NRA

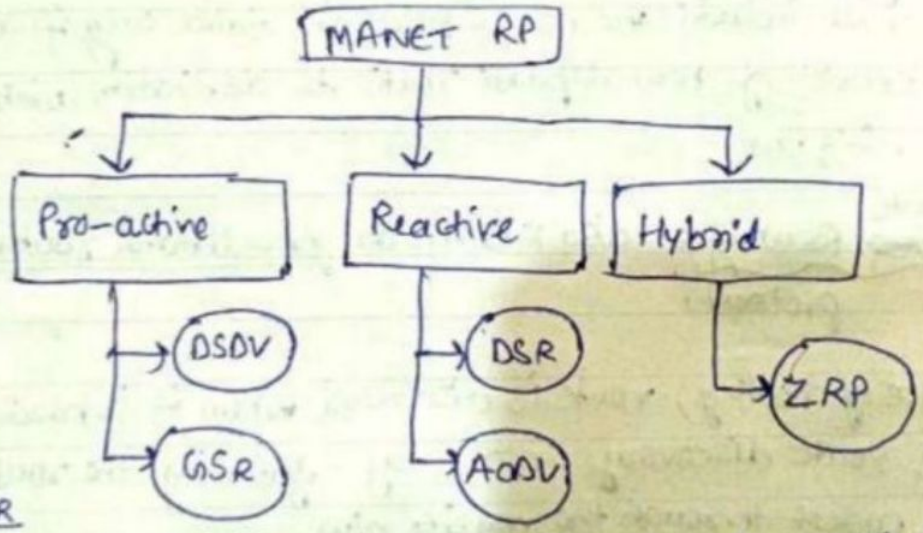
UNIT-5

Activity No. Date :

Topic : MANET : In mobile Adhoc Network (MANET), nodes do not know the topology of the network, instead they have to discover it by their own as the topology in ad-hoc network is dynamic topology

Aim/Objective :

The basic rule is that a new node whenever enters into an adhoc network, must announce arrival & presence & should also listen should also listen similar announcement broadcast made by other mobile nodes.



IDR

1) Pro-active routing protocols : They are also name as table driven routing, Each mobile node maintain a seperate routing table which contain the info of the routes to all possible destination mobile nodes.

→ Topology in mobile adhoc is dynamic
→ routing table updates periodically when network topology changes.
→ Limitation : 1) It does n't work on large network.
2) As entries in RT becomes too large since they need to maintain the route info all possible nodes.

Teacher's Signature

1) DSDV (Destination sequenced Distance Vector Routing): It is a proactive table driven routing protocol

→ It is based on Bellman-ford routing algo.
→ It actually extends the distance vector routing protocol of wired network.
→ Distance vector RP is not suited for mobile adhoc nlw due to count to infinity prblm, hence DSDV came into picture to solve it,
→ (DS)no: Destination sequence number is added with every routing entry in the routing table maintained by each node.
→ A node will include the new update in table only if new entry consist of new update route to destination with higher seq. no.

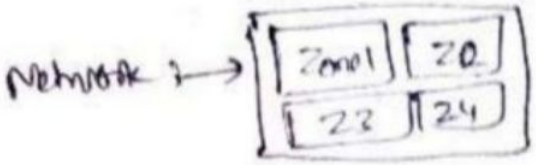
2) Global State routing (GSR): It is pro-active table driven routing protocol.
→ It actually extends the link state routing of wired nlw.
→ It is based on the Dijkstra's routing algorithm.
→ Link state routing protocol is not suited for mobile adhoc nlw because each node flood the link state RP info directly into whole N/w.
→ global flooding leads to congestion of control packets in N/w.
→ Here soln is (GSR), it doesn't flood link state RP packet globally into N/w.
→ In GSR each mobile node maintain one list & three tables, adjacency list, topology table, next hop table, distance table.

2) Reactive Routing Protocol: also known as on-demand routing protocol.
→ In this type route is discovered when it is needed/req.
→ process of route discovery occurs by flooding route request packet through the mobile nlw.

& , then position of source & destination mob node is observed.

⇒ If source & destination mobile node are present in same zone, then proactive RP is used for transmission of data bw them.

⇒ And if source & destination mob node is in diff^{n} zones then reactive RP is used for transmission data bw them



* Characteristics of MANET

1) It must be localized.
2) It should be widely distributed
3) Should able to improve high quality service
4) It must be free of imperable routes.
5) The convergence of route must be fast.
6) Each node in nw should be rep to store information abt nw topology

⊛ Cluster-Head gateway Switch Routing Protocol (CGSR)

→ CGSR is a heirarchical routing protocol & it is a proactive protocol.
→ When a source route the data packet to destination, the routing tables are already available at the nodes
→ A cluster higher in heirarchy send the packet to the cluster lower in heirarchy.
→ Each cluster have several daughters & forms a tree like structure
→ The nodes aggregate into a cluster use an appropriate algo. The algorithm define a cluster-head, the node used for connection to other.
→ Also defines gateway node, which provide switching bw two or more cluster head..

⊛ CGSR Working : 1) Periodically each node sends a hello message containing its id and monotonically increasing S.N.

