

A decorative graphic on the left side of the slide, consisting of overlapping colored squares (blue, red, yellow) and a black crosshair.

Ad hoc Wireless Networks

A Presentation

October 17, 2001

By

Dipesh Patel

Dr. Rakesh Nagi



Overview

- Ad Hoc Networks
 - Definition
 - Characteristics
 - History and Applications
 - Examples
 - Challenging Areas



What are ad hoc networks....

- Definition

“Ad Hoc network is a self-organizing multi-hop wireless network, which relies neither on fixed infrastructure nor on predetermined connectivity”.



How are they different.....

Characteristics

- Rapidly deployable
- Reconfigurable
- High node mobility
- Low Bandwidth
- Lack of centralized entity



How to classify them.....

Ad Hoc networks can be classified using various parameters

- Symmetric and Asymmetric.
- Traffic Characteristics
- Routing Methods
- Some other metrics such as time and reliability constraint



Some History.....

- Packet Radio Network(PRNET)
- Survivable Adaptive Network(SURAN)
- Global Mobile Information Systems(GloMo)



Typical Applications.....

- Military communications
- Law enforcement
- Disaster situations e.g. earthquake



Typical Examples.....

- MANET (Mobile Ad Hoc Networks)
 - Working Group of IETF (Internet Engineering Task Force) dealing with the routing aspects in Internet Network

- RWN (Reconfigurable Wireless Network)



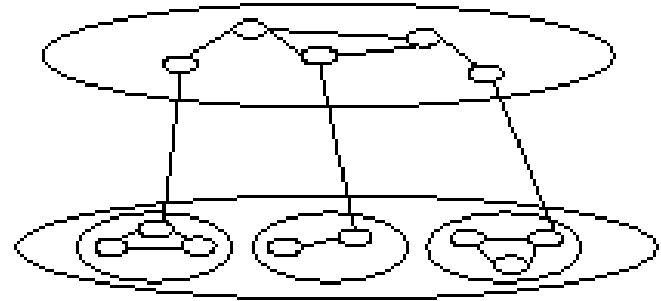
Challenging Areas.....

- Network Architecture or Topology
- Mobility or Location Management
- Routing Management

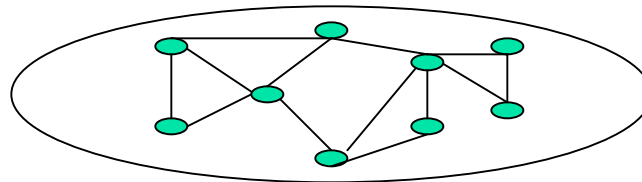
Network Architecture or Topology

Networks in ad hoc networks have:

- *Hierarchical Architecture* or



- *Flat Architecture*





Flat Architecture

- Characteristics
 - Nodes at same level
 - No hierarchy in network
 - All nodes participate in routing
- Example
 - RWN (Reconfigurable wireless networks)



Hierarchical Architecture

- Characteristics
 - Consists of > 1 *tier* or *level*
 - Node *clusters*
 - Clusters have a *head*
 - Routing through cluster heads
 - Heads keep locations info for cluster
- Example : MMWN (Multimedia support for Mobile Wireless Networks)



Hierarchical or Flat ?

- Hierarchical
 - Better location management
 - Scalable
 - Routing sub-optimal
 - Single points of failure (cluster heads)
- Flat
 - Optimal Routing
 - Low power consumption
 - No single point of failure
 - Not scalable

Mobility or Location Management

- Location management (LM) has:
 - Static strategy
 - Dynamic strategy
- LM deals with:
 - location updates
 - location finding
 - node movement



Routing Management

Sends packets:

- from source to destination
- through one or more intermediate nodes

Routing protocols classified as:

- *Proactive Protocol* (Table-driven)
- *Reactive Protocol* (On-demand)
- *Hybrid Protocol* (e.g. ZRP)



Proactive Protocols

- Characteristics

- Continuously evaluate route
- Route determined with negligible delay
- Uses significant wireless resources

- Examples

- Destination-sequenced Distance-Vector Routing (DSDV)
- Wireless Routing Protocol (WRP)



Reactive Protocols

- Characteristics
 - Evaluates route on demand
 - Delay is significant
 - Avoids wastage of resources
- Examples
 - Dynamic Source Routing (DSR)
 - Associativity Based Routing (ABR)

