CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A great deal of excitement has recently propelled m-Learning to the forefront of instructional technology. As the use of mobile gadgets like phones, Personal Digital Assistants (PDAs), is rising by the day, the prospects for using these devices to support learning is also increasing.

Multicast is used as support to group communication, where several destinations can receive a data packet by a single transmission. This does not involve all hosts connected to a network, but only a defined subset of these hosts, that is the multicast group.

The organization of the chapter is as follows: A review on various m-learning techniques previously proposed in MANETs is presented in Section 2.2. This research focuses on the explicit multicast support in MANETs. In section 2.3, a detailed review is presented on the multicast problem in MANETs. In Section 2.4, the objectives of VCR using multicast MANET has been presented.

2.2 MOBILE LEARNING

One of the most straightforward applications of the usage of mobile devices as educational supporting tool is messaging. Again different educational bodies have made experiments in this area.
At Kingston University, UK, an experiment was undertaken to research the effectiveness of a two-way Short Message Service (SMS) campaign in the university environment and was described in Stone and Briggs (2002) and Stone et al (2002). The team has developed a system that sent SMS to students who have registered to the service—about their schedule, changes in it, examinations dates and places, student’s marks, etc.

In Seppala and Alamaki (2002), it was depicted at the University of Helsinki that the Learning In Virtual Environment (LIVE) experiments, made with SMS system and with Wireless Application Protocol (WAP) phones, were very positive. The project went on by introducing digital imaging and sharing photos between the participants. The authors (Seppala and Alamaki 2002) concluded that the introduction of Multimedia Message Service (MMS) and the Third Generation (3G) services in the large scene would lead to more and more possibilities for m-Learning.

In Garner et al (2002), an evaluation of a SMS to support undergraduate students was done at Sheffield Hallam University. The experiment was with 67 undergraduate psychology students. The implemented system was again not for learning, but for managing learning activities. The findings were positive, with students perceiving the system to be ‘immediate, convenient and personal’.

Positive results were underlined after the outcomes from a survey in Norway - almost 100% of the students in the University have cell phones; SMS system would be widely accepted as described in Divitini et al (2002). Once again an SMS system was considered to be used to spread information about lectures and classes, corrections in the schedule, etc. In certain cases students found it more convenient than either e-mail or WWW as the information was always on time.
UltraLab m-Learning project described in 2003 was one of the projects that have a special section dedicated on creation of a WAP portal for educational purposes. The technical aspects in the creation of a WAP portal for educational purposes did not differ from a common WAP portal. As the target users for this project were young people (age 16-24) with literacy problems. The group studied the problem of keeping the interest of the young adults to the useful learning materials, by exposing modish and exciting subjects.

One of the biggest initiatives in the m-Learning domain was at the University of Birmingham – the HandLeR project (Vavoula and Sharples 2002). The project tried to understand in depth process of learning in different contexts and to explore the lifelong learning. The main ideas they investigated were concept mapping and knowledge sharing, lifelong learning, wearable learning technologies and conversation between mobile learners.

Similar in some concepts to HandLeR was the project undertaken at the Tampere University of Technology, Finland, as found in Ketamo (2002), where PDAs were used for lifelong learning of children. The study content was presented in the form of a game where the pupils could communicate and help each other and the electronic device was used to measure the average students’ knowledge level and to adopt the speed of presenting new material to the learners.

In Smordal et al (2002), it was found that “Problem-Based” learning was the aim of KNOWMOBILE project in Norway, where PDAs and smart-phones were used for experiment in medical education of students from the School of Medicine at University of Oslo. The students were put in different environment and were given different devices. After a few weeks of experiment the research team found that even the medical students were eager to test the PDAs and investigated how they could be useful in learning. They
concluded that the PDAs should not be regarded as Personal Digital Assistants, but rather as gateways in complicated webs of interdependent technical and social networks.

