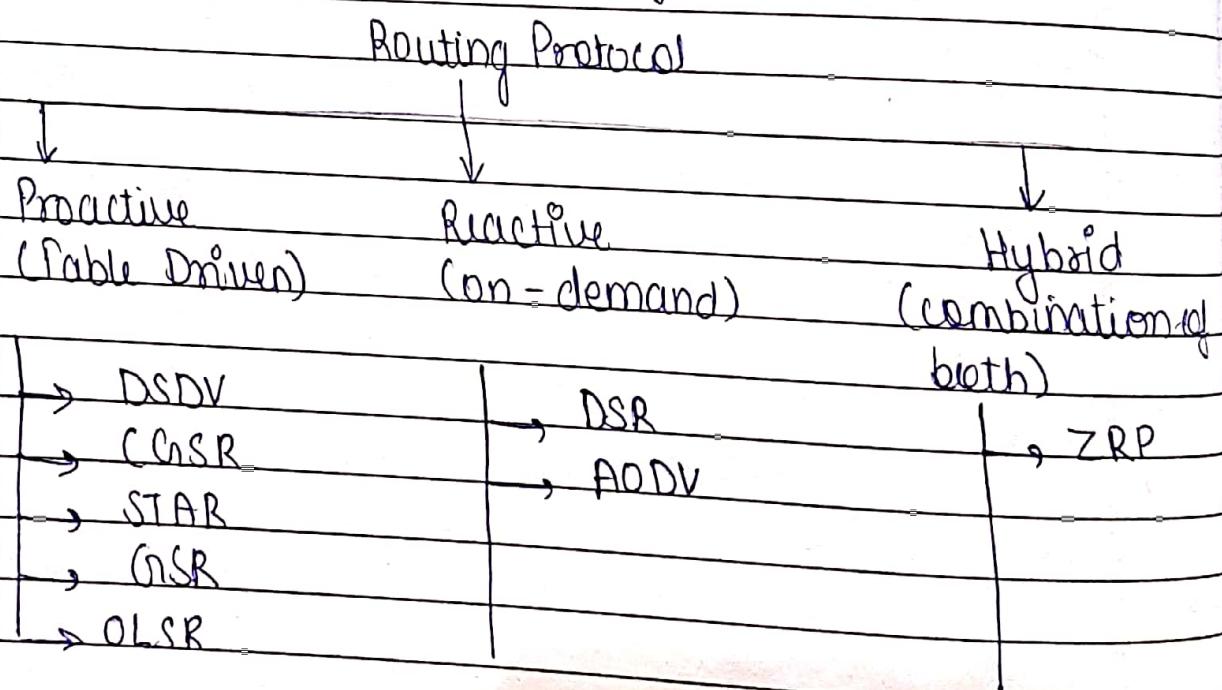


## Unit - II

#) **Routing** → Routing is a process of selecting paths across one or more networks. The principle of routing can apply to any type of network, from telephone networks to public transportation.

### Classification of Routing Protocols

Ad hoc wireless network routing protocols can be classified into 3 Major categories. They are.



## Proactive or table driven routing protocols

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

## Reactive or on demand routing Protocol

- dont maintain the network topology information
- obtain the necessary path when it is required, by using a connection establishment process.

## Hybrid Routing Protocols

- Combines the best feature of the above two categories
- 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.
- For routing within this zone, a table driven approach is used.

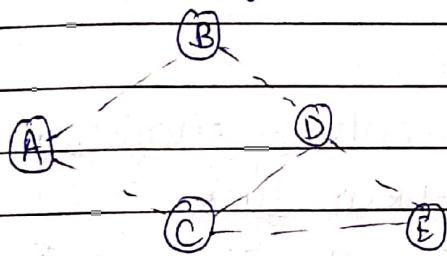
## #) PROACTIVE Routing Protocol

- These protocols are extensions of the wired network routing protocols
- They maintain the global topology information in the forms of tables at every node.
- Tables are updated frequently in order to maintain consistent and accurate network state information.
- Ex- DSDV, STAR, CGSR , CSR

### ① Destination Sequenced distance Vector Protocol (DSDV)

- It is an enhanced version of the distributed Bellman-Ford Algorithm where each node maintains a table that contains the shortest distance and the first node in the shortest path to every other node in the network.
- It incorporates tables update with increasing sequence number tags to prevent loops, to counter the count to infinity problem and for faster convergence.
- As it is a Table driven routing protocol, routes to all destinations are readily available at every node at all times.
- The table are exchanged between neighbours at regular interval to keep an up-to-date view of the network topology.

