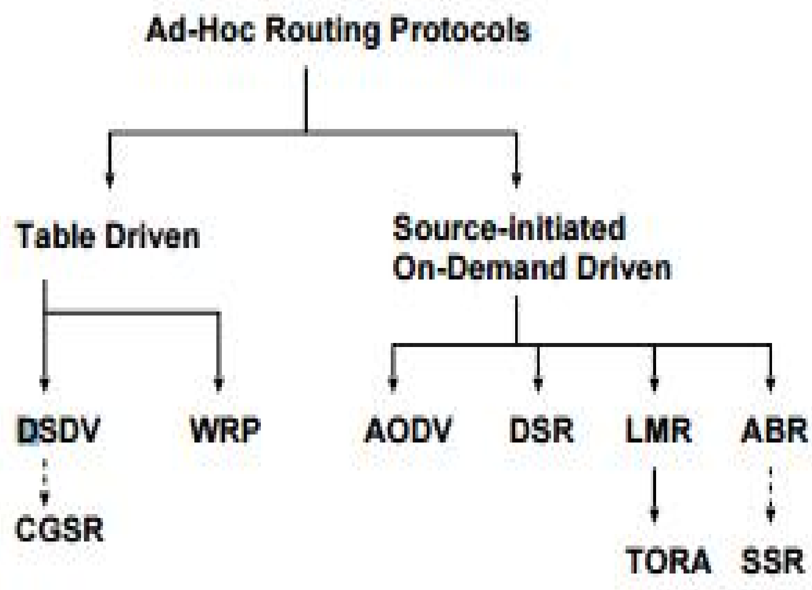
MANET

WIRELESS NETWORKS

- Wireless networks can be classified in two types:
- Infrastructure network
- Infrastructureless (ad hoc) networks.

Routing protocols for ad hoc networks

- Table-driven (Proactive)
- On-demand routing (reactive)



Categorization of Ad-Hoc Routing Protocols.

TABLE DRIVEN ROUTING PROTOCOLS

- In Table-driven routing protocols each node maintains one or more tables containing routing information to every other node in the network.

- All nodes update these tables so as to maintain a consistent and up-to-date view of the network.

- When the network topology changes the nodes propagate update messages throughout the network in order to maintain updated information.

To	A	I	H	K
A	0	24	20	21
B	12	36	31	28
C	25	18	19	36
D	40	27	8	24
E	14	7	30	22
F	23	20	19	40
G	18	31	6	31
H	17	20	0	19
I	21	0	14	22
J	9	11	7	10
K	24	22	22	0
L	29	33	9	9

Table Driven Routing

The main disadvantages of such algorithms are:

- Respective amount of data for maintenance.
- Slow reaction on restructuring and failures.

Destination-Sequenced Distance-Vector Routing Protocol

- Every mobile station maintains a routing table that contain-
  - All available destinations,
  - The number of hops to reach the destination
  - The sequence number
    - The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops.
- The stations periodically transmit their routing tables to their immediate neighbours.
- A station also transmits its routing table if a significant change has occurred in its table from the last update sent.

“FULL DUMP" VS “INCREMENTAL UPDATE”

- A full dump sends the full routing table to the neighbours.
- In a fast-changing network, incremental packets can grow big so full dumps will be more frequent.

INCREMENTAL UPDATE

- In an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet.
- Each route update packet, in addition to the routing table information, also contains a unique sequence number assigned by the transmitter. The route labelled with the highest (i.e. most recent) sequence number is used.
- Incremental updates are sent to avoid extra traffic.

THE WIRELESS ROUTING PROTOCOL (WRP)

Each node in the network maintains a

- Distance table : The Distance table of a node x contains the distance of each destination node y via each neighbour z of x.
- Routing table : The Routing table of node x contains the distance of each destination node y from node x. (shortest dist and status flag)
- Link-Cost table contains cost of link to each neighbour of the node and the number of timeouts since an error-free message was received from that neighbour.
- Message Retransmission list : (MRL) contains information to let a node know which of its neighbour has not acknowledged its update message and retransmits update message to that neighbour. It maintains a counter for each entry.

