Mobility Pattern Aware Mobile Ad hoc Networks and It's Applications in m-Governance

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ABSTRACT
Ad hoc networks are emerging as the next generation of networks. An ad hoc network is an autonomous system of mobile stations connected by wireless links, union of these mobile stations form a communication network in the form of an arbitrary communication graph. Mobile stations in mobile ad hoc network are not just end systems, each node must be able to function as a router as well to relay the packets generated by other nodes. In ad hoc networks, a node moves to different locations over time, thus creating a different network topology. Routing in ad hoc network has been an active area of research. Significant work has been done on routing in ad hoc network. But with increasing acceptance of mobile ad hoc networks, the demand now is being placed on performance of these types of networks due to non-deterministic nature of these networks. Non deterministic nature is inherent property of mobile ad hoc network, but there are cases where the mobile node movements are predictable to some extent. It is the mobility of nodes that renders the network topology in a state of flux, resulting in degradation in performance of network. Issues of mobility can be resolved by defining mobility into various patterns. This paper tries to characterize the mobility of the nodes into some pre-identified mobility patterns where movements can be approximated to simple patterns and this information may be used to bring in predictability to motion. Most of the prior research on ad hoc networks assumed random mobility model but real world is complex and vastly diverse that makes the existing models inappropriate of representing the real world context properly. This paper proposes a general mobility model capable of considering more realistic scenarios by exploiting the concept of fixed hotspot inclusion. The m-Governance is at its nascent stage. Because MANETs are infrastructure less, they can be easily adapted to provide low cost m-Governance services. This paper describes how these mobility patterns can be used in m-Governance and how adoption of these patterns affects performance of network.

Keywords
m-Governance ;Mobility Models;

1. INTRODUCTION
Ad hoc network is one of the wireless networks that dynamically form a temporary network without using any infrastructure or centralized administration. Therefore, a good routing protocol is required to establish connection between nodes since mobile nodes can change their topology frequently [1]. Topology of MANET and mobility of mobile nodes are the key factors that have an impact on the performance of protocols [2]. Mobility management in ad hoc wireless networks faces many challenges. Mobility constantly causes the network topology to change. In order to keep accurate routes, the routing protocols must dynamically readjust to such changes. Different mobility patterns have in general different impact on specific network protocol or application. Consequently the network performances will be strongly influenced by nature of mobile pattern. Because of highly dynamic nature of MANET, there are some challenges to be considered before deploying it in real time application scenarios such as conferences, exhibitions, ad hoc meeting etc. Nodes are allowed to move freely within application area, so, network topology changes in no time. Routing protocols should be well aware of such frequent changes and disseminate proper information timely to continue communication smoothly [3]. The topology of MANET and the mobility of mobile nodes are the key factors that have an impact on the performance of protocols. However, most of the existing works are based on random movement and the fact that the network topology is highly related to the environment of MANET is overlooked [2]. Literature review show that performance of ad hoc network protocol is not only influenced by mobility models but also significantly affected by environment objects which are abstracted from real environment.

Mobile Governance is at implementation stage in various countries including India. The m- Governance can be a whole range of government services and applications, available via various mobile networks which are designed for a broad range of devices. The m-Governance environment need low cost infrastructure which must also provide high quality transmission and constant connectivity. Mobile Ad-hoc Networks (MANETS) are self-creating, self-organizing, and self-administrating. MANET offer unique benefits and versatility if the environment and application is appropriate and m-governance is one such application. Due to this reason MANETS can be easily adapted to m-Governance. Due to infrastructure less and self-organizing nature of MANET, this network can be used in m-Governance. The term MANET@MGOV is introduced to describe the possible situations where MANET can be used in m-Governance [4].

The remainder of this paper is organized as follows: Section II discusses the various mobility models proposed in literature. Section III, proposes an Environment Aware Mobility model (EAM $\oplus$ H) which considers already installed hotspots as a part of environment in which MANET will be deployed. Section IV, details about simulation results .Section V highlights implementation of MANET in m-Governance and requirement of Environment Aware Mobility model (EAM $\oplus$ H) for m-Governance. Finally section VI concludes the findings material.