Advanced wireless technologies were used in a project eSchoolbag system at the Aletheia University, Taiwan, as described in Chang and Sheu (2002). The so called “Paperless education” was observed together with the acceptance from the students (the term “paperless education” and research on the topic was made also in 2003). The traditional classroom was replaced by the newly developed electronic tools (electronic blackboard, rubber, colour chalk and so on). Pupils were strongly encouraged to communicate and to learn together.

The positive results of many more systems, developed to combine WAP courses and SMS notification systems, were published by different universities. Some examples of them were HyWeb found in Jones et al (2002) at Griffith University, Gold Coast, mid-2000 found in Virtanen et al (2002) at Minnesota State University and in Canada the NAIT m-Learning project found in 2003.

2.3 MANET ROUTING PROTOCOLS

This section presents brief descriptions of some existing MANET routing protocols.

2.3.1 Proactive

Core-Assisted Mesh Protocol (CAMP) (Garcia-Luna-Aceves and Madruga 1999) extends the notion of Core Based Trees (CBT) (Ballardie et al 1993) introduced for Internet multicasting into multicast meshes, which have much richer connectivity than trees. A shared multicast mesh is defined for
each multicast group to maintain the connectivity of multicast groups, even during the frequent movement of network routers. CAMP needs an underlying proactive unicast routing protocol (the Bellman-Ford routing scheme) to maintain routing information about the cores, in which case considerable overhead may be incurred in a large network.

Ad Hoc Multicasting Routing Protocol (AMRoute) (Xie et al 2002) creates an efficient and robust shared tree for each group. It helps keep the multicast delivery tree unchanged with changes of network topology, as long as paths between tree members and core nodes exist via mesh links. When mobility is present, AMRoute suffers from loop formation, creates nonoptimal trees, and requires higher overhead to assign a new core. Also, AMRoute suffers from a single point of failure of the core node.

2.3.2 Reactive

Associativity-Based Ad Hoc Multicast (ABAM) (Toh et al 2000) is an On-Demand Source based multicast routing protocol for mobile ad hoc networks. A multicast tree rooted at the multicast sender is established for each multicast session based primarily on association stability. Association stability helps the source to select routes to receivers which will probably last longer and need less reconfiguration. ABAM introduces less control overhead traffic and achieves a higher packet delivery ratio, due to the stability of the path between the source and destination nodes. At the same time, the path may be long, and some latency in delivering the data packets will be incurred.

Adaptive Demand Driven Multicast Routing Protocol (ADMR) (Jetcheva and Johnson 2001) maintains a tree for every source-multicast pair. Each tree is maintained by a periodic flood of keep alive packets within the tree. The Multicast Routing state in ADMR is dynamically established and maintained only for active groups with at least one receiver and one active
sender in the network. Each multicast data packet is forwarded from the sender to the receivers along the shortest delay path with the multicast forwarding state. ADMR adapts well to the network load, and also avoids unnecessary redundancy. One of its shortcomings is that a large amount of state information needs to be maintained at every node for every group source.

The MAODV (Royer and Perkins 2000) protocol is extended from AODV (Perkins et al 2003). It maintains a shared tree for each multicast group, which consists only of receivers and relays (forwarding nodes). It determines a multicast route on demand by using a broadcast route discovery mechanism. The first member of a multicast group becomes the leader of that group. The multicast group leader is responsible for maintaining the multicast group sequence number and broadcasting this number to the multicast group.

Neighbor-Supporting Multicast Protocol (NSMP) (Seungjoon Lee and Chongkwon Kim 2000) is a source-initiated multicast routing protocol, and is an extension to ODMRP (Lee et al 2002). A mesh is created by a source, which floods a request throughout the network. Intermediate nodes cache the upstream node information contained in the request and forward the packet after updating this field. When any receiver node receives the route discovery packets, it sends replies to its upstream nodes. Intermediate nodes receiving these replies make an entry in their routing tables and forward the replies upstream toward the source. NSMP is aimed at reducing the flood of control packets to a subset of the entire network. It utilizes node locality to reduce control overhead while maintaining a high delivery ratio. NSMP favors paths with a larger number of existing forwarding nodes to reduce the total number of multicast packets transmitted.