DSDV maintains only one topology tab, WRP uses a set of tables

PROBLEMS

- The complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the ad hoc wireless network.
- WRP requires large memory storage and resources in maintaining its tables
- It is not suitable for highly dynamic and also for a very large ad hoc wireless network

Global State Routing

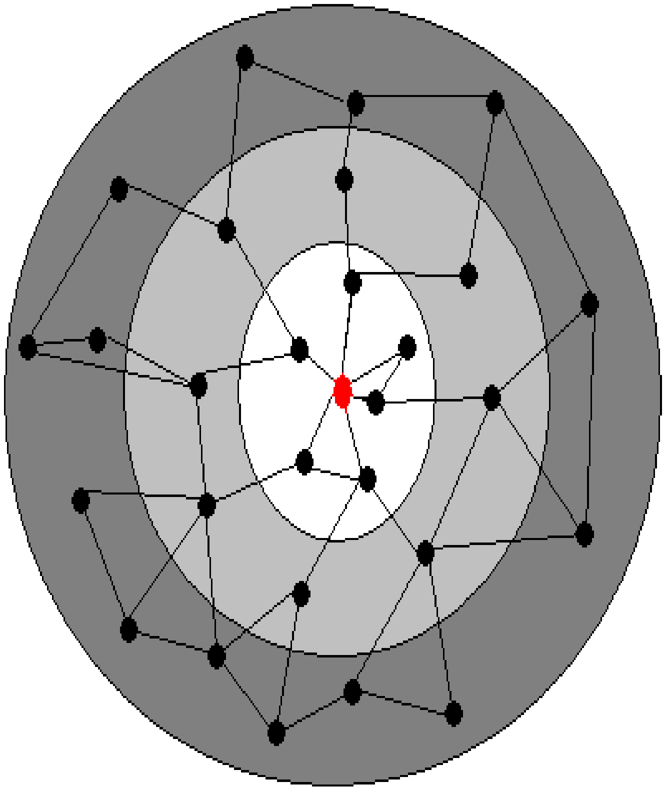
- It takes the idea of link state routing but improves it by avoiding flooding of routing messages

- Each node maintains a Neighbours list, a Topology table (contains the link state information), a Next Hop table and a Distance table.

- The routing messages are generated on a link change as in link state protocols. On receiving a routing message, the node updates its Topology table.

