Ad hoc Wireless Networks

A Presentation
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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”.

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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?

Diagram:

- S (Source)
- D (Destination)

Connections:
- Route
- Query

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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