Source Routing based Multicast Protocol (SRMP) (Moustafa and Labiod 2002) is an on-demand multicast routing protocol. It constructs a mesh
topology to connect each multicast group member, thereby providing a richer connectivity among members of a multicast group or groups. To establish a mesh for each multicast group, SRMP uses the concept of Forwarding Group (FG) nodes. SRMP applies the source routing mechanism defined in the Dynamic Source Routing (DSR) (Johnson and Maltz 1996) protocol to avoid channel overhead and to improve scalability. Also, SRMP addresses the concept of connectivity quality. Moreover, it addresses two important issues in solving the multicast routing problem: the path availability concept and higher battery life paths.

Multicast for Ad hoc Networks with Swarm Intelligence (MANSI) (Shen and Jaikaeo 2005) applies swarm intelligence mechanisms to the problem of multicast routing in MANETs. Swarm intelligence refers to complex behaviors that arise from very simple individual behaviors and interactions, which are often observed in nature, especially among social insects such as ants and honey bees. Although each individual (an ant, e.g.,) has little intelligence and simply follows basic rules using local information obtained from the environment, global optimization objectives emerge when ants work collectively as a group. Similarly, MANSI utilizes small control packets which deposit information at the nodes they visit. This information is used later by other control packets. MANSI adopts the concept of swarm intelligence to reduce the number of nodes used to establish multicast connectivity. However, the path between the multicast member and forwarding set to the designated core is not always the shortest.

Protocol for Unified Multicasting through Announcements (PUMA) (Vaishnampayan and Garcia-Luna-Aceves 2004) establishes and maintains a shared mesh for each multicast group. It eliminates the need for a unicast routing protocol or the preassignment of cores (it makes use of dynamic cores) to multicast groups. PUMA uses a receiver-initiated approach,
in which receivers join a multicast group using the address of a core node, without the need for network-wide flooding of control or data packets from all the sources of a group. PUMA elects the first receiver of the group as the core of the group, and informs each node in the network of at least one next-hop to the elected core of each group. A core node of a group transmits multicast announcements periodically for that group. PUMA minimizes data packet overhead by using only one node, that is, the core node floods the network.

An ad hoc multicast protocol based on passive data acknowledgement, called Passive Data Acknowledgement On Demand Multicast Routing Protocol (PDAODMRP), has been proposed (Shaobin Cai et al 2006). PDAODMRP knows the status of its downstream forwarding nodes by route information collected from data packets instead of by means of the beacon signal of the Medium Access Control (MAC) layer, and reduces the wasting of wireless bandwidth created by the beacon signal. It has also adopted a new method of route information collection from data packets to reduce CPU usage. In addition, it has adopted dynamic local route maintenance to enforce its local route maintenance methodology.

2.3.3 Hybrid

Multicast Core Extraction Distributed Ad Hoc Routing (MCEDAR) (Prasun Sinha and Bharghavan 1999) is a Source-Tree-based multicast protocol. It combines the Tree-based protocol and the Mesh-based protocol to provide efficiency. It uses Core Extraction Distributed Ad Hoc Routing (CEDAR) (Sivakumar et al 1999) to construct the mesh. MCEDAR uses a mesh structure called the mgraph as its multicast routing infrastructure. MCEDAR is robust and efficient, since a receiver node has multiple paths to a multicast tree. However, when used with small and sparsely distributed groups, it may become less efficient and more expensive due to bandwidth constraints, network topology dynamics, and high channel access cost.
Multicast Routing Protocol Based on Zone Routing (MZRP) (Zhang and Jacob 2004) is a source-initiated multicast protocol that combines reactive and proactive routing approaches. Every node has a routing zone. A proactive approach is used inside this zone and a reactive approach is used across zones. First, a source node constructs a multicast tree inside its routing zone, and then it tries to extend the tree outside the zone (the entire network). One of the main drawbacks of this protocol is that a node outside a source routing zone will wait a considerable time to join the group.