- The table updates are of two types :-  
 → Incremental updates :- Takes a single network data packet unit (NDPU). These are used when a node does not observe significant changes in the local topology.
- Full dumps :- Takes multiple network data packet unit. It is done either when the local topology changes significantly or when an incremental update requires more than a single NDPU.



Routing Table from A

Dest.	Next hop	Dst.	Seq. No
B	B	1	340
C	C	1	164
D	B	2	114
E	C	2	20

when D got disconnected, Dist got infinity

When D is connected to E, we have to take greater seq. no for broadcasting.

### Advantages

- less delay involved in the route setup process
- mechanism of incremental update with sequence number tags makes the existing wired network protocols adaptable to ad hoc wireless network
- The updates are propagated throughout the network in order to maintain an up-to-date view of the network topology at all nodes

### Disadvantage

- suffers from excessive control overhead
- The updates due to broken links lead to heavy control overwhelmed during high mobility
- In order to obtain information about a particular destination node, a node has to wait for a table update message initiated by the same destination node
- This delay could result in stale routing information at nodes

## ② Cluster Head Gateway switching Routing Protocol (CHSR)

- It uses a hierarchical Network Topology
- CHSR organizes nodes into clusters with coordination among the members of each cluster

- to a special node named cluster head.
- This cluster head is elected dynamically by employing a Least Cluster Change (LCC) algorithm.
- In this, a node ceases to be a cluster-head only if it comes under the range of another cluster head, where the tie is broken either using the lowest ID or highest connectivity algorithm.
- Clustering provides a mechanism to allocate bandwidth, which is a limited resource among different clusters, thereby improving reuse.
- A token based scheduling is used within a cluster for sharing the bandwidth among the members of the cluster.
- CCRS assumes that all communication passes through the cluster-head.
- A gateway is expected to be able to listen to multiple spreading code that are currently in operation in the clusters in which the node exist as a member.
- Gateways that are capable of simultaneously communicating over two interfaces can avoid gateway conflicts.
- Every member node maintains a routing table containing the <sup>destination</sup> cluster-head for every node in the network.

## Advantages

- CSSR is a hierarchical routing scheme which enables partial coordination between nodes by electing cluster heads.
- Better bandwidth utilization
- Easy to implement

## Disadvantages

- Increase in path length and instability
- In <sup>order to</sup> avoid gateway conflicts, more resources are required.
- Power consumption at the cluster head node is also a matter of concern
- Need to frequent changes in the cluster head, which may result in multiple path breaks.

## ③ Global State Routing (GSR)

- It is a pre active routing / table driven routing protocol.
- It actually extends the link state routing of the wired networks.
- Link State Routing Protocol was not suited for mobile ad-hoc networks because in it, each node floods the link state routing information directly into the whole network i.e. global.

- Flooding which may lead to the congestion of control packets in the network
- CISR doesn't flood the link state routing packets globally into the network
  - In CISR, each of mobility node maintains one list and three tables namely adjacent list, topology table, next hop table and distance table.