2. RELATED WORK
There exists many mobility models proposed for mobile wireless networks. Mobility models are used to describe the

movement pattern of mobile nodes. The category of conventional models is illustrated in Figure 1. The Entity Models are used to model the movement behavior of an individual mobile node. The Random Waypoint model [5] is widely implemented by network simulators such as ns2 [6]. In each movement, the mobile node picks a position within the simulation area and moves towards it with a speed distributed in the range [vmin, vmax]. Instead of moving to the next destination immediately as soon as it arrives at the current destination, the mobile node pauses for a specified time then repeats the procedure. The major drawback is that the nodes tend to move around the Centre area so that they are not really distributed into the entire simulation area. The Random Direction [5] model is proposed to avoid this distribution problem. It forces the mobile node to move until it reaches the border of area. The models introduced previously are all considered to be memory-less models since the next movement segment has no dependency on the previous movement regarding either speed or direction. This memory-less feature causes frequent sharp change in speed and direction of movement which is obviously not applicable in a

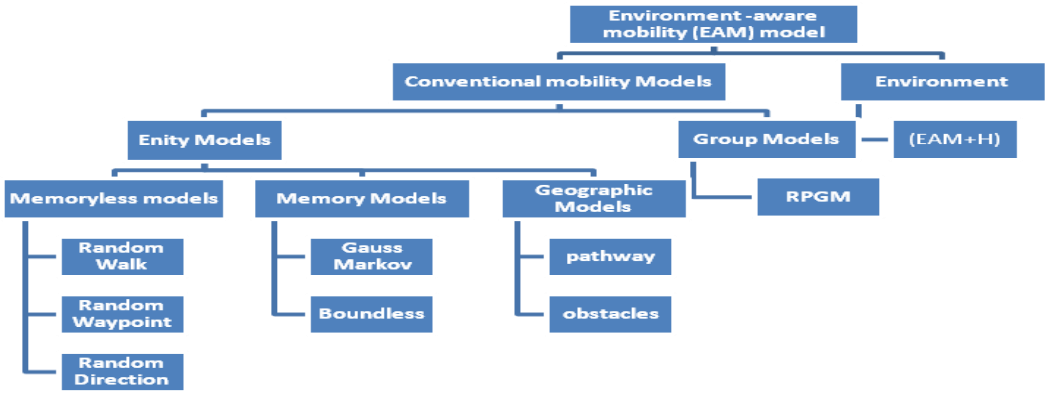


Figure 1: Mobility Models

realistic world. Some memory models are proposed. In Gauss-Markov model, the velocity of the mobile node is assumed to be correlated over time and modeled as a Gauss-Markov stochastic process. The Boundless model [5] is another example of a memory model but with no geographical restriction. Mobile nodes are allowed to cross the boundaries and appear at the other side of the area. The resulting effect is that the simulation area is modeled as a torus instead of a flat area. In ad hoc networks, there are many situations where the movements of mobile nodes have some correlation with each other, i.e. mobile nodes have some group behavior in common.

To present this characteristic, Group Models have been proposed. One typical example is the Reference Point Group Mobility model (RPGM) [7] In RPGM, a logical Centre of a group is defined and its movement is used to direct the group-wide movement. Individual members of the group move not purely on a random basis, their movements are also affected by the group movement. RPGM is popularly used in research to depict some scenarios with group behaviors such as avalanche rescue. Other group models can also be found in [5]. All these models assume that the simulation area is a free space area where mobile nodes can move anywhere inside. They expose the self-organization feature of mobile nodes, but they are not generally applicable and the geographic factors have to be considered. The Pathway models [8] and the Obstacle models [9] partially overcome this disadvantage. The Pathway Model forces each mobile node to move along the shortest path towards its destination. Similar behavior is also modeled in the Freeway mobility model and in the Manhattan mobility model in [10]. The Obstacle mobility model was first introduced in [11]. Unlike the Pathway model, the Obstacle model defines some obstacles in the simulation area. These obstacles have a signal-blocking effect on the communication of mobile nodes. This model also allows the nodes to change this movement trajectory when obstacles are encountered. needs to be constructed before running the simulation. As a conclusion, every model mentioned above has some abilities to model the mobility of mobile node in MANET. They can be applied to particular situations, but none of them is flexible and suitable enough for modeling more realistic scenarios. As a matter of fact, Entity Models and Group Models can co-exist in some scenarios with obstacles. Geographic models support more realistic scenarios than Entity and Group models. Several works have brought the idea of real-world simulation into MANET simulations. The realistic environment in which the network exists The Obstacle model seems to give a good solution for signal-blocking but it leaves entity and group mobility properties unconcerned. Obstacles and Paths are detected but the trajectories to deal with obstacles are simple and not general. Depend on the roles they play in the environment, the mobile nodes can have different mobile characteristics. The fact that environment factors can affect the movement is also overlooked by all of them. By taking the environment into account as illustrated in Fig. 1, EAM model proposed in [2] provides a more general approach to model more realistic ad hoc networks. The EAM model proposed in [2] is designed to model the movement behavior of mobile nodes in the environments of realistic ad hoc networks. By studying the possible environment where MANET is located, different sub-areas within the entire simulation area are abstracted to several environment objects, such as a Route, Junction, Hotspot, etc. Literature reviewed by the author show that performance of ad hoc network protocol is not only influenced by mobility models but also significantly affected by environment objects which are abstracted from real