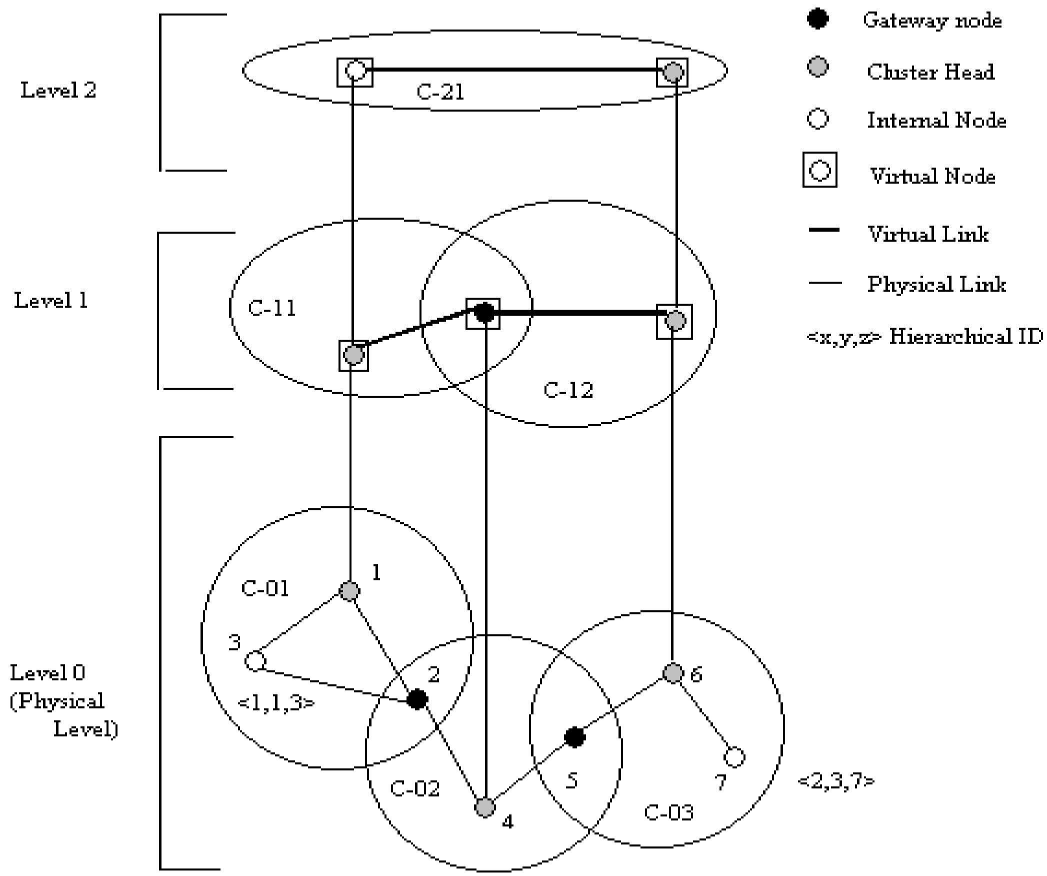
Fisheye State Routing

- The large size of update messages in GSR wastes a considerable amount of network bandwidth.
- In FSR zones are classified according to the distance, measured by hops, from the node
- In FSR, each update message does not contain information about all nodes.
- Instead, it exchanges information about closer nodes more frequently than it does about farther nodes



HIERARCHICAL STATE ROUTING

- Multilevel clustering and logical partitioning of mobile nodes.
- The network is partitioned into clusters and a cluster-head elected as in a cluster-based algorithm.
- In HSR, the cluster-heads again organize themselves into clusters and so on.
- The cluster-head summarizes its cluster's information and sends it to neighbouring cluster-heads via gateway
- A node at each level floods to its lower level the information that it obtains after the algorithm has run at that level.
- So the lower level has a hierarchical topology information. Each node has a hierarchical address.



clustering in HSR

II. On-Demand Routing Protocols

This type of protocol finds a route on demand by flooding the network with Route Request packets.

This process is completed once a route is found or all possible route permutations have been examined.

After that there is a route maintenance procedure to keep up the valid routes and to remove the invalid routes.

I. Cluster based Routing Protocols

- In Cluster Based Routing protocol (CBRP) , the nodes are divided into clusters.
- When a node comes up, it enters the "undecided" state, starts a timer and broadcasts a Hello message.
- When a cluster-head gets this hello message it responds with a triggered hello message immediately.
- When the undecided node gets this message it sets its state to "member".
- If the undecided node times out, then it makes itself the cluster-head if it has bi-directional link to some neighbour otherwise it remains in undecided state and repeats the procedure again.
- Clusterheads are changed as infrequently as possible.

Cluster based Routing Protocols

- Each node maintains a neighbour table, which contains information about
  - the status of the link (uni- or bi-directional
  - the state of the neighbour (cluster-head or member).
- A cluster-head maintains a <u>cluster adjacency table</u> to keep information about the members and neighbour members.

Routing in Cluster Based

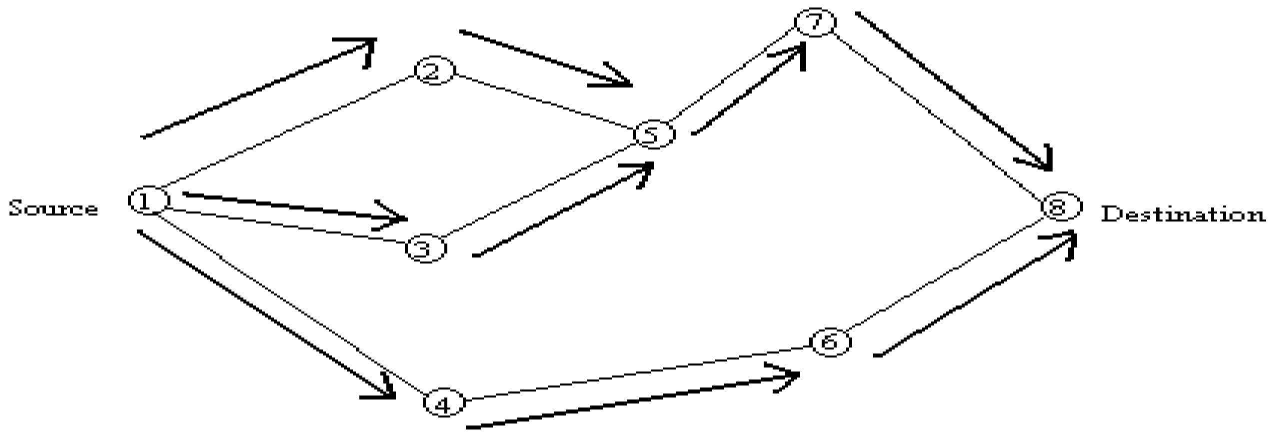
- When a source has to send data to destination, it floods route request packets only to the neighbouring cluster-heads.
- On receiving the request a cluster-head checks to see if the destination is in its cluster.
- If yes, then it sends the request directly to the destination else it sends it to all its adjacent cluster-heads.
- The cluster-heads address is recorded in the packet so a cluster-head discards a request packet that it has already seen.
- When the destination receives the request packet, it replies back with the route that had been recorded in the request packet.
- If the source does not receive a reply within a time period, it backs off exponentially before trying to send route request again.

II. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING

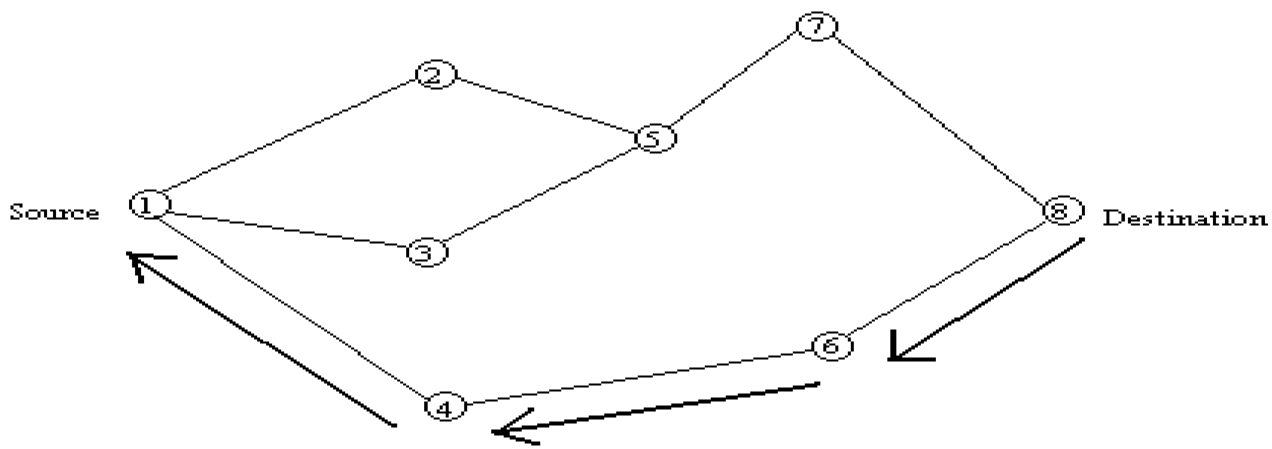
- AODV minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes.
- To find a path to the destination, the source broadcasts a <u>route request packet.</u>
- The neighbours in turn broadcast the packet to their neighbours till it reaches an intermediate node that has a recent route information about the destination or till it reaches the destination.
- A node discards a route request packet that it has already seen.

AD HOC ON-DEMAND DISTANCE VECTOR ROUTING

- The route request packet uses sequence numbers to ensure that the routes are loop free and to make sure that if the intermediate nodes reply to route requests, they reply with the latest information only.
- When a node forwards a route request packet to its neighbours, it also records in its tables the node from which the first copy of the request came.
- This information is used to construct the reverse path for the route reply packet.
- The route reply packet follows the reverse path of route request packet.
- As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables.



(a) Propogation of Route Request (RREQ) Packet



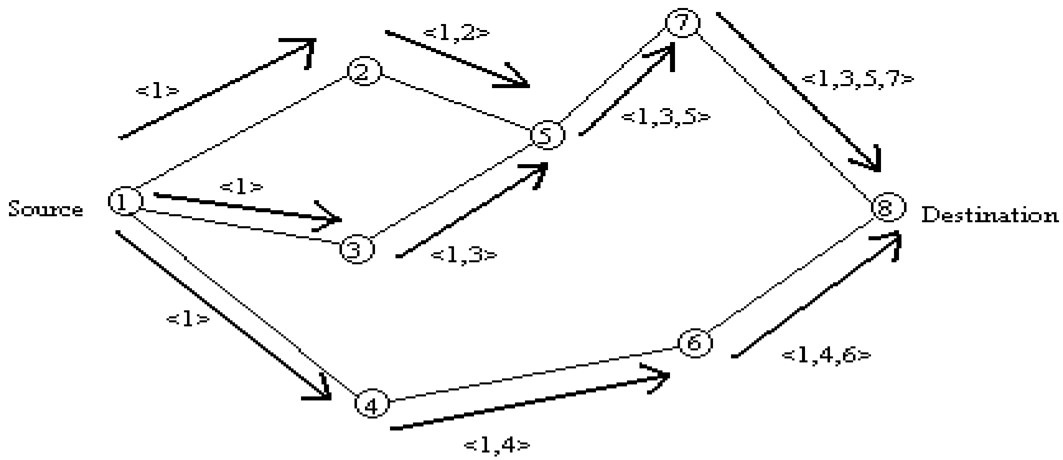
(b) Path taken by the Route Reply (RREP) Packet

