Routing Mechanisms in Ad Hoc Networks

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Abstract – Ad-hoc networking is a concept in computer communications, which means that users wanting to communicate with each other form a temporary network, without any form of centralized administration. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. For this purpose, a routing protocol is needed. An ad-hoc network has certain characteristics, which imposes new demands on the routing protocol. In this paper, we have discussed about ad hoc networks and their types along with routing and forwarding mechanism in ad hoc network.

Index Terms – Ad hoc Network, Mesh Network, Routing, Protocol.

1. INTRODUCTION

Mobility is becoming increasingly important for users of computing systems. Technology has made possible smaller, less expensive and more powerful wireless communicating devices and computers. As a result users gain flexibility and the ability to exchange information and maintain connectivity while roaming through a large area. The necessary mobile computing support is being provided in some areas by installing base stations and access points. Mobile users can maintain their connectivity by accessing this infrastructure from home, from the office, or while on the road. Such mobility support is not available in all locations where mobile communication is desired. Access points may not be set up due to high cost, low expected usage, or poor performance [**1**]. This may happen during outdoor conferences or in emergency situations like natural disasters and military maneuvers in enemy territory. If mobile users want to communicate in the absence of a support structure, they must form an *ad hoc network.*

Since the inception of wireless networking there have been two types of wireless networks: the infrastructure network, including some local area networks (LANs), and the ad hoc network. *Ad hoc* is Latin meaning "for this purpose" [2]. Ad hoc networks therefore refer to networks created for a particular purpose. They are often created on-the-fly and for one-time or temporary use. Often, ad hoc networks are comprised of a group of workstations or other wireless devices which communicate directly with each other to exchange information. Think of these connections as spontaneous networks, available to whoever is in a given area. Ad hoc networks are generally closed in that they do not connect to the Internet and are typically created between participants. But, if one of the participants has a connection to a public or private network, this connection can be shared among other members of the ad hoc network. This will allow other users on the spontaneous ad hoc network to connect to the Internet as well. Ad hoc networks are common for portable video game systems like the Sony PSP or the Nintendo DS because they allow players to link to each other to play video games wirelessly. Some retail stores even create networks within them to allow customers to obtain new game demos via the store's own ad hoc network [3].

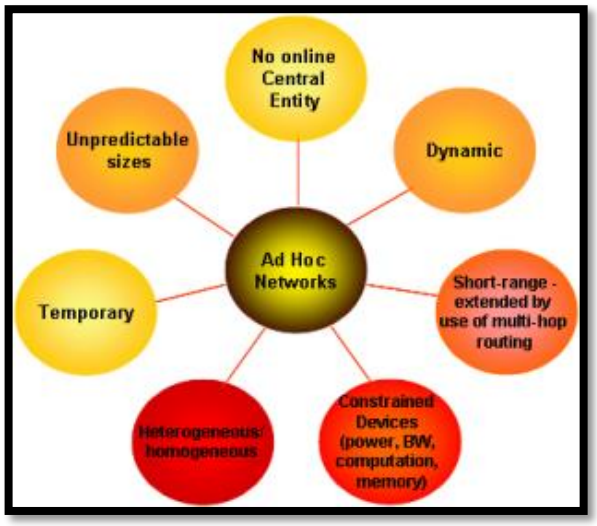

Figure 1: Ad hoc Network

2. TYPES OF AD HOC NETWORKS

The self-supporting nature of ad hoc networks makes them quite useful in situations such as natural disasters **[4],** emergency military operations, or even to just quickly transfer information between two computers at home. However, in spite of such ease of use and scalability, there are physical and performance limitations to an ad hoc network in the practical world. The types of ad hoc networks are as follows:

- **Mobile ad hoc networks:** A mobile ad hoc network (MANET), sometimes called a wireless ad hoc network or a mobile mesh network is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication, without the aid of any established infrastructure or centralized administration such as a base station in cellular network or an access point in wireless local area network [5,6,7,8].