environment. With the technology advancements, the number of wireless networks is growing. So there will be no surprise if in future MANET will be deployed in a place where already some hotspots are installed in the environment. Availability of these hot spots can significantly affect the performance of the MANET. This paper considers already installed hotspots as a part of environment.

3. EAM⊕H AND ITS SIMULATION

There is a growing interest recently in the convergence of wired networks and wireless access systems and networks. Development in wireless communication technologies and mobile networks has posed various challenges to researchers in the field of performance modeling. These challenges require effective performance evaluation tools, techniques and methodologies to design new protocols and robust solutions before a global and wide-scale integrated broadband infrastructure of convergent multi-service networks can be established towards the next generation of networks with efficient support of a wide range of applications. While describing the mobility pattern of nodes in MANET, we are trying to consider the available wired or wireless network hotspots. The popularity of Mobile Networks is on the rise in turn creating more opportunity for m-services, but all the wired networks cannot be replaced by wireless networks. Therefore while implementation of MANET, we should consider already available network infrastructure to be the part of MANET. In this paper we are proposing a model, where nodes move in a predefined pattern and also consider the preexisting hotspots as a part of MANET environment. To present and validate proposed model, different scenarios are used and simulation is performed using Network Simulator2 (NS-2) [6], particularly popular in ad hoc networking community. Simulations were done for a rectangular area of 600m X 600m with 5 nodes initially.

Simulations were done for following three scenarios:

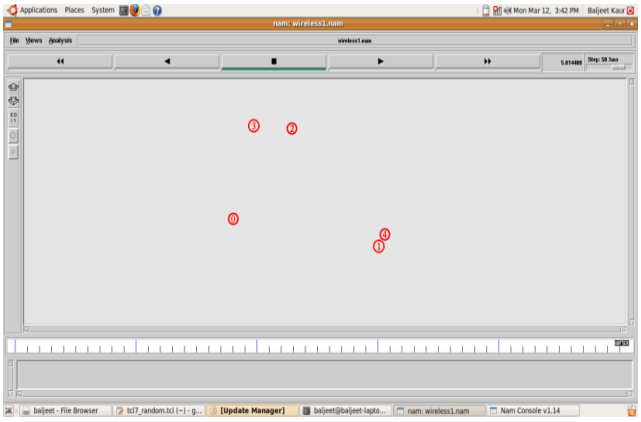
a) Scenario I, where source - destination pairs are spread randomly over the network.

b) Scenario II, where source - destination pairs are moving according to specified Mobility Pattern.

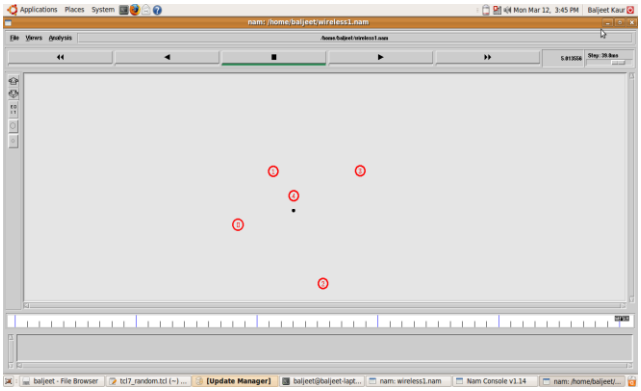
c) Scenario III, where source - destination pairs are moving according to specified Mobility Pattern considering the fixed hotspot as a part of environment.

Snapshot of different Scenarios is as following:

