Chapter 1

INTRODUCTION

Mobile Ad Hoc Networks (MANETs) [1], [2] are infrastructure less, decentralized, random, dynamic, rapidly changing, and multi hop networks composed of bandwidth constrained wireless links and no centrally accessed routers or servers. Due to these properties, it has got potential applications in both military and civilian systems. Handheld personal computer and mobile connectivity (Laptop, Smartphone and Tablet Computer), vehicle and ship networks, and rapidly deployed emergency networks in disaster and war scenario are all applications of this kind of network.

As the nodes in a wireless network are free to move around, the topology is dynamic. These properties of MANET make them difficult to evaluate analytically. Therefore, the studies are based on simulation of the network by creating different scenarios like node density, node speed, mobility model, transmission range etc. Although simulation is considered imitation of the operation of a real-world process or system; it may lead to misleading results [3]. However, it continues to remain a popular and cost effective strategy to analyze MANETs. Hence, we have chosen NS2, Qualnet and GloMoSim for the purpose.

Choice of simulator is an important consideration as they have their own limitations. Cavin et.al [4] suggested that the learning curve for NS-2 is steep and debugging is difficult due to the dual C++/OTcl nature of the simulator. An important limitation of NS2 is its large memory footprint and its lack of scalability as soon as simulations of a few hundred to a few thousand of nodes are undertaken.

Node density is considered to be an important parameter, as at lower density the destination may not be reachable. This is due to the fact that small number of nodes separated by a longer distance may not be reachable because of transmission range. At higher density battery power (which again, is an important parameter) may be wasted, as depending upon the area only a particular number of nodes may be needed for communication.

The mobile nodes are free to move (constrained by mobility models) within the area with a minimum and maximum speed. The speed is considered to be an important parameter. At lower speeds link breakage is not often, but at higher speeds links may break often because the nodes joins and leaves the network at faster speed.

Mobility model is the pattern in which the nodes travel from a point to another in a network. They define the location of node at a particular time. They also have an effect on the performance of routing protocols. The commonly used models are Random waypoint mobility model (random points are chosen), Gauss Markov model (velocity of a node is assumed to be correlated over time and is modeled as a Gauss-Markov stochastic process), Manhattan Grid model (the horizontal and vertical mobility of nodes on streets defined by maps) and Reference point group mobility model (Mobility for each node is assigned with a reference point, which follows the group movement. Based on this reference point, each mobile node can be placed randomly in the neighborhood).

The transmission range is the distance to which a node is capable of sending packets. If it is chosen to be low, the packets may not be able to reach destination and if chosen to be high, although all the packets may reach destination but will greatly impact the battery performance. A node has limited battery power, so conserving the power will result in longer runtime. Hence, the choice of transmission range is an important parameter.

Fault tolerance is the level of tolerance offered by the network when a number of nodes stop working i.e. sending and receiving packets. In that case, the remaining nodes take over the load. The single path routing protocols provide a lesser degree of tolerance as a single route is used for communication and if that route fails alternate routes may not be available. But multi path routing protocols maintains more than one route and hence offer more fault tolerance.

The usability of MANETs has a wide application area ranging from military (war) to civilian (vehicular ad hoc network, disaster management) systems. This study considers the disaster management aspect. In this case, there is an immediate need of communication setup. The communication needs to be efficient, in order to save life.

The routing protocols in MANET are classified into two groups: single path and multi path. Single path protocols learn routes and select the best route to destination. It is

further classified into four groups namely proactive (route is established well ahead of the transmission), reactive (routes are established on demand), hybrid (combination of reactive and proactive) and geographic (routes are established on the basis of geographic location of the nodes). Multi path routing protocols learn routes and can select more than one path to destination. For our simulations studies, we have chosen representative protocols from each of these groups, namely: OLSR, DSDV, FISHEYE, LANMAR, AODV, DSR, DYMO, ZRP, LAR and E2FT.

One of the objectives of the study is to compare two popular simulation platforms NS2 and Qualnet. Chapter 3 details, performance comparison of these simulators for AODV (reactive) and OLSR (proactive). It was observed that NS2 exhibits scalability issues with these protocols. Therefore, Qualnet and other simulators (GloMoSim) were used for further simulation studies detailed subsequently.

In chapter 4, an analysis and comparison study of routing protocols is described for variation in node velocity, node density and mobility models. Such studies are quite popular for MANETs and are reported in [5-28]. Our results are mostly in agreement with the reported results. The performance metrics considered were end to end delay, throughput and packet delivery ratio. From the simulations, it was observed that the above given parameters has a marked impact on the performance of routing protocols. Different combinations of these simulation parameters are present in each of the wide ranging applications of MANET. For few selected applications, we have proposed range of simulation parameters and suitable mobility models to effectively model them.

A study of routing protocols was done by varying transmission range, node density and node speed as detailed in chapter 5. Similar studies have been reported by authors in [29-35]. The transmission range is the distance to which a node is capable of sending packets. A node has limited battery power, so conserving the power will result in longer runtime. We have studied the effect of varying transmission range, node density and speed on three routing protocols namely OLSR, DSR and ZRP representing the three groups in which MANETs have been classified namely proactive, reactive and hybrid routing protocols respectively. There was an obvious impact on these metrics on variation of transmission range.

Chapter 6 details the possibility of fault tolerance offered by single path and multi path routing protocols in MANET earlier studied by authors in [36-57]. Faults can occur in

the form of link failure, node failure, network failure and misbehaving nodes either due to maliciousness or selfishness (to preserve battery power) etc. In case of a fault, new routes are searched for transmission. We simulated three protocols namely AODV and DSR (single path) and E2FT (multi path). Variations have been done on pause time and faultiness of nodes. Performance metrics included packet delivery percentage. The multipath protocols offered more fault tolerance than single path.

A considerable amount of study on disaster management has been reported by [58-64]. We propose a post disaster management system using MANET consisting of three stages namely disaster location, assign tasks and relief base with two interfaces, one between first and second layer and other between first and third layer. The links are provided by relief ambulance. The co-ordination task is managed by a four way movement. Mobility of nodes between the stages has been modeled with reference point group mobility model (RPGM). Performance of the scenario is considered for reactive (AODV) and proactive (OLSR) protocols. Our simulation studies conducted on Qualnet indicates that both the mobility model and routing protocols affect the communication between the stages as detailed in chapter 7.