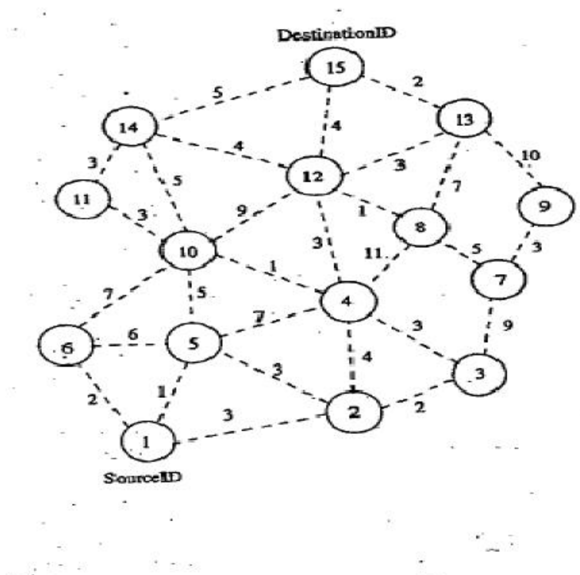

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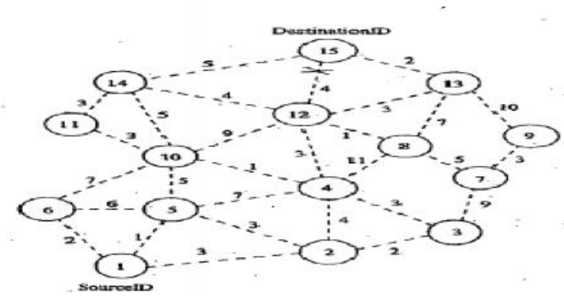
8	12	12	5
7	8	12	10
6	10	12	15
5	10	12	13
4	12	12	10
3	4	12	7
2	4	12	11
1	2	12	14

Figure 7.7. Route establishment in WRP.



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12	15	13	5
11	14	14	8
10	4	13	9
9	13	13	12
8	12	13	6
7	8	13	11
6	10	13	16
5	10	13	14
4	12	13	8
3	4	13	11
2	4	13	12
1	2	13	15

Figure 7.8. Route maintenance in WRP.

When a node detects a link break, it sends an update message to its neighbors with the link cost of the broken link set to ∞. After receiving the update message; all affected nodes update their minimum distances to the corresponding nodes. The node that initiated the update message then finds an alternative route, if available from its DT. Figure 7.8 shows route maintenance in WRP.

Advantages

WRP has the same advantages as that of DSDV.
It has faster convergence and involves fewer table updates.

Disadvantages

The complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the adhoc wireless network.
It is not suitable for highly dynamic and also for very large ad hoc wireless networks.

Give the classification of routing protocols in ad-hoc wireless networks with examples of each.

The routing protocol for adhoc wireless networks can be broadly classified into 4 categories based on

Routing information update mechanism.
Use of temporalinformation for routing
Routing topology
Utilization of specific resources

Based on the routing information update mechanism

Ad hoc wireless network routing protocols can be classified into 3 major categories based on the routing information update mechanism. They are:

Proactive or table-driven routing protocols :

o Every node maintains the network topology information in the form of routing tables by periodically exchanging routing information.
o Routing information is generally flooded in the whole network.
o Whenever a node requires a path to a destination, it runs an appropriate path-finding algorithm on the topology information it maintains.

Reactive or on-demand routing protocols:

o Do not maintain the network topology information.
o Obtain the necessary path when it is required, by using a connection establishment process.

Hybrid routing protocols:

o Combine the best features of the above two categories.
o Nodes within a certain distance from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given node.
o For routing within this zone, a table-driven approach is used.

o For nodes that are located beyond this zone, an on-demand approach is used.

Based on the use of temporal information for routing

The protocols that fall under this category can be further classified into two types :

Routing protocols using past temporal information:

o Use information about the past status of the links or the status of links at the time of routing to make routing decisions.

Routing protocols that use future temporal information:

o Use information about the about the expected future status of the wireless links to make approximate routing decisions.

o Apart from the lifetime of wireless links, the future status information also includes information regarding the lifetime of the node, prediction of location, and prediction of link availability.