Optimized Polymorphic Hybrid Multicast Routing protocol (OPHMR) (Mnaouer et al 2007) is built using the reactive behavior of ODMRP (Lee et al 2002) and the proactive behavior of the MZRP (Zhang and Jacob 2004) protocol. In addition, the Multipoint Relay-based mechanism of the Optimized Link State Routing (OLSR) (Jacquet et al 2002) protocol is used to perform an optimization forwarding mechanism. OPHMR attempts to combine the three desired routing characteristics, namely, hybridization (the ability of mobile nodes (MNs) to behave either proactively or reactively, depending on the conditions), adaptability (the ability of the protocol to adapt its behavior for the best performance when mobility and vicinity density levels are changed), and power efficiency. OPHMR is, in the long run, able to extend battery life and enhance the survivability of the mobile adhoc nodes.

2.3.4 Multi-path

Wei and Zakhor (2007) proposed two routing protocols for mobile ad hoc networks with multiple tress construction ability, namely Serial Multiple Multiple Disjoint Tree Multicast Routing (Serial MDTMR) protocol and Parallel Multiple Nearly-Disjoint Trees Multicast Routing (Parallel MNTMR) protocol. Both protocols are developed on top of the well-known source initiated On-Demand Multicast Routing Protocol. The first protocol applies a
strict requirement on the tree disjointedness and therefore, complete tree connectivity is not guaranteed. Meanwhile, the second protocol allows looser requirements on tree disjointedness in order to achieve full connectivity to both multicast tree.

Ad hoc On-demand Multi-path Distance Vector (AOMDV), described in Marina and Das (2001), was an extension to the AODV protocol for computing multiple loop-free and link-disjoint paths. Loop-freedom was guaranteed by using a notion of “advertised hop count”. Link-disjointness of multiple paths was achieved by using flooding.

Ad hoc On-demand Distance Vector Multi-path Routing (AODVM), described in Ye et al (2003), was an extension to AODV for finding multiple node-disjoint paths. Instead of discarding the duplicate request packets, intermediate nodes were required to record the information contained in these packets in the route table. The reply packet contained an additional field called “last hop ID” to indicate the neighbour from which the particular copy of request packet was received.

Split Multi-path Routing (SMR), proposed in Lee and Gerla (2001), was an on-demand multi-path source routing protocol that built multiple routes using a request-reply cycle. When the source needed a route to the destination but no route information was known, it flooded the request message to the entire network. Since the request packet was flooded, several duplicates that traversed through different routes reached the destination. The destination node was made to select multiple disjoint routes and sent reply packets back to the source via the chosen routes. Unlike DSR, intermediate nodes did not keep a route cache, and therefore, did not reply to requests.
Multipath Passive Data acknowledgement On-Demand Multicast Protocol (MPDAODMRP) (Shaobin Cai et al 2006) is proposed to extend PDAODMRP by its multipath policy. MPDAODMRP distributes data overhead to multipath based on diversity coding and a member selects three groups of paths between a source and itself. Compared with PDAODMRP, MPDAODMRP distributes its data packets on its multipath instead of all paths delivering same packets. Since its local route maintenance is strong enough to amend all link failures, and its diversity coding can self-heal most communication errors. Therefore, the multipath policy based on diversity coding does not affect the robustness of forwarding meshes. Compared with PDAODMRP, MPDAODMRP not only greatly reduces its data overhead and its data delivery delay but also scales better because of its more efficient forwarding mesh.

