Design of a Low Cost Radio Based Ad hoc Communication System for Rural Areas

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Abstract: Mobile ad hoc network is a collection of wireless mobile hosts which are interconnected by a communication media like radio. The communication network is formed without the aid of any centralized authority or preexisting infrastructure. By its characteristic this type of network is self-starting and self-organizing. It has been observed that mobile ad hoc networks can be exploited for many useful applications including rural communication. Wireless Sensor Network is a collection of inexpensive sensor nodes which also form a communication network is a self organized manner. These sensors communicate with each other wirelessly. In this paper we propose architecture of an easily deployable and low cost communication system for rural areas of India which is basically a combination of Mobile Ad hoc Networks and Wireless Sensor Networks. We propose a suitable protocol stack for this architecture. In this architecture in some point in time the communication network may function as Mobile Ad hoc Network and at a later state it may be a Wireless Sensor Network or a combination of both. An idea for designing routing protocol which is highly adaptive, scalable and efficient has been proposed and this routing protocol may be well-suited for the mobile ad hoc network in discussion for rural communication. Future scope of the present work has also been outlined.
Key Words: Mobile ad hoc Networks, Routing, Rural Communication, Low Cost Communication

I Introduction

Recent advancements in communication and computation technology have enabled many sophisticated applications for making human life more comfortable. Mobile ad-hoc networks are a special type of wireless networks which utilize multi-hop radio relaying and these networks are capable of functioning without support of any fixed infrastructure. Ad-hoc networks are extremely useful in emergency situations for example, search and rescue, commando operations etc. It has been observed that ad-hoc networks might be useful even in rural communication, where high end communication infrastructure may not be expected. And also this can be a low cost solution for rural area communication. A model for this purpose has been introduced here in this paper. We also propose a protocol stack for this architecture. This model is a combination of both mobile ad hoc network and wireless sensor network. We also address a very important network layer issue called routing for the proposed model. The limitations and future scope of the proposed routing protocol has also been outlined.

II Background

Already this area of ad hoc networks has grown significantly over past few years. Now focus has been in developing application specific protocols and system development. In different literatures [2][7] routing protocols for mobile ad hoc networks have already been discussed. [2] Discusses different application areas of mobile ad hoc networks. It also discusses different issues related to the development of mobile ad hoc network systems in detail. Wireless Sensor Networks is a relatively new paradigm for communication. [5] Discusses different issues related to the design of wireless sensor networks, also provides a protocol stack for WSN. Different routing protocols developed so far for WSN has been reported in [4][8][9][10].

III Proposed Architecture

The proposed architecture is for making communication easier in an area where there might not be any sophisticated communication infrastructure. Let us consider a scenario in which few villagers want to communicate with each other without coming out of their home or the current place of presence. We assume that everybody in the situation has a mobile phone equipped with radio communication facility. And we also assume that there is at least one laptop computer or any computer of sufficient processing capability operating on, which might be static and this might be called as Station. This computer has also to be radio equipped and might be used for relatively long range communication. Use of this computer is mainly for having a larger network covering a wide geographical area. In the network under discussion, there will be no centralized control and every node either the mobile phone or the Laptop Computer may have to work as even a router. So they are required to be more intelligent. The schematic diagram showing the proposed architecture has been given below.

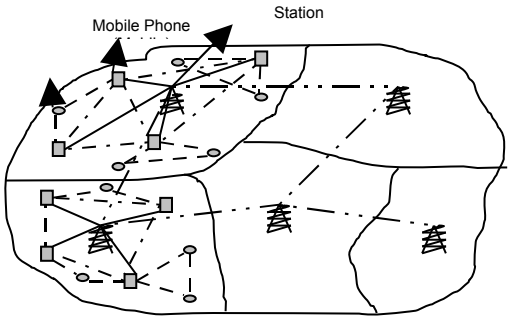


FIG 1: RURAL

If we look at the cost of the proposed communication system, we observe that there is no running cost of the network except the cost of the battery for power with each of the node. Once the persons concerned are equipped with a mobile phone loaded with proper software, they are ready for communication and this way this can be a low cost solution.

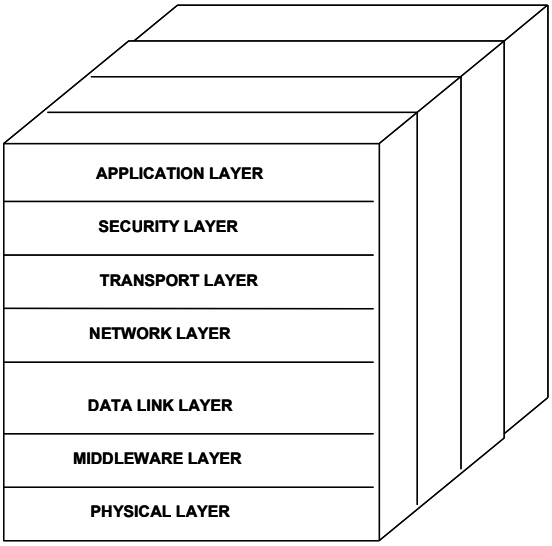
Since we know that the Laptop Computer is relatively powerful than a mobile phone, we assume that the communication range of the Laptop Computer/Computer is also very high. This special Computer helps in maintaining a wider geographical area with connectivity. And based on the scale of the system, the optimum number of Laptop Computers/Computers required may be determined.

Moreover in order to monitor some areas of interest like paddy field in the village, some sensors might be deployed in the area and those sensors will form wireless sensor networks in a self organized manner. This network might then be interfaced with the mobile ad hoc network and due to this it shall be possible for a villager to even monitor his paddy field from his home.