Based on the routing topology

Ad hoc wireless networks, due to their relatively smaller number of nodes, can make use of either a flat topology or a hierarchical topology for routing.

Flat topology routing protocols:

o Make use of a flat addressing scheme similar to the one used in IEEE 802.3 LANs.

o It assumes the presence of a globally unique addressing mechanism for nodes in an ad hoc wireless network.

Hierarchical topology routing protocols:

o Make use of a logical hierarchy in the network and an associated addressing scheme.

o The hierarchy could be based on geographical information or it could be based on hop distance.

Based on the utilization of specific resources

Power-aware routing:

o Aims at minimizing the consumption of a very important resource in the ad hoc wireless networks: the battery power.

o The routing decisions are based on minimizing the power consumption either logically or globally in the network.

Geographical information assisted routing :

o Improves the performance of routing and reduces the control overhead by effectively utilizing the geographical information available.

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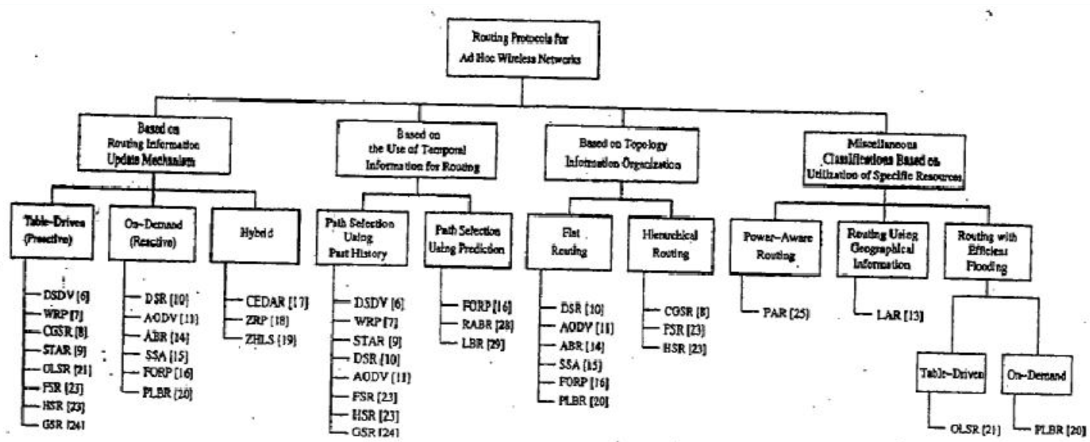


Figure 7.4. Classifications of routing protocols.

3.Explain zone based hierarchical link state routing protocol with example

Working (5)
Advantages disadvantages (5)

Diagram (1)

ZHLS uses the geographical location info of the nodes to form non-overlapping zones. A Hierarchical Addressing that consists of a zone ID and a node ID is employed.

Similar to ZRP, ZHLS also employs a Proactive approach inside the geographical zone and a Reactive approach behind the zone.

Every node requires GPS support for obtaining its own geographical location that is used to map itself into corresponding zone.

The assignment of zone addresses to geographical areas is important and is done during a phase called the network design phase or network deployment phase.

Each node maintains two link state packets: (LSP)

Node level LSP: list of connected neighbors.

Zone LSP: list of connected zones.

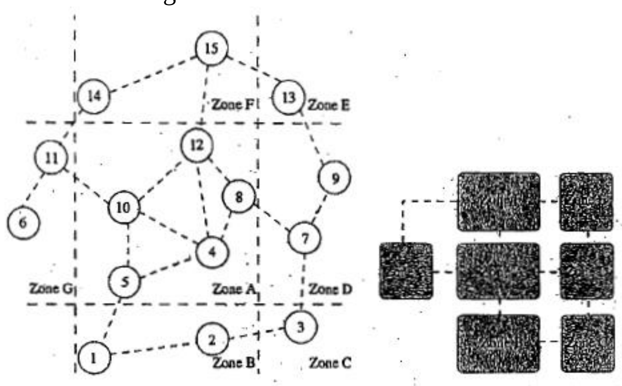
Route Establishment If a source node src wants to communicate with a destination node dest, src checks whether dest resides in its own zone.