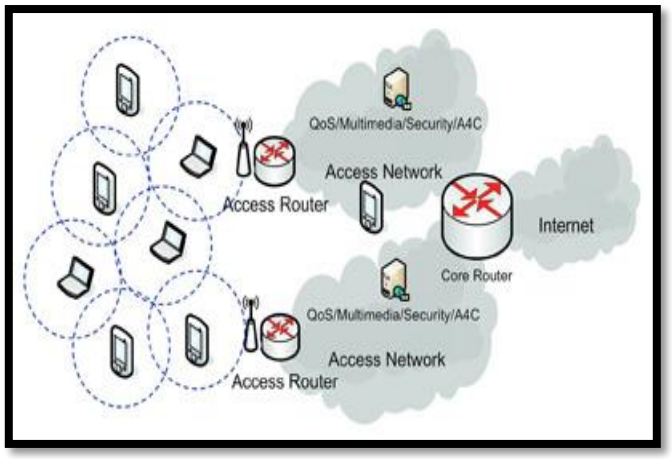

Fig 2: A MANET Example

A mobile ad hoc network (MANET) is a self-forming network of mobile devices connected wirelessly. Mobile ad hoc networks eliminate the constraint of infrastructure set up and enable devices to create and join networks on the fly, anywhere, any time and virtually for any application. However, these flexibilities and convenience do come at a price. Mobile ad hoc networks inherit the common problems of wireless networking in general, and add their own constraints specific to ad hoc routing [6].

- **Wireless mesh networks**

Wireless mesh networks (WMNs) are dynamically self-organized and self-configured, with the nodes in the network automatically establishing an ad hoc network and maintaining the mesh connectivity[9]. WMNs are comprised of two types of nodes: mesh routers and mesh clients.

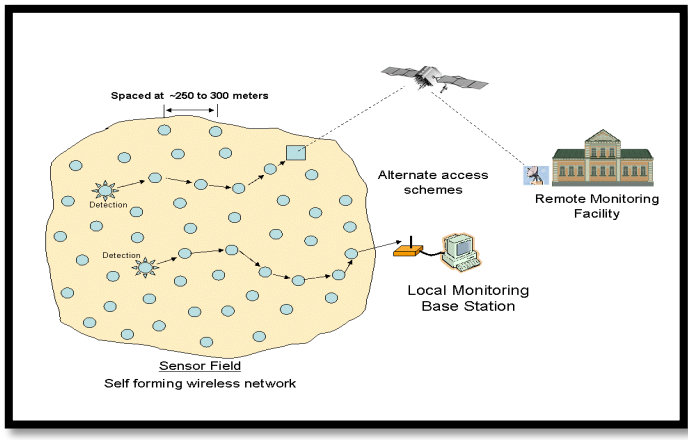

Figure 3: Wireless Sensor Networks

- **Wireless sensor networks**

A wireless sensor network is a collection of nodes organized into a cooperative network [10]. Each node consists of processing capability (one or more microcontrollers, CPUs or DSP chips), may contain multiple types of memory (program, data and flash memories), have a RF transceiver (usually with a single omni- directional antenna), have a power source (e.g., batteries and solar cells), and accommodate various sensors and actuators.

3. ROUTING AND FORWARDING MECHANISM IN AD HOC NETWORK

- **Routing Introduction**

Routing is the act of moving information from a source to a destination in an internetwork. During this process, at least one intermediate node within the internetwork is encountered. This concept is not new to computer science since routing was used in the networks in early 1970's. But this concept has achieved popularity from the mid-1980's. The major reason for this is because the earlier networks were very simple and homogeneous environments; but, now high end and large scale internetworking has become popular with the latest advancements in the networks and telecommunication technology. The routing concept basically involves, two activities: firstly, determining optimal routing paths and secondly, transferring the information groups (called packets) through an internetwork. The later concept is called as packet switching which is straight forward, and the path determination could be very complex [12]. Routing and forwarding mechanism in ad hoc network are quite complex and complicated due to an unpredictable random nature of the network topology. Routing mechanism is categorized in four distinct cast properties [12]

- **Types of routing**

➢ **Unicast routing**

Most applications in the MANET are based upon unicast communication. Thus, the most basic operation in the IP layer of the MANET is to successfully transmit data packets from one source to one destination. The forwarding procedure is very simple in itself: with the routing table, the relay node just uses the destination address in the data packet to look it up in the routing table. If the longest matching destination address is found in the table, the packet is sent to the corresponding next hop. In the unicast routing, one separate copy sends to each receiver from the source node. Data packet is replicated at the sender node and then delivered to each destination node. By this process we can easily see that bandwidth is consumed by the redundant data packets. Many application uses the unicast routing protocol depending upon the need of the application

➢ **Multicast routing**

Multicasting plays a crucial role in MANETs. It involves the transmission of a datagram to a group of zero or more hosts

identified by a single destination address, and so is intended for group-oriented computing. A multicast datagram is delivered to all members of its destination host group with the same "best effort" reliability as regular Unicast IP datagram, i.e. the datagram is not guaranteed to arrive intact at the destinations of all members of the group, or in the same order relative to other datagram [12].