IV Protocol Stack/Issues

In general TCP/IP protocol stack is used for making a mobile ad hoc network system functioning. The details about the TCP/IP protocol stack can be found in [1]. Also the protocol stack discussed in [5] may be used for a wireless sensor network. But this architecture is a hybrid of the above two. We propose a protocol stack by combining main features of both the already existing protocol stacks and introducing two new independent layers security layer and middle ware layer.

A discussion on these issues can be found in [1].



PROPOSED PROTOCOL STACK

Fig 2. Protocol Stack for the hybrid network

V Routing

As we have already mentioned that routing is a very important issue in Mobile Ad hoc Network, a routing protocol basically discovers effective route from the source to the destination and then maintains the routes and also if it requires the protocol re-discovers route between a pair of source and destination.

VI Proposed idea for designing Routing Protocol

This idea is mainly for designing routing protocol which shall be suitable for MANET. Whenever the system starts functioning as a pure MANET, this protocol shall be applicable.

In this section we first describe how the location information is obtained in our modified routing protocol, the routing table data structure, the role of fixed host if available, in the MANET, the algorithm, and how it can be improved with the use of software agents modeled on ants.

Location Information:
We assume that all mobile hosts participating in a MANET have a GPS unit which provides to the host its approximate three-dimensional position (latitude, longitude and altitude), velocity and accurate time in Universal Time Coordinate (UTC) format.
The information provided by a GPS unit may have some inaccuracy of a few meters depending on the system employed. In the algorithm proposed we assume that the location information of a mobile host to reduce the number of routing message.

Routing Table:
All hosts in the MANET have a routing table where each entry represents a known host id and has the following information:

- The source node
- Neighbors node
- Information type (LOCAL/GLOBAL)
- Cost

The information in each entry may be updated whenever a host receives more recent information from mobile agent.

The Algorithm:
Whenever a mobile node wants to join the MANET it listens to the medium to find out neighbor node n. Once a neighbor node n is identified the mobile host sends a request packet (HELLO) to n asking for its routing table which is send back to the host. From this moment host can start routing and sending packets in the MANET. Frequent HELLO broadcasts by agents are used to maintain a neighbor node.

Routing protocol is based on the physical location of a destination host d stored in the routing table, if there is a entry in the routing table for host d, the best possible route is chosen using a shortest path algorithm. The route comprised of a list of nodes and the corresponding timestamps is attached to the packet which is sent to the first host in the list. If host d is not found in the routing table, the mobile node sends a message to the nearest fixed node, if available, that tries to find the destination node. Otherwise the data packet is not delivered.

An important aspect of any routing algorithm for MANET is how the routing table is updated. It is clear more recent information about the network configuration. Routing information can be obtained both locally and globally. Local information is obtained from a neighbor node that periodically broadcasts only the changes occurred since the last time (this interval is a configuration parameter). Global information can be disseminated more rapidly using mobile software agents modeled on ants as explained in the following-

- Each node first check its buffer to find is there any route to destination or not if it not find any route to destination then it send a RREQ packet to find new route.
- The source node buffers all alternative routes to the destination in buffer.
- Each node contain three buffers
  - First for routing table which contain both local and global information.
  - Second for all paths to the destination
  - Third for message till route is not found.
- Each node compute shortest path to destination when required from the information stored in routing table

Disseminating Routing Information Using Ants:

The route discovery can be accelerated using mobile software agents modeled on ants responsible for collecting and disseminating more up-to-date location information of mobile host. When a host receives an ant it compares the routing table present in the ant packet with its routing table and updates the entries that have older information as explained above. When this ant leaves a node it carries the most updated routing table from the point of view of the nodes already visited and the current one. This process is fundamental for there is an overhead associated with this process which can be controlled with the number of ants in the MANET.

In our modified protocol agents work independently and provide routes to the nodes. The nodes also have capability of launching on-demand route discovery to find routes to destinations for which they do not have a fresh enough route entry. The use of agents with AODV increases the node connectivity (the number of destinations for which a node has un-expired routes), which in turn reduces the amount of route discoveries.

- Agent is used for maintaining the global as well as local information in routing table of each node in the network (save power consumption)
- Agent also broadcast HELLO packet to know about its neighbors.
- Agent also informs each node in the network if a new node is joining the network.
- Agent also inform if some node leave the network.
- Agent also helps in drastic change in the network by informing all nodes in the network about this change.
- There are 4-5 no of nodes moving in the network which will keep the information about network.

Advantages:

Our modified routing protocol overcomes some of inherent drawbacks of various routing protocol. These hybrid techniques enhance the ***node connectivity (through AGENT)*** and ***decrease the end-to-end delay (AODV & REROUTING)*** and ***route discovery latency (REROUTING)*** and reduce ***the number of routing messages (through GPS)***.

VII Conclusion and Future Scope of this Work

In the routing protocol proposed here in this paper we assume that all mobile hosts participating in a MANET have a GPS unit which provides to the host its approximate three-dimensional position (latitude, longitude and altitude), velocity and accurate time in Universal Time Coordinate (UTC) format.

The information provided by a GPS unit may have some inaccuracy of a few meters depending on the system employed. In the algorithm proposed we assume that the location information of a mobile host to reduce the number of routing message.

In future, effort may be put to decrease the number of routing messages in the system.

A similar protocol for routing in wireless sensor network may be developed. Also a hybrid protocol for routing which shall work for both WSN and MANET may be designed since it is a requirement in the System.

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