If dest belongs to same zone, then packets are delivered to the dest as per the Intra-Zone routing table.

If dest does not belong to the same zone, then the src originates a location request packet containing the sender's and destination's information. This location info is forwarded to every other zone.

The gateway node of a zone at which the location request packet is received verifies its routing table for the destination node.

The gateway node that finds the destination node required by a location request packet originates a location response packet containing the zone information to the sender.



(a) Node-level topology in ZHLS

(b) Zone topology for the node-level topology in (a)

Figure 7.28. Zone-based hierarchical link state routing protocol.

Table 7.1: Zone link state packets

Source Zone	Zone Link State Packet
A	B, D, F, and G
B	C and A
C	B and D
D	A, C, and E
E	A, D, and F
F	A, E, and G
G	A and F

Route Maintenance If a given gateway node away causing a zone level connection failure, can still take place with the help of the other gateway nodes.

This is due to the hierarchical addressing that makes use of zone ID and node ID.

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Advantages

Reduce storage requirements and common overhead.

Robust and resilient to path breaks.

Non overlapping zones.

Disadvantages

Additional overhead incurred in creation of zone level topology.
Path to Destination is suboptimal.
Geographical info may not be available in all environments.

Explain the operation of Fisheye State Routing Protocol (FSRP).

Working (5)
Advantages disadvantages (5)
Diagram (1)

It is a generalization of the GSR protocol.

It uses Fisheye technique to reduce the routing overhead.
Principle: Property of a fish's eye that can capture pixel information with greater accuracy near its eye's focal point.
This accuracy decreases with an increase in the distance from the center of the focal point
This property is translated to routing in adhoc wireless networks by a node
Each node maintains accurate information about near nodes.
Nodes exchange topology information only with their neighbors.
A sequence numbering scheme is used to identify the recent topology changes
This constitutes a link-level information exchange of distance vector protocols and complete topology information exchange of link state protocols.
FSR defines routing scope, which is the set of nodes that are reachable in a specific no. of hops.
The scope of a node at two hops is the set of nodes that can be reached in two hops fig 7.32 shows scope of node 5 with one hop and two hops.
The routing overhead is significantly reduced

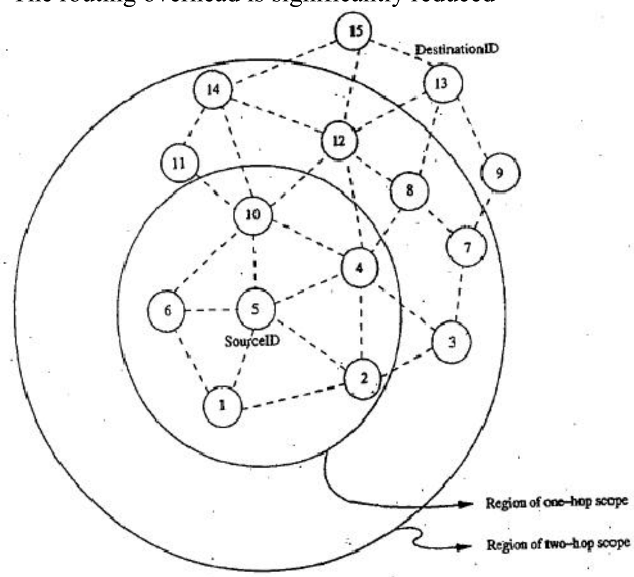

Figure 7.32. Fisheye state routing.

The link state info for the nodes belonging to the smallest scope is exchanged at the highest frequency. Frequency of exchanges decreases with an increase in scope.

Fig 7.33 illustrates an example depicting the n/w topology information maintained at nodes in a n/w.
Message size for a typical topology information update packet is significantly reduced

The routing information for the nodes that are one hop away from a node are exchanged more frequently than the routing information about nodes that are more than one hop away

Information regarding nodes that are more than one hop away from the current node are listed below the dotted line in the topology table.

Advantages

Reduce bandwidth consumption by link state update packets.

Suitable forlarge and highly mobile adhoc wireless network.