Two phases namely & DSR (Dynamic Source RP)

Activity No:
Topic:
Aim/Objective:

Phases of
1) Route discovery : It is a on demand routing protocol. this phase determine most optimal path for the transmission of data b/w source to destination mobile node.
2) Route maintainance : phase perform maintainance work of route as the the topology in mobile adhoc is dynamic in nature.

* Reactive Routing protocols : done → (DSR) phase 1, phase 2
→ (AODV)

1) Dynamic Source Routing Protocol (DSR) : it is on demand routing protocol, route is discovered only when it is required by request
→ phase 1 and phase 2 of DSR

2) Adhoc-on-demand Vector Routing Protocol (AODV) : It is on-demand reactive routing protocol.
→ It is extension of DSR & it helps to remove limitations of DSR.
→ DSR stores stores the path in the data packet's header, hence network size ↑, & the data packet size also ↑ which makes whole n/w slow.
→ BUT AODV stores path in ~~data~~ the routing table. It also operate two phases like DSR: Route discovery, Route maint.
→ AODV is the solution of DSR problems

* Hybrid Routing Protocol : It is basically combines the adv of both reactive and pro-active routing protocols.
→ these protocols are adaptive in nature and adapts accordingly to zone and position of source & destination mobile node
* most popular HRP → Zone routing protocol (ZRP).

In ZRP, → whole network is divided into diff zones

Teacher's Sign

2) using this message, every cluster head maintain table containing ID's of nodes belonging to it

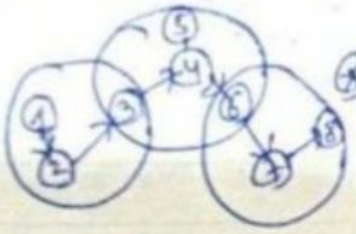
Activity No.

3) Cluster head exchanges these tables with each other through gateways.

Topic:

Aim/Objective:

4) Each cluster head & each gateway maintain a routing table with an entry for each cluster head that the next gateway on the shortest path to that cluster head.



* Three types of Nodes
Node: Internal node which receive & transmit the data packet.
Cluster head: It control group of adhoc host, monitoring broadcasting within cluster, forward msg to another clus. head.
Gateway node: to carry out transmission of packet & msg b/w cluster head of 2 cluster

* Advantage of CGSR

1) Better bandwidth utilization is possible.
2) It enables partial coord. b/w nodes by electing cluster head.
3) It is easy to implement priority scheduling scheme with token scheduling and gateway code scheduling.

Disadvantage

1) Increase in path length & instability in the system at high mobility
2) Rate of change of cluster-head is high.
3) High power consumption; battery draining at cluster head is higher than a normal node.
4) It cause multiple path breaks.

* Power Aware Routing Protocols (PAR) → Power consumption is a crucial design concern in wireless adhoc network since wireless nodes are typically limited battery

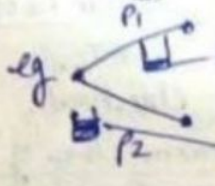
Teacher's Signature

→ (PAR) is a consideration in a way that it minimize the energy consumption while routing traffic.

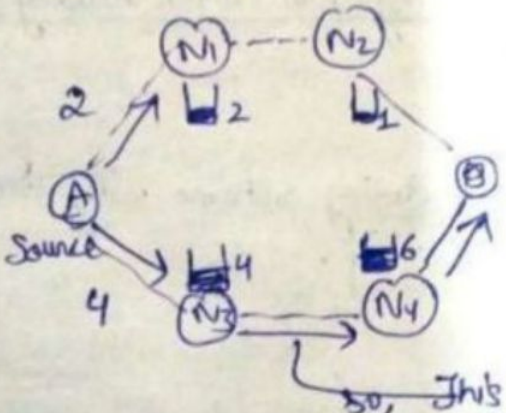
→ Routers are also power-constrained like nodes.

(*) Power aware - routing Metrics & Routing protocol that select paths so as to conserve power must be aware of the state of the batteries.

↳ (i) minimal energy consumption per packet
(ii) maximize N/w connectivity,
(iii) minimum variance in node power levels
(iv) minimum cost per packet
(v) Minize maximum node cost.



eg So, we use path that contains more battery to avoid N/w connectivity failure.



eg!

So in PAR we select less cost path & high battery path to avoid Sys connectivity failure

battery > cost

So, This path will be select for each destination.

Various Power aware Routing Protocol (PAR):

1) minimum total transmission power routing protocol (MTTR)
2) minimum battery cost routing protocol. (MBCR)
3) Min-Max battery cost Routing. (MMBCR)

1) MTTR → tries to select a path that has minimum total power. A node that is required to a distant node broadcast RREQ to all its neighbours, the process continues at each & every intermediate node till packet reach destination.

(72)

Activity No.

Date :

Topic :

Aim/Objective :

Algo : 1) Calculate the total transmission power for all route in nlw.

2) Select the route with min MTTR among all routes.

MTTR limitation :

1) It is always select nearest neigh. node, so battery extract quickly.

2) More number of nodes are active.

3) Network is congested ; packet has to route from multi nodes.