### Advantages

- CISR greatly reduces the control overhead as it is avoiding flooding
- Routing accuracy is better.
- It is suitable for mobile environment where mobility & bandwidth is high

### Disadvantages

- latency of link state change propagation depends on the update period, it has been chosen to be 10s
- large size of routing message

## ④ Optimized link state Routing (OLSR)

- OLSR stands optimized link state Routing Protocol
- In this, each node periodically flood status of its links. Each node re-broadcast link state information received from its neighbours
- Each Node keeps track of link state information received from other nodes
- Each Node uses above information to determine next hop to each destination.
- It is proactive and stable
- It utilizes a technique to reduce message flooding - Multipoint Relaying (MPR)

In this, each Node  $N$  in the network selects a set of neighbor Nodes as multipoint relays,  $\text{MPR}(N)$  that retransmits control packets from  $N$ -Neighbours not in  $\text{MPR}(N)$ . Process control packets from  $N$ , but they do not forward the packets. It Reduces no. of links.

### Advantages

- OLSR has less average end-to-end delay.
- It is also a flat routing protocol.
- It does not need central administrative system to handle its routing process.
- Increases protocol reliability.

## Disadvantages

- It needs considerable time to re-discover a broken link.
- It requires more processing power.
- It maintains routing table for all possible routes.

## # FISHEYE State Routing Protocol (FSR)

The fisheye state Routing protocol is generalization of CSR protocol, FSR uses the fish eye technique to reduce information required to represent graphical data, to reduce routing overhead. FSR maintains the topology of the network at every node and computes the shortest paths.

- Periodically, every node exchange the topology information with sequence Number only with its neighbour.
- The accuracy decreases with increase in the distance from the center of focal point.
- A sequence Numbering scheme is used to identify the recent topology changes.

FSR defines routing scope which is the set of nodes that are reachable in specific number of scopes hops.

## Advantages

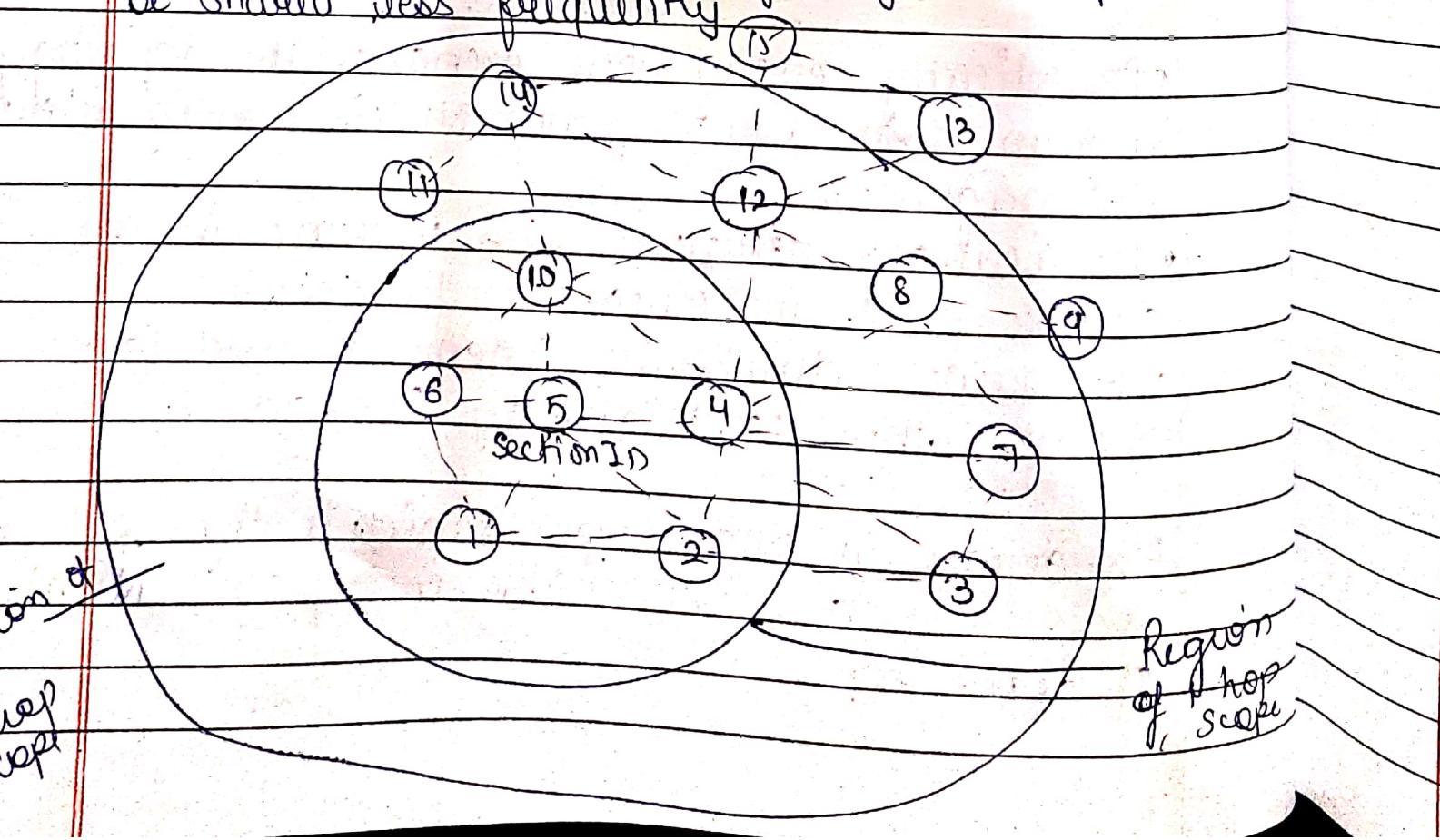
- FSR is suitable for large & highly mobile adhoc wireless Network
- FSR reduces the bandwidth consumed by link state update Packets.