Disadvantages

Very poor performance in small adhoc networks

Briefly explain the core extraction distribution Ad-hoc routing protocol by mentioning its advantages and disadvantages.

Working (5)

Advantages disadvantages (5)

Diagram (1)

CEDAR integrates routing and support for QoS.

It is based on extracting core nodes (also called as Dominator nodes) in the network.

Core nodes together approximate the minimum Dominating Set (DS).

A DS of a graph is defined as a set of nodes such that every node in the graph is either present in the DS or is a neighbor of some node present in the DS.

There exists at least one core node within every three hops.

The nodes that choose a core node as their dominating node are called core member nodes of the core node concerned.

The path between two core nodes is termed as virtual link.

CEDAR employs a distributed Algorithm to select core nodes.

The selection of core nodes represents thecore extraction phase.

CEDAR uses the core broadcast mechanism to transmit any packet throughout the network in the unicast mode, involving as minimum number of nodes as possible.

Route Establishment in CEDAR: It is carried out in two phase.

The first phase finds a core path from source to destination. The core path is defined as the path from dominator of the source node (source core) to the dominator of the destination node (destination core).

In the second phase, a QoS feasible path is foundover the core path.

A node initiates a RouteRequest if the destination is not in the local topology table of its core node; otherwise the path is immediately established.

For establishing a route, the source core initiates a core broadcast in which the RouteRequest is sent to all neighboring core nodes which inturn forwards it.

A core node which has the destination node as its core member replies to the source core.

Once the core path is established, a path with the requested QoS support is thenchosen.

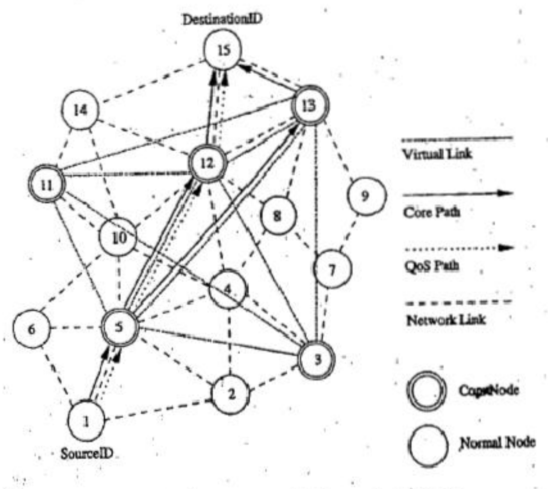

Figure 7.24. Route establishment in CEDAR.

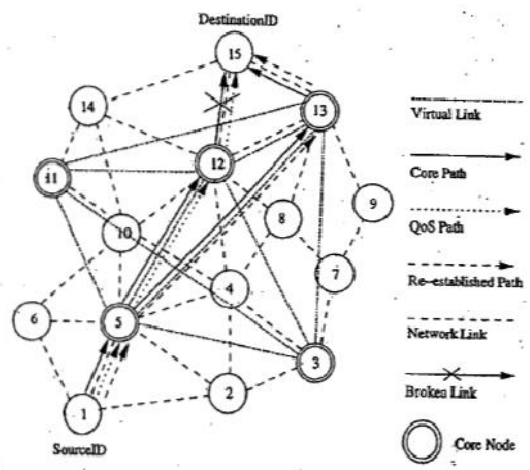

Figure 7.25. Route maintenance in CEDAR.

Route Maintenance in CEDAR: attempts to repair a broken route locally when a path break occurs.

A node after which the break occurred:
o Sends a notification of failure.
o Begins to find a new path from it to the destination.
o Rejects every received packet till the moment it finds the new path to the destination.
Meanwhile, as the source receives the notification message:
o It stops to transmit.
o Tries to find a new route to the destination.
o If the new route is found by either of these two nodes, a new path from the source to the destination is established.

Advantages

Performs both routing and QoS path computation very efficiently with the help of core nodes.

Utilization of core nodes reduces traffic overhead.

Core broadcasts provide a reliable mechanism for establishing paths with QoS support.

Disadvantages

Since route establishment is carried out at core nodes, the movement of core nodes adversely affects the performance of the protocol.

Core node update information causes control overhead.