2 (MBCR) : → prevent nodes from being overused.

→ In MBCR battery cost fun^c $\propto \frac{1}{\text{battery capacity}}$.

→ as the battery capacity ↑, value of cost fn ↑.

→ as a result node which have little battery capacity still may be selected for transmission.

→ If all nodes have similar battery, it select shortest hop route.

→ Algo same as MTTR change transmission power to battery cost

⊛ limitation : Some nodes may be overused because route containing nodes with little remaining battery capacity may be selected again & again.

3. MMBCR : → It overcomes limitation MBCR.

→ Nodes with smaller battery remaining are avoided. & ones with larger battery capacity are picked up for transmission.

Algo : 1) for each route, select battery cost fn which having maximum value among all nodes in route.

2) Now select the route with minimum battery cost among all routes.

Teacher's Signature

73

Limitation: 1) → Consume more power to transmit traffic from source to destination, which reduce lifetime of all nodes.

2) No guarantee that minimum total transmission power path will be selected under all circum.

(*) PSTN (Public Switched Telephone Network):

PSTN is the world's collection of interconnected voice-oriented public telephone network. PSTN comprises all the switched telephone network around the world that are operated by local, national or international carriers.

→ these network provides infrastructure & service for public telecom.
→ helps to telephone comm. each other.

(*) PSTN working

when we dial phone number our calls moves through the n/w to reach its destination & two phones are connected.
To fully understand POTS actually work:

Step#1: Your telephone set convert sound wave into electrical signal & these signal are then transmitted to a terminal via cable.

Step#2: the terminal collects the electrical signal & transmit these to central office (CO).

Step#3: the central office route the calls in the form of electrical signal through fiber optic cable. the fiber optic carries these signal in form of light pulses to their final dest.

Step#4: Your calls is routed to a tandem office or CO.

Step#5: when your call reaches the right office, the signal converted back to ES and then is routed to a terminal

Step#6: the terminal route the calls to the appropriated telephone number. Upon recieving the call, telephone

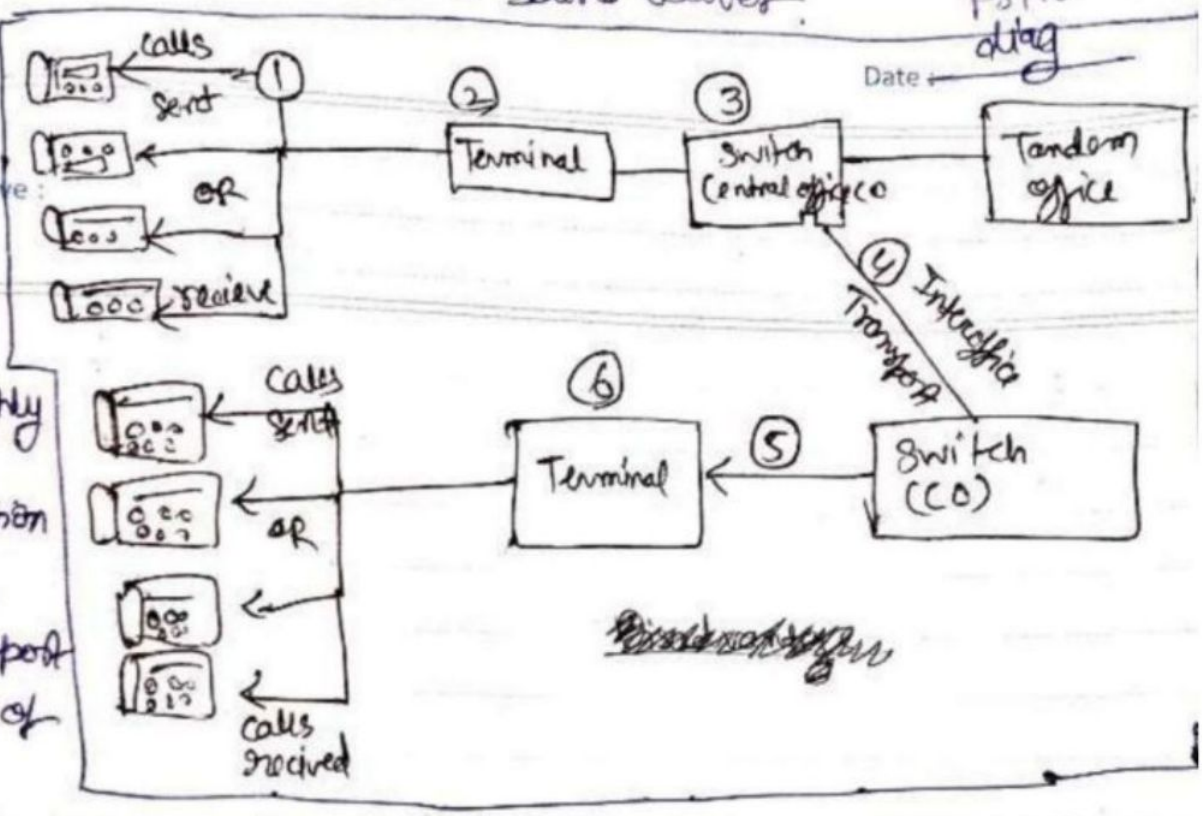
and convert ES into back to sound waves.