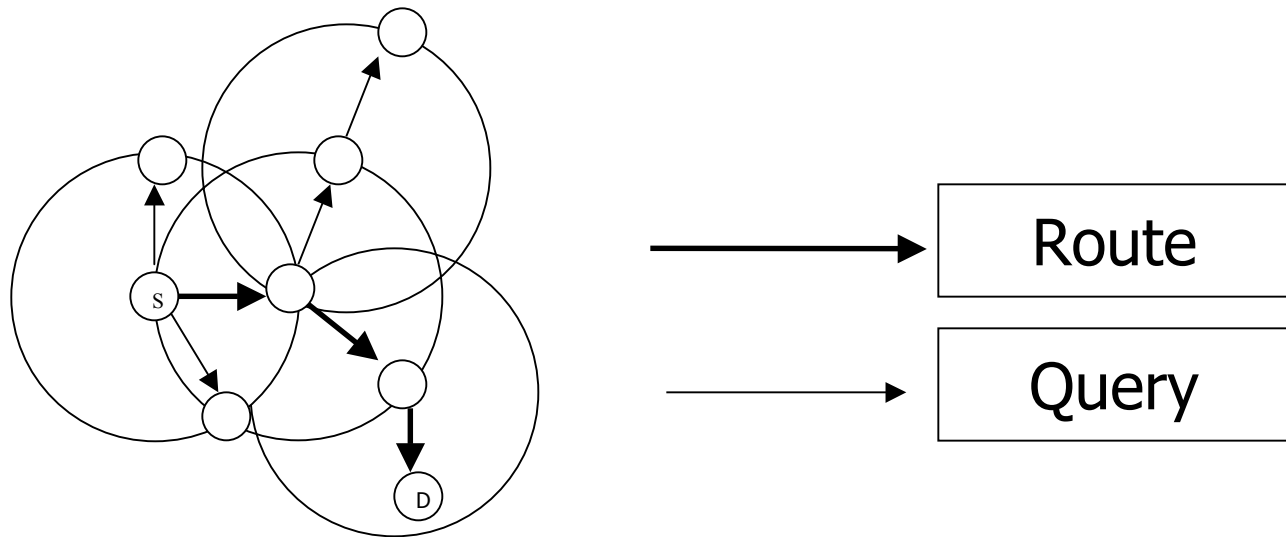


Hybrid Protocol

- Example : ZRP (Zone Routing Protocol)
 - Nodes maintain route information
 - for all the nodes within routing zone
 - Large zone radius--proactive protocol
 - Small zone radius--reactive protocol
 - Consists of route discovery/accumulation
 - Discovers multiple routes to destination
 - Fewer hops

Hybrid Protocol (ZRP)

- How ZRP Works ?





Clustering

- Graph Based Clustering
 - Highest Degree Heuristic
 - Lowest ID Heuristic
 - Node-Weight Heuristic
 - Weight Based Clustering algorithm
- Geographical Based Clustering



Highest Degree Heuristic

Steps:-

1. Add all the nodes in List L.
2. Select a node with highest degree as clusterhead.
3. Select all the nodes which can be reached in 1-hop to form cluster.
4. Now remove all nodes included in the cluster from L.
5. Repeat step 2 to 4 until all nodes are assigned to a cluster.



Lowest ID Heuristic

Steps:-

1. Add all the nodes in List L.
2. Select a node with lowest ID as clusterhead.
3. Select all the nodes which can be reached in 1-hop to form cluster.
4. Now remove all nodes included in the cluster from L.
5. Repeat step 2 to 4 until all nodes are assigned to a cluster.



Node Weight Heuristic

Steps:-

1. Add all the nodes in List L.
2. Select a node with highest weight as clusterhead.
3. Select all the nodes which can be reached in 1-hop to form cluster.
4. Now remove all nodes included in the cluster from L.
5. Repeat step 2 to 4 until all nodes are assigned to a cluster.



Weight Based Clustering Algorithm

Steps:-

1. Add all the nodes in List L.
2. Find neighbors of each node v (d_v)
3. Compute degree difference $D_v = |d_v - M|$ for all v
4. Compute sum of the distances, P_v with all neighboring nodes of v
5. Compute running average of the speed for every node (M_v)
6. Compute the total time T_v for which a node has been a clusterhead

Weight Based Clustering Algorithm

Steps:-

6. calculate combined weight for each node v
$$I_v = c_1 D_v + c_2 P_v + c_3 M_v + c_4 T_v$$
7. Choose v with minimum I_v as the clusterhead
8. Select all the nodes which can be reached in 1-hop to form cluster.
9. Now remove all nodes included in the cluster from L .
10. Repeat step 2 to 9 until all nodes are assigned to a cluster.



Summary and Future Research

- Hybrid Architecture
- A clustering algorithm which considers all the system parameters such that the frequency of reconfiguration is as low as possible with keeping the network connected.
- Designing the network with following issues
 - Reliability
 - Time(Delay)
 - Cost