Difference between AODV & DSDV

DSDV	AODV
It always discovers the route to all available destinations	A route discovery is initiated, only when it is required
The routing table retains the route to all destination table	Only the path with the least hop count value is maintained in the routing
The routing information is propagated periodically, irrespective of the network topology dynamics	The routing information is not propagated unless, the network topology changes
Frequent route discovery requires more control packets for high scalable networks	Requirement of control packets is less, when compared to DSDV
Link breakage due to node mobility does not interrupts the data communication because it ha alternative path to the same destination	The link failure interrupts the data communication until an alternative route is discovered
The increased size of the routing table in a large scale network results in high routing overhead	There is no additional overhead due to the maintenance of a fresh route
Frequently changed network topology affects the data packet latency	Scalability and mobility effect on data packet latency is lower than the DSDV
The increased rate of link failure, achieves poor packet delivery ratio	Packet delivery ratio is higher than DSDV
High scalable MANET incurs high bandwidth and power consumption owing to the frequent route discovery	Power consumption is less than DSDV since, it demands route only when it is required

Explain power aware routing protocol

Metrics explanation 2 marks each

Power-Aware Routing Metrics

The limitation on the availability of power for operation is a significant bottleneck. Hence, the use of routing metrics contributes to the efficient utilization of energy and increases the lifetime of the network

Minimal energy consumption per packet

o This metric aims at minimizing the power consumed by a packet in traversing from source node to the destination node.

o The energy consumed by a packet when traversing through a path is the sum of the energies required at every intermediate hop in that path.

o This metric doesn't balance the load

o Disadvantages

o Selection of path with large hop length

o Inability to measure the power consumption in advance

o Inability to prevent the fast discharging of batteries at some nodes

Maximize network connectivity

o This metric attempt to balance the routing load among the cut set (the subset of the nodes in the network, the removal of which results in network partitions).

It is difficult to achieve a uniform battery draining rate for the cut set.

Maximum variance in Node power levels

o This metric proposes to distribute the load among all nodes in the network so that the power consumption pattern remains uniform across them.

o This problem is very complex when the rate and size of the data packets vary

Minimum cost per packet

o In order to maximize the life of every node in the network, this routing metric is made as a function of the state of the node's battery.

o A node's cost decreases with an increase in its battery change and vice versa.

o Cost of node can be easily computed

o Advantage congestion handling & cost calculation

Minimize maximum node cost

o This metric minimizes the maximum cost per node for a packet after routing a number of packets or after a specific period.

o This delays the failure of a node, occurring due to higher discharge because of packet forwarding

7a Explain preferred link state routing protocol and optimized link state routing protocol.

Use the preferred link approach in an implicit manner by processing a RouteRequest packet only if it is received through a strong link.

Here a node selects a subset of nodes from its Neighbors List (NL). This subset is referred to as the Preferred List (PL) selection of this subset may be based on link or node characteristics.

All neighbors receive RouteRequest packets because of the broadcast radio channel, but only neighbors present in the PL forward them further.

Each node maintains information about its neighbors and their neighbors in a table called Neighbor's Neighbor Table (NNT). It periodically transmits a beacon containing the changed neighbor's information.

Route Establishment

If dest is in src's NNT, the route is established directly. Otherwise, src transmits a RouteRequest packet containing

o Source node's address (SrcID)

o Destination node's address (DestID)

o Unique sequence number (SeqNum)

o Traversed path (TP)

o PL

o TTL flag

o NoDelay flag

A node is eligible for forwarding a RouteRequest only if it satisfies the following criteria:

The node ID must be present in the received RouteRequest packet's PL

RouteRequest packet must not have been already forwarded by the node, and the TTL on the packet must be greater than zero.

If the dest is in the eligible node's NNT, the RouteRequest is forwarded as a unicast packet to the neighbor

If the computed PLT is empty, the RouteRequest packet is discarded and marked as sent.

If the RouteRequest reaches the destination, the route is selected by the route selection procedure given below.

Route selection:

When multiple Route Request packets reach dest,the route selection procedure selects the best route among them.

The criterion for selecting the best route can be the shortest path, or the least delay path, or the most stable path.