Multi Path-Multicast Adhoc OnDemand Distance Vector (Hong Tang et al 2008) is MAODV-based multipath routing algorithm, which distributes traffic through two node-disjoint routes to improve network efficiency and balances the network loads. Only when the two links are broken, the source nodes restart to find new routes. So it decreases the number of routing discovery and reduces routing overhead. The MP-MAODV preferably ensures the network performance in heavy load ad hoc networks.

Multiple Tree-Multicast Adhoc OnDemand Distance Vector (Chee-Onn and Hiroshi 2008) is also an extension to the Multicast Ad Hoc OnDemand Distance Vector to construct two highly-disjoint trees in a single routine; by using Multiple Description Coding (MDC) scheme for video coding, the video is divided into two independent sub-streams and is transmitted separately along these trees. This technique is believed to improve the overall quality for best-effort video.
The above stated routing algorithms can be classified in different ways based on the following properties:

- **How the routing information is update?** - Proactive, reactive and hybrid.

- **How multicast connectivity is established and maintained?** - Source-Initiated, receiver-Initiated and both.

  The **Source-Initiated** approach, in which a multicast group is initiated and maintained by the source node (multicast group/source).

  The **Receiver-Initiated** approach, in which any receiver node wishing to join a multicast group floods the network with a Join Request message searching for a route to a multicast group.

- **Loop free** - A situation may exist where some nodes are forwarding data according to the older tree and some according to the newer tree, which may result in loops.

- **Periodic control messages** - For maintaining the group, nodes are sending periodical control messages.

- **Quality of Service (QoS) support** – Multicast routing protocols should be able to reserve different network resources to achieve QoS requirements such as, capacity, delay and packet loss.

- **How routes are constructed for the members of the multicast group (multicast topology)?** - Tree-Based, Mesh-Based and Hybrid.
Tree-based, in which a single path between source-destination pairs is established. There are two kinds of Tree based approaches: Source-Tree-based and Shared-Tree-based. In the Source-Tree-based approach (persource tree), each source node creates a single multicast tree spanning all the members in a group. In the Shared-Treebased approach, only one multicast tree is created for a multicast group which includes all the source nodes.

In the Mesh-based approach, a multicast mesh connecting a source to all receivers in the network is constructed.

- **Multipath Support** – These multiple paths between source and destination can be used to compensate for the dynamic and unpredictable topology change in MANET.

Table 2.1 summarizes the major features of the multicast routing protocols described earlier. It provides a comparison of those protocols in terms of various characteristics: routing scheme, initialization of Multicast Connectivity, and multicast Topology, and in terms of the presence or absence of the following characteristics: loop-free, periodic control message, QoS support, multipath support.

It is worth to be noted that most of the algorithms in Table 2.1 (namely ADMR, ABAM, ODMRP, NSMP, AMRIS, MZRP, OPHMAR, Serial MDTMR, Parallel MNTMR, MPDAODMRP) to establish and maintain the multicast connectivity as Source Initiated. Some of the algorithms supports receiver initiated approach or both. Moreover some of these approaches (namely SRMP, MCEDAR, Serial MDTMR, Parallel MNTMR and MPDAODMRP) are support Quality of Service, whereas the others does not support the QoS.
Table 2.1 Classification of MANET Multicast Routing Protocols