## Disadvantages

- The Path Information for far away nodes may be inaccurate.
- The frequency of exchange decreases with increase in scope.

Nodes are having less scope, their information will be shared with the neighbours more frequently as compare to the node having high scope.

Information of Nodes having highest scope will be shared less frequently.



## #) Dynamic Source Routing (DSR)

Dynamic Source Routing is an demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table update messages required in the table driven approach.

It is beacon less and hence does not require periodic hellopacket transmission which are used by a node to inform its neighbours of its presence.

The basic approach of this is to establish a route by flooding Route Request packets in the network. The destination node, on receiving a Route Request packet, responds by sending a Route Reply packet back to source, which carries the route unanswered by Route Request packet received.

In this type of routing the route is discovered only when it is required. The process of route discovery occurs by flooding the route request packets throughout the mobile network.

When an intermediate node in the path moves away, causing a wireless link to break, a Route Error message is generated.

It consists of two phases :-

- Route Discovery :- This Phase determines the most optimal path for the transmission of data packets B/w source & destination Mobile Nodes.
- Route Maintenance :- This phase performs the maintenance work of the network to obtain as the topology in the mobile ad hoc Network is dynamic in Nature and hence, there are many cases of link breakage resulting in the Network failure B/w the Mobile Nod

## Advantages

- A route is established only when it is required
- The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead
- No need to update the routing table

## Disadvantages

- The route maintenance mechanism does not locally repair a broken link.
- There is always a small time delay at the begin of new connection

## # Ad Hoc on demand Distance Vector Routing Protocol (AODV)

AODV is a reactive / on demand routing protocol. It is an extension of dynamic source routing protocol (DSR) and it helps to remove the disadvantage of dynamic source Routing Protocol.

Every Node has a routing table, when a node knows a route to the destination, it send a route reply to the source node.

The Main difference Between DSR & AODV lies in the way of storing the path.

- DSR use source routing in which a Data Packet carries the complete path
- AODV stores the next hop information corresponding to each flow for data Packet transmission

AODV uses a Sequence No. to determine an up-to-date path to the destination.

A Route Request carries the source identifier, the destination identifier, the source sequence Number, the destination sequence Number, the broadcast identifier, the time to live field.

### Types of Routing in AODV

It consists of 3 types of routing messages :-

#### ① RREQ: Route Request -

A Node, send a Packet along with RREQ multicast message to start the route discovery process.

#### ② RREP: Route Reply -

The destination Node responds with an RREP, which returns to the source through the path taken by the RREQ

#### ③ RRER: Route Error -

In case of the connection interruption ie. messages cannot be sent, a RRER message is sent through a node detecting the link interruption.