Activity No.

Date

Topic :

Aim/Objective :



Advantages

1) It provide highly private & secure connection
2) ability to scale & support large volume of traffic
3) It provide pristine quality, nearly 100% uptime.

* Disadvantage →
1) It is less efficient
2) more expensive than a packet switch network
3) It requires a dedicated line for making and completing a call.
4) Scalability is limited. & cannot use bandwidth optimally

Teacher's Signature

75

ANKIT
Date
Page

* On-Demand Routing Protocol :-
1. Ad-hoc On-Demand Distance Vector (AODV)
2. Dynamic Source Routing (DSR)
3. Temperary ordered routing Algo. (TORA)
4. Associativity Based Routing (ABR)
5. Signal Stability Routing (SSR)

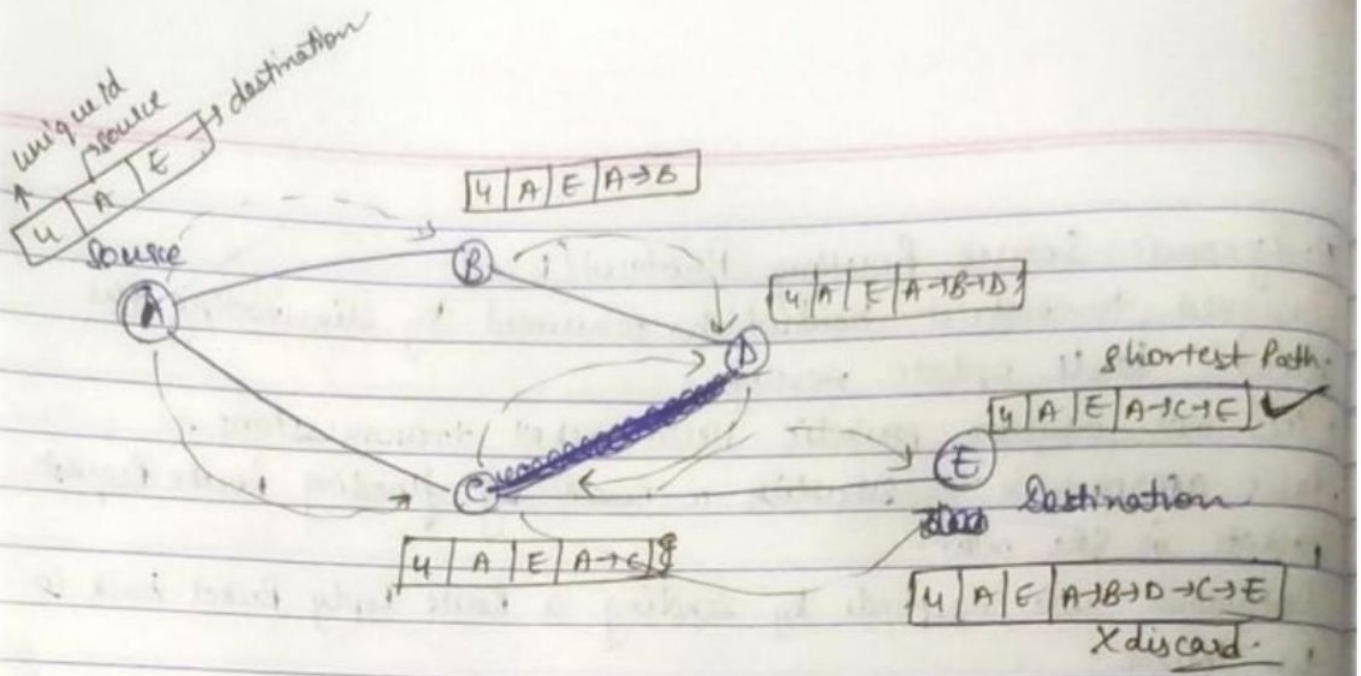
(*). Dynamic Source Routing Protocol (DSR)

→ Designed to restrict bandwidth consumed by eliminating the periodic table update messages.
→ Does not require periodic Hello packet transmissions.
→ Basic approach is to establish a Route by flooding Route Request packets in the n/w.
→ Destination node responds by sending a Route Reply Packet back to the source.
→ Each Route Request carries a sequence no. generated by source node.
→ The packet is forwarded only if it is not a duplicate Route Request.
→ The sequence number on the packet is used to prevent loop formations and multiple transmissions.
→ This protocol uses a route cache that stores all the possible information extracted from the source route.
→ for optimization, the intermediate nodes are also allowed to originate Route Reply packets.
→ The source node selects the best route from multiple replies and then uses that for sending data packets.
→ Each data packet carries complete path to its destination.
→ If a link breaks, source node again initiates the route discovery process.
→ Phases: Route Discovery — Route Maintenance

↳ RREQ packet (broadcast) ↳ RERR message

Source node ID — Destination node ID

↳ RREP packet (unicast)



We find the shortest path that is A→C→E.
Now E will reply to C with complete packet and C will reply to A with complete packet.
Now A will have complete information about the path.