<table>
<thead>
<tr>
<th>Algorithm name</th>
<th>Routing Scheme</th>
<th>Initialization of Multicast Connectivity</th>
<th>Loop free</th>
<th>Periodic control message</th>
<th>QoS support</th>
<th>Multicast Topology</th>
<th>Multipath Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMRoute (Xie et al 2002)</td>
<td>Proactive</td>
<td>Source or Receiver Initiated</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Hybrid</td>
<td>No</td>
</tr>
<tr>
<td>CAMP (Garcia-Luna-Aceves and Madruga 1999)</td>
<td>Proactive</td>
<td>Source or Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Source tree based</td>
<td>No</td>
</tr>
<tr>
<td>ADMR (Jetcheva and Johnson 2001)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Source tree based</td>
<td>No</td>
</tr>
<tr>
<td>ABAM (Toh et al 2000)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>MAODV (Royer and Perkins 2000)</td>
<td>Reactive</td>
<td>Source or Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Shared tree based</td>
<td>No</td>
</tr>
<tr>
<td>ODMRP (Lee et al 2002)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>NSMP (Seungjoon Lee and Chongkwon Kim 2000)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>AMRIS (Wu et al 2000)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Shared tree based</td>
<td>No</td>
</tr>
<tr>
<td>SRMP (Moustafa and Labiod 2002)</td>
<td>Reactive</td>
<td>Receiver Initiated</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>MANSI (Shen and Jaikaeo 2005)</td>
<td>Reactive</td>
<td>Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>PUMA (Vaishampayan and Garcia-Luna-Aceves 2004)</td>
<td>Reactive</td>
<td>Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>PDAODMRP (Shaobin Cai et al 2006)</td>
<td>Reactive</td>
<td>Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>MCEDAR (Prasun Sinha and Bharghavan 1999)</td>
<td>Hybrid</td>
<td>Source or Receiver Initiated</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Hybrid</td>
<td>No</td>
</tr>
<tr>
<td>MZRP (Zhang and Jacob 2004)</td>
<td>Hybrid</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Source tree based</td>
<td>No</td>
</tr>
<tr>
<td>OPHMAR (Mnaouer et al 2007)</td>
<td>Hybrid</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Mesh based</td>
<td>No</td>
</tr>
<tr>
<td>Serial MDTMR, Parallel MNTMR</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Mesh based</td>
<td>Yes</td>
</tr>
<tr>
<td>MPDAODMRP (Shaobin Cai et al 2006)</td>
<td>Reactive</td>
<td>Source Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Mesh based</td>
<td>Yes</td>
</tr>
<tr>
<td>MP-MAODV (Hong Tang et al 2008)</td>
<td>Reactive</td>
<td>Source or Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Shared tree based</td>
<td>Yes</td>
</tr>
<tr>
<td>MT-MAODV (Chee-Omn and Hiroshi 2008)</td>
<td>Reactive</td>
<td>Source or Receiver Initiated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Shared tree based</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Based on the above literature it is found reactive routing scheme has more advantages than proactive routing on the aspect of control overhead, power saving and capacity. For example, Multicast Ad hoc On-demand Vector routing protocol (Royer and Perkins 1999) is an on-demand scheme that constructs a shared delivery tree to support multiple senders and receivers in a multicast session.

MAODV shows a smooth performance in light load networks (Royer and Perkins 1999). However, network congestion, network load imbalance and QoS degradation are easy to occur when network loads increase heavily. To improve the quality of MANET routing, multipath routing has attracted more and more research attentions.

### 2.4 Objectives of the Proposed Work

- To enhance the teaching-learning process within a campus of about 500m diameter, a MANET among the group members is proposed. A wireless platform is implemented to avail group learning among the teachers and students dynamically, whenever and wherever they want to take a lesson and to enable the students to post their queries for immediate clarification. The performance of two multicast routing algorithms namely, MAODV and ODMRP for MANET is studied.

- To study the existing multipath multicast routing protocols for providing the benefits of fault tolerance, load balancing, bandwidth aggregation, and improvement in QoS metrics such as delay. The performances of two existing multipath multicast routing algorithms namely, MP-MAODV and MT-
MAODV for mobile ad hoc network are studied for improving the routing performance of VCR.

- To propose a new Power Aware approach for providing QoS properties for real-time flows in MANET. Power Aware scheme is used for Multi path MAODV routing for route discovery and route maintenance. Battery capacity prediction is performed to improve the QoS of the network.

- To propose congestion identification and handling scheme to improve the packet delivery ratio of Power Aware Multi Path Multicast Adhoc On Demand Routing Protocol.