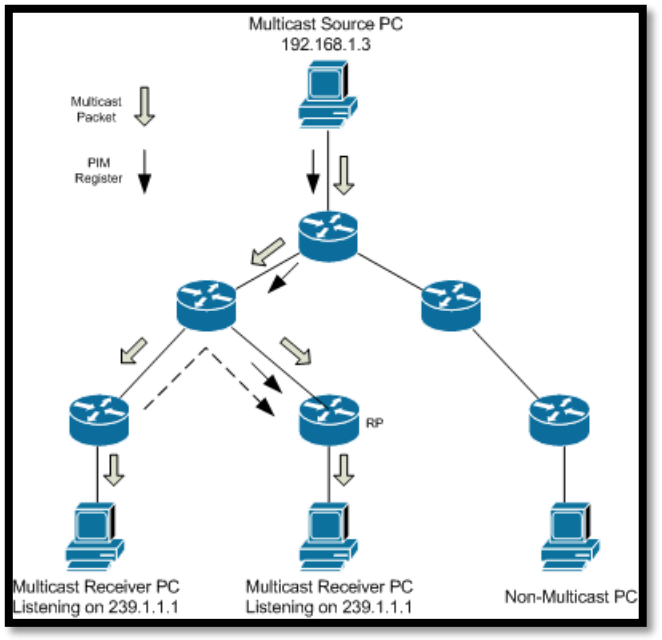

Figure 4: Multicast Routing

The use of multicasting within MANETs has many benefits. It can reduce the cost of communication and improve the efficiency of the wireless channel when sending multiple copies of the same data by exploiting the inherent broadcasting properties of wireless transmission. Instead of sending data via multiple unicasts, multicasting minimizes channel capacity consumption, sender and router processing, energy consumption, and delivery delay, which are considered important MANET factors. In addition, multicasting provides a simple yet robust communication method whereby a receiver's individual address remains unknown to the transmitter or changeable in a transparent manner by the transmitter [12,14].

- **Broadcast routing**

Broadcast routing involves sending the message across the network to all receivers that are listening.Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. Broadcasting is used when message needs to b disseminated to the vehicle beyond the transmission range i.e multi hops are used. Broadcast sends a packet to all nodes in the network, typically using flooding. This ensures the delivery of the packet but bandwidth is wasted and nodes receive duplicates. In VANET, it performs better for a small number of nodes. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST[13].

- **Geocast routing**

Geocasting, a special variant of multicasting, has become sort of a default choice as the mode of transmission in Wireless Ad Hoc Sensor Networks (WASN). Here, unlike multicasting the node id of the traversed nodes are not checked to see whether or not the target nodes are reached. Rather, some specified geographic areas are considered as the *target geocast regions* and the routing protocols thus designed concentrate on the location of the destination for delivering data packets and not on node id. Geocast routing protocols are concerned till the different target regions are reached.

4. CONCLUSION

To summarize, unicast routing establishes an efficient route between the communicating terminal pairs with reliable and in time message delivery. MANET further spits the routing protocols into proactive and reactive protocols. They are emerged from link state and distance vector protocols, proactive regularly propagate routing updates between each network pair terminals which are in the form of routing tables while proactive reduces the overheads though requirement based nodes discovery. Proactive routing route are created and maintained through event driven and periodic messages regularly. DSDV, OLSR, GRP and TBRPF are few examples of proactive routing protocols. AODV, DSR, ABR, SSR and TORA are examples of reactive routing protocols. In a Unicast routing protocols, ZRP acts as a hybrid routing protocol as it contains both proactive and reactive properties. Multicast routing provides support for multipoint applications and uses two main approaches for fixed networks i.e. group shared and resource specific tree. Group shared approach constructs a single tree while resource specific manages a tree for individual nodes which leads towards its all receivers. MAODV and AMRIS are examples of multicast routing protocols[14]. These protocols are on demand supported through multiple senders/receivers with dynamic network topology which causes large overheads for tree maintenance. GPS and other mechanism are used to provide nodes position location identification in location aware routing mechanism; packet forwarding is performed through selection of physical location of next neighboring node. Location aware routing is free from storing routing information, maintenance and establishment of routes. Upon information of geo-location, both control packets and data packets are forwarded towards the destination coordinates comprised of three strategies i.e. greedy forwarding, direct forwarding, and hierarchical routing. In greedy forwarding, nodes forward the packets to its neighboring nodes based on certain choices if more than

single node exist in closer location, while alternative strategy is used if no closer nodes exist. In direct flooding, node floods the packets to all the neighboring nodes by using DREAM and LAP routing algorithms. In hierarchical routing, two structure layers are used for routing. First for long distances, location aware routing (LPR Protocol) and second for shorter distances, proactive distance routing scheme is used. High security risks are associated with the dynamic topology change, as it restrict/fails standard security solutions provided for wireless infrastructure networks [15].

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