(*) Hybrid Routing Protocols:

(*) Core Extraction Distributed Ad Hoc Routing Protocol (CEDAR)
→ CEDAR integrates routing and support for QoS.
→ Based on extracting Core Nodes (also called Dominator Nodes) in the Network.
→ Core nodes together approximate the Minimum Dominating Set.
→ There exists atleast one core node within every three hops.
→ The nodes that choose the 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 a virtual link.
→ CEDAR employs a distributed Algo. to select core nodes.
→ Selection of core nodes represent the core extraction phase.
→ CEDAR uses core broadcast mechanism to transmit any packet throughout the network in the unicast mode.
→ Transmission involves minimum no. of nodes possible

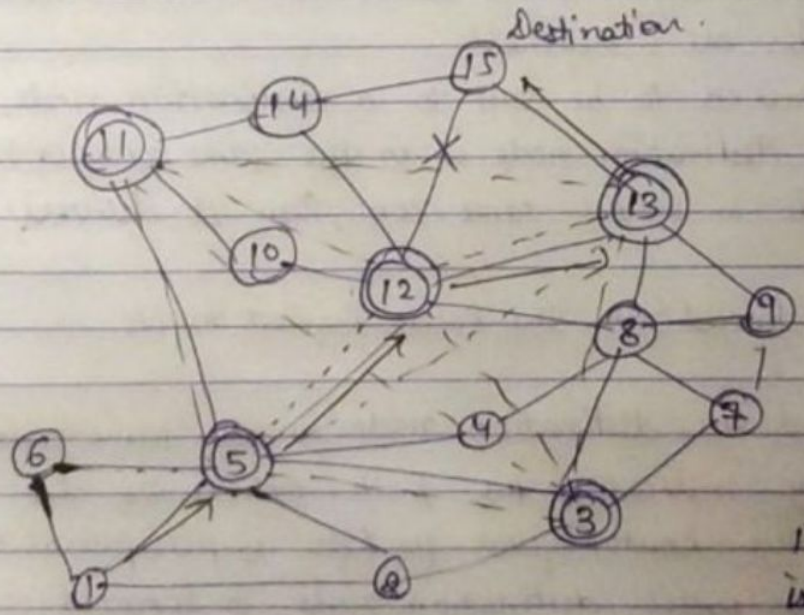
→ Route establishment in CEDAR is done in two phases:
(i) First Phase finds a core path from source to destination.
(ii) In the second phase, the QoS feasible path is found over the core path.

→ A node initiates a Route Request if the destination is not in the local topology table of its core node. Otherwise the path is established immediately.

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

→ A node after which break occured: → Sends the notification of failure.
→ Begins to find a new path from it to destination.
→ Rejects every received packet till it finds the new path to destination.

→ Meanwhile, as the source receives the notification message:
→ It stops to transmit.
→ It tries to find a new path to destination.



---- Virtual link
○ → Normal Node
◎ → Core node

Final path: 1 → 5 → 12 → 13 → 15

13 is chosen because it is the nearest core node from the destination.

(*) - Preferred Link Based Routing Protocol:

→ Uses the prefered link approach by processing a Route Request Packet only if it is achieved through a strong link.

→ A Node selects the subset of nodes from its Neighbours 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 the neighbours receive Route Request Packet but only neighbours present in the PL forward them further.

→ Each node maintains info about its neighbour and their neighbours in a table called Neighbours Neighbour Table (NNT)

→ Route Establishment: If the destination is in NNT of the source, then the route is established directly. Otherwise, source transmits a Route Request Packet.

→ A node is eligible for forwarding Route Request only if:

(a). It should be present in PL. ✓

(b). RREQ packet must not have been already forwarded by the node and the TTL on the packet must be greater than zero.

→ If dest is in the eligible node's NNT, the Route Request is forwarded as a unicast packet to the neighbours.

→ If the RREQ packet reaches the destination, then the route selection is done.

→ When multiple RREQ packets reach dest, the best path is selected.

→ Criteria can be shortest path, or least delay path or most stable path.

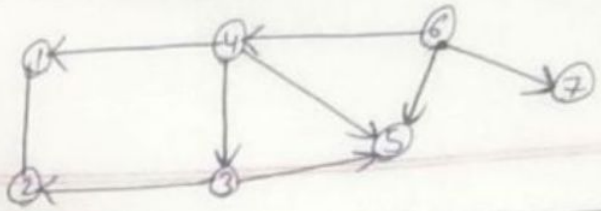
→ Destination starts a timer after receiving 1st RREQ packet. After a particular time, no RREQ packets are accepted.

→ Algorithms for preferred links computation:

(a) - NBPL (Neighbour-degree - Based Preferred Link Algorithm)

(b) - WBPL (Weight based Preferred Link Algorithm).

Disadvantage → Computationally more complex.



(*) - Optimized link state Routing (OLSR):

→ 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:

(a) - By reducing size of control packets.

(b). By reducing the no. of links that are used to forward the link state packets.

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

→ The set consisting of nodes that are multipoint Relays is referred to as MPR set.

→ Each node in the nhd selects the MPR set that processes and forwards every link state packet that the node originates.

→ The neighbour nodes that do not belong to MPR set process the packets but do not forward them.

→ In order to decide on the membership of the nodes in the MPR set, a node periodically sends Hello messages which contains:

(a) list of neighbours with which the node has bidirectional link

(b) - List of neighbours whose transmission was received in 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 Neighbour table is used to store the lists of neighbours, the two hop neighbours, and the status of neighbour nodes.

Advantages: (a) - Reduces Routing Overhead.

(b) Reduces the no. of broadcasts done.

(c). Low connection setup time.

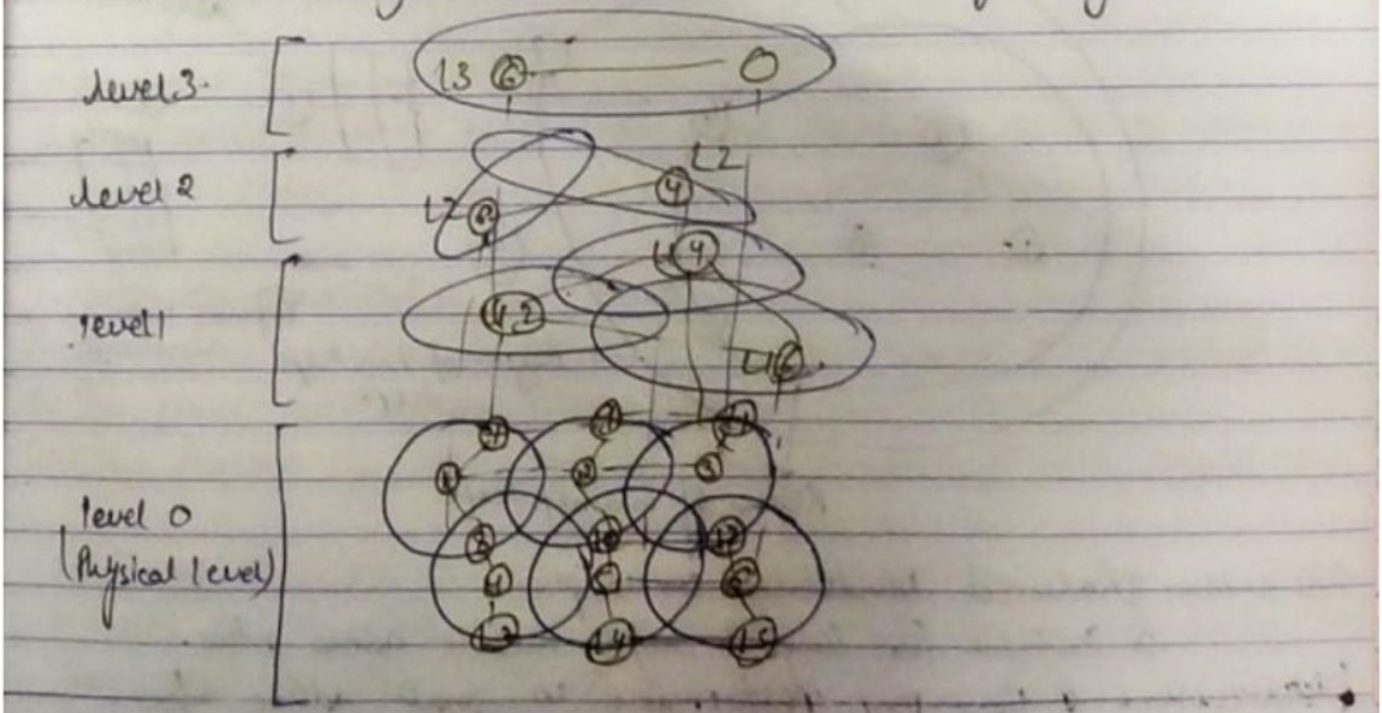
Unit 5 - (NRA)

(*). Hierarchical Routing Protocols:

→ Advantages in use of routing Hierarchy (a). Better Scalability
(b). Reduction in size of Routing Tables.