III. Dynamic Source Routing Protocol

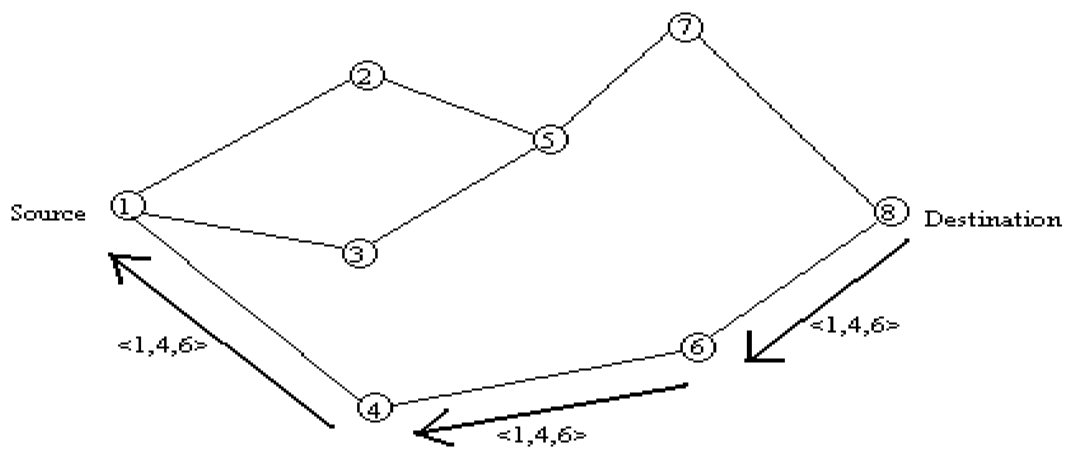
- It is a source-routed on-demand routing protocol.
- Performs - route discovery and route maintenance.

- A node maintains route caches containing the source routes that it is aware of.

- The node updates entries in the route cache as and when it learns about new routes.
- If route in cache is unexpired same route is followed otherwise it sends route discovery packet.



(a) Building Record Route during Route Discovery



(b) Propogation of Route Reply with the Route Record

Associativity Based Routing

- ABR defines a new metric for routing known as the degree of association stability.
- The three phases of ABR are
  - Route discovery, Route reconstruction (RRC) and Route deletion
- It is free from loops, deadlock, and packet duplicates.
- In ABR, a route is selected based on associativity states of nodes.
- All node generate periodic beacons to signify its existence.
- When a neighbour node receives a beacon, it updates its associatively tables.
- For every beacon received, a node increments its associativity tick with respect to the node from which it received the beacon.

Associativity Based Routing

- Association stability means connection stability of one node with respect to another node over time and space.
- A <u>high value</u> of associativity tick with respect to a node indicates a <u>low state of node mobility</u>, while a <u>low value</u> of associativity tick may indicate <u>a high state of node mobility.</u>
- Associativity ticks are reset when the neighbors of a node or the node itself move out of proximity.
- The fundamental objective of ABR is to find longer-lived routes for ad hoc mobile networks.

PROACTIVE VS REACTIVE PROTOCOLS

- • Average end-to-end delay or the time taken by the data to reach the destination from the source is variable in Reactive Protocols but remains constant in Proactive Protocols for a given Ad hoc network.
- • The delivery of packet data is much more efficient in Reactive Protocols than in Proactive Protocols.
- • Reactive Protocols are much faster in performance than Proactive protocols.
- • Reactive Protocols are much more adaptive and work much better in different topographies than Proactive Protocols.

REFERENCE

- http://www.cse.wustl.edu/~jain/cis788-99/ftp/adhoc_routing/