### Advantages

- Establish on demand
- Destination Sequence are used to find the latest path to destination.
- The connection setup delay is less.

### Disadvantages

- Heavy control overhead
- There is always a small time delay at the begin of a new connection
- Intermediate Nodes lead to inconsistent route.

## #) Temporally Order Routing Algorithm (TORA)

Temporally Order Routing Algorithm (TORA) is a source-initiated on demand routing protocol which uses a linked renewal algorithm & provides loop free multipath routes to a destination Node.

TORA is highly adaptive, efficient, loop free and scalable routing protocol based on link renewal algorithm.

TORA has three main functions : establishing, maintaining & erasing routes.

- Route creation : from source to destination
- Route Maintenance : Maintenance of the route
- Route erasure : Erasing of route when the route is no longer valid.

It is designed to reduce communication overhead by adapting local topological changes in ad hoc Network.

TORA supports Multiple routes to transmit data packet between source & destination Node of mobile ad hoc Network.

This process establishes a destination oriented directed acyclic graph (DAG) using query/update mechanism.

TORA attempts to build a special directed Acyclic graph by each Node to every destination. When a route to a particular destination is required, the source Node broadcasts a query packet containing the address of the destination.

### Advantages

- low Connection Setup time.
- less Control overhead

### Disadvantages

- The local reconfiguration

## #) Location Aided Routing (LAR)

Location aided Routing Protocol (LAR) utilizes the location information for improving the efficiency of routing by reducing the control overhead.

LAR assumes the availability of the Global positioning System (GPS) for obtaining the geographical position information necessary for routing.

LAR designates two geographical regions for selective forwarding of control packets, namely Expected Zone & Request Zone.

- The Expected zone is the region in which the destination node is expected to present, given information regarding its location in the past and its mobility information.
- The Request zone is the geographical region within the path finding control packets are permitted to be propagated.

LAR uses flooding - but here flooding is restricted to small geographical region. The nodes decide to forward or discard the control packets based on two algorithm namely LARI and LAR2.

### Advantages

- Increase Utilization Bandwidth
- Reduce Control Overhead

Disadvantages:

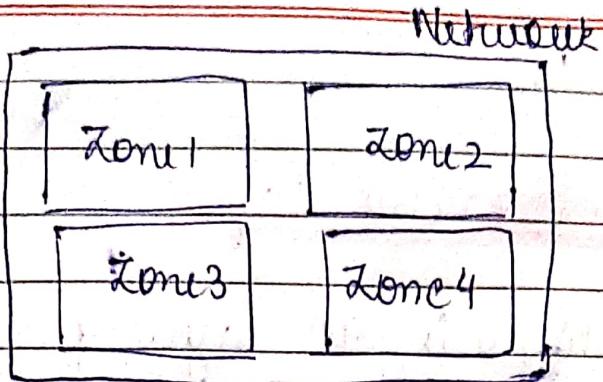
- Depend heavily on availability of APs.

## #) Zone Routing Protocol (ZRP)

Zone Routing Protocol is a hybrid routing protocol which effectively combines the best feature of both proactive & reactive routing protocols. Zone routing protocol finds loop free routes to the destination. ZRP divides the network into zones of variable size.

The whole Network is divided into different zones & then the position of source & destination mobile Node is observed. If the source & destination mobile Nodes are present in the same zone, then proactive routing is used for the transmission of data packets between them.

And if the source & destination mobile Nodes are present in different zones, then reactive routing is used for the transmission of data packets between them.



An Intra Zone Routing Protocol is used in the zone where a particular node employs proactive routing. The Reactive Routing protocol used beyond this zone is referred to as inter-zone routing ZRT.

### Advantages

- ZRP reduces the control overhead employed in on demand approach & the periodic flooding of routing information in a table driven manner.

### Disadvantages

- In the absence of a timely Control, ZRP tends to produce higher Control overhead.
- The absence or the zone radius has a significant impact on the performance.