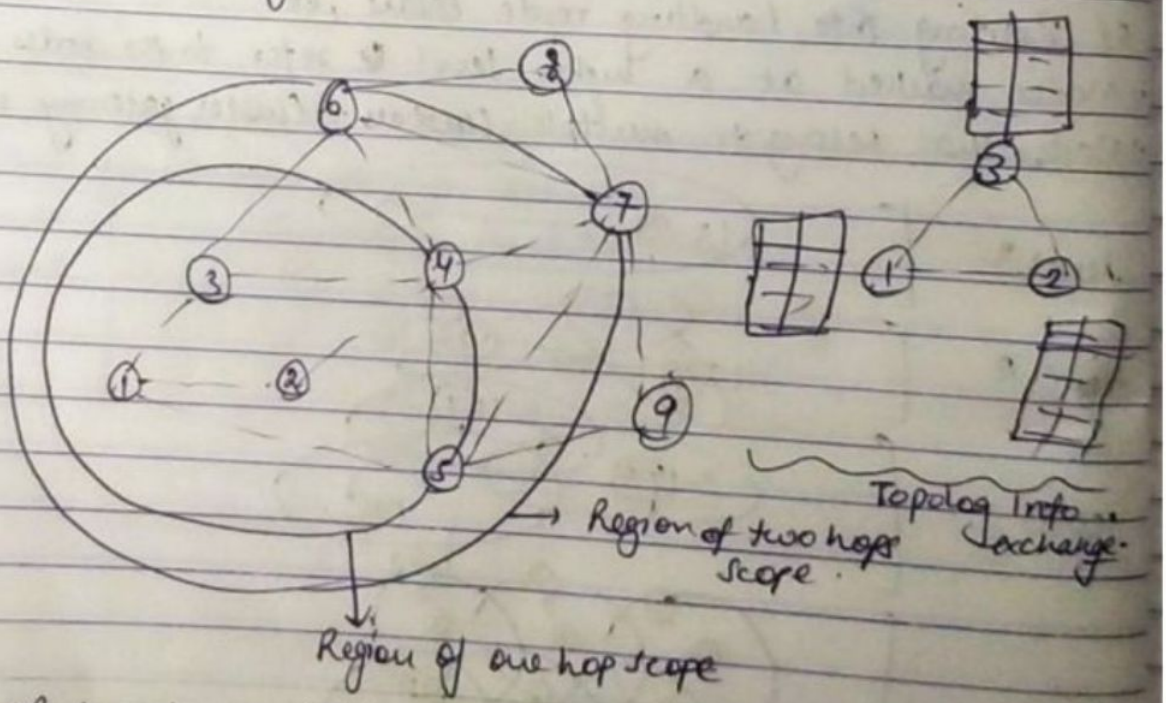
(*) Hierarchical State Routing Protocol:

→ Distributed multi-level hierarchical Routing Protocol.
→ Employs 'clustering at different levels.
→ Each cluster has its leader.
→ Levels of Clustering:
(a). Physical: Nodes that have physical wireless one-hop link between them.
(b). Logical: based on certain relations.
→ Cluster leader is entrusted with responsibilities such as exchange of Routing Info, handling route breaks, etc.
→ Nodes marked at a higher level refer to the nodes of lower level.
→ Nodes that belong to multiple clusters → Cluster gateway nodes.



Disadvantage: ① Process of exchanging info at all levels of hierarchy is difficult.
② Process of electing leader for all clusters is difficult.

② Fish Eye State Routing Protocol (FSR)
→ Uses fish eye technique to reduce overhead.
→ Can capture pixel info with greater accuracy.
→ Thus accuracy decreases with increase in distance from center of focal point.
→ Each node maintains accurate info about near nodes.
→ Nodes exchange topology info only with their neighbours.
→ Link level info exchange of Distance Vector RP & complete topology info exchang of link state protocols.
→ FSR defines the set of nodes reachable in specific no. of hops.
→ Routing overhead is significantly reduced.



Advantages ① Reduced bandwidth consumption.
② Suitable for large & highly mobile adhoc nws.
Disadvantage: ① Very poor performance in small adhoc nws.

(*) Quality of Service Routing for next Generation:
→ The upcoming high speed n/ws are expected to support a wide range of communication intensive real time applications.
→ One of the key issues is Quality of Service Routing.
→ It selects network routes with sufficient resources.
→ The goal is: (a) Satisfying QoS requirements for every connection.
(b) Achieving Global efficiency in resource Utilization.
→ The routing algorithms to achieve QoS Routing can be divided into:
(i) Source Routing Algorithms
(ii) Distributed Routing Algorithms
(iii) Hierarchical Routing Algorithms.
→ QoS Routing is expected to direct n/w traffic in an efficient way that can maximize the total n/w throughput.
→ One common scheme is to always choose short path b/c longer path means using more n/w resources.

(*) Multiprotocol label Switching (MPLS)
→ MPLS is an IP packet Routing Technique that routes IP packets through paths via labels instead of looking at complex Routing tables of routers.
→ This feature helps in increasing the delivery Rate of IP Packets.
→ It uses layer 3 service, i.e., Internet Protocol and uses router as a forwarding device.
→ The traffic of different customers is seperated from each other b/c MPLS works somewhat like VPN.
→ It does not encrypts but makes sure packet from one customer cannot be received by other customer.
→ MPLS header is added to packets that lie btw layers 2 & 3.
→ Hence, it is also called layer 2.5 protocol.

(*) Generalized Multi Protocol Label Switching:
→ Extending MPLS to manage further classes of switching technology other than packet switching.
→ Extends support to multiple types of switching such as TDM, wavelength
→ It is based on Generalized labels.
→ The MPLS label can represent (a). a single fiber in a bundle.
(b). a single waveband within fiber.
(c). a single wavelength within a waveband.
(d). a set of time slots within a wavelength.
→ Enables fast and reliable nlw switching of data flows.
→ Adds support for TDM (Time Division Multiplexing)
→ Helps to make Quick decisions on how to forward data.
→ Its use greatly benefits fiber optic nlws.
→ It supports parallel links simultaneously.