Dest starts a timer after receiving the first route request packet. The timer expires after a certain RouteSelectWait period, after which no more RouteRequest packets would be accepted.

From the received Route Request packets, a route is selected as follows:

For every RouteRequesti that reached Dest during the RouteSelectWait period, Max(Wmin) is selected, where is the min. Weight of the link in the path followed by i if two or more paths have the same value for the shortest path is selected.

After selecting a route, all subsequent RouteRequest packets from the same src with a seqnum less than or equal to the seqnum of the selected RouteRequest are discarded.

If the node delay flag is set, the route selection procedure is omitted and TP of the first RouteRequest reaching the Dest is selected as the route.

Algorithms for preferred links computation

Neighbor-Degree-Based preferred link algorithm(NDPL) Weight Based preferred link algorithm(WBPL)

NDPL

Let d → node that calculates the preferred list table PLT. TP Traversed path. OLDPL → preferred list of the received RouteRequest packet. NNTd → NNT of the node d. N(i) → neighbors of node I and itself. INL→ include list, a set containing all reachable neighbors by transmitting the RouteRequest packet. EXL → Exclude list, a set containing all neighbors that are unreachable by transmitting the RouteRequest packet after execution of the algorithm. **Step 1:** Node d marks the nodes that are not eligible for further forwarding the RouteRequest packet.

a) If a node i of TP is a neighbor of node d mark all neighbors of i as reachable i.e add N(i) to INL.

b) If a node i of OLDPL is a neighbor of node d and i< d, then include N(i) in INL.

c) If neighbor i of node d has a neighbor n present in TP, add N(i) to INL.

d) If neighbor i of node d has a neighbor n present in OLDPL and n < d, add N(i) to INL.

Step 2: If neighbor i of node d is not in INL, put i in PLT and mark all neighbor of i as reachable. If i is present in INL, mark the neighbors of i as unreachable by adding them to EXL. **Step 3:** If neighbor i of d has a neighbor n present in EXL, put i in PLT and mark all neighbors of i as reachable. Delete all neighbors of i from EXL. **Step 4:** Reduction steps are applied here in order to remove overlapping neighbors from PLT without compromising on reachability.

a) Remove each neighbor i from PLT if N (i) is covered by remaining neighbors of PLT. Here the minimum degree neighbor is selected every time

b) Remove neighbor i from PLT whose N (i) is covered by node d itself.

Advantages

Minimizes broadcast storm problem. Hence, highly scalable.

Reduction in control overhead results in decrease in the number of collisions and improvement in efficiency of the protocol.

Disadvantage

Computationally more complex.

Optimized Link State Routing (OLSR)

It is a proactive routing protocol that employs an efficient link state packet forwarding mechanism called multipoint relaying (MPR).

This protocol optimizes the pure link state routing protocol.

Optimizations are done in two ways:

o By reducing the size of control packets.

o By reducing the no. of links that are used for forwarding the link state packets.

The subset of links or neighbors that are designated for link state updates and are assigned the responsibility of packet forwarding are called multipoint relays.

Theset consisting of nodes that are multipoint relays is referred to as MPRset.

Each node(say, P) in the n/w selects an MPRset that processes and forwards every link state packet that node P originates.

The neighbor nodes that do not belong to the MPRset process the link state packets originated by node P but do not forward them.

Similarly, each node maintains a subset of neighbors called MPR selectors, which is nothing but the set of neighbors that have selected the node as a multipoint relay.

Inorder to decide on the membership of the nodes in the MPRset, a node periodically sends Hello messages that contain

o List of neighbors with which the node has bidirectional links

o List of neighbors whose transmission was received in the recent past but with whom bidirectional links have not yet been confirmed.

The nodes that receive this Hello packet update their own two-hop topology tables.

The selection of multipoint relays is also indicated in the Hello packet.

The Data structure called neighbor table is used to store the list of neighbors, the two-hop neighbors, and the status of neighbor nodes.

The neighbor nodes can be in one of the three possible link status states, i.e

o Unidirectional

o Bidirectional

Advantages:

Reduces the routing overhead.

Reduces the no. of broadcasts done.

Hence low connection setup time and reduced control overhead.