(*). MPLS Traffic Engineering:
→ Traffic Engineering refers to selecting paths in order to balance load on various links, routers, switches, etc.
→ Goal of Traffic Engineering is to facilitate efficient IP nlw operations.
→ Traffic Engineering in MPLS involves technique of directing traffic that flows within a nlw.
→ following Advantages enhance Traffic Engineering:
(i) Minimize network congestion: An MPLS nlw can implement TE to boost up performance. Such a mapping process can handle bottlenecks of packet overcrowding.
(ii) Fast Reroute for link/node failure: Handles link / node failures by directing the traffic to a secondary path when primary one fails. This is not possible in case of IP nlws as redirecting mechanism is not applicable here.

→ MPLS Header: 32 bits long divided into 4 parts:

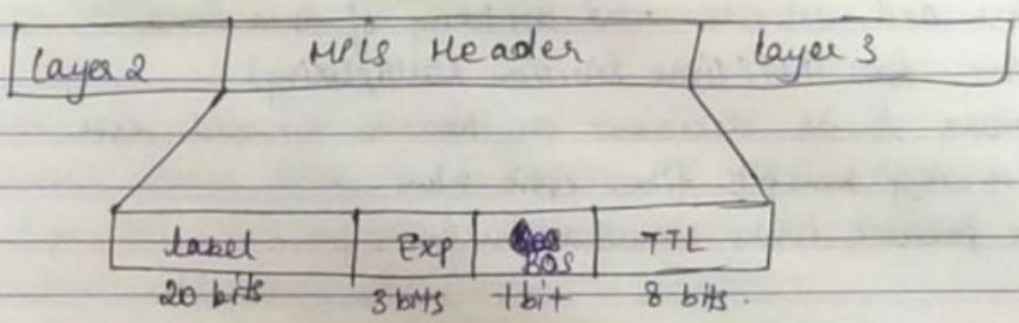
(i) Label : (20 bit)

(ii) Exp : 3bit (used for QoS)

(iii) Bottom of Stack (S): 1 Bit.

(iv). Time to Live (TTL): 8 bit long. Value is decreased by 1 at every hop.

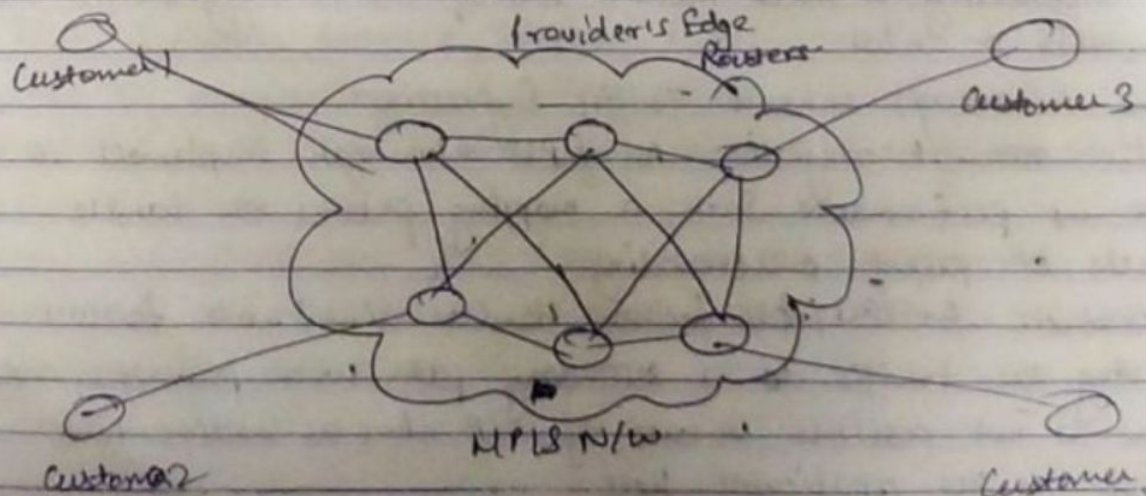
MPLS labels are stacked one over other. If there is only one label remained in MPLS header, then the value is 1 otherwise 0.



→ Label switch Router (LSR) receives an IP packet and adds MPLS header.

→ MPLS forwarding is based on label attached to IP packet.

→ This label attachment is regulated by a protocol called Label Distribution Protocol (LDP)



(iii) Deployment flexibility: A TE system is efficient even when MPLS n/w is under-developed. It is flexible during situations when the overflowing packets from links are transferred to available links.

(iv) Class of service: 3 bit field. Based on this field, the traffic in its priority queue is used for transmission.

(v) Customer traffic identification: MPLS TE classifies the customer traffic based on the service provider used in MPLS N/w.

(e). Limitations of MPLS Traffic Engineering:

(i) Over-utilization of secondary links.

(ii) Manual path setup: To implement TE, paths require manual configuration. This manual setting needs professional solution providers

(iii) Protocol dependency for automatic Rerouting:

(iv) Performance variation in MPLS fast reroute.

(v) Configuring intermediate nodes in MPLS is manually not achievable.

(vi) Lack of systematic mapping system: The dynamic mapping of IP traffic on MPLS TE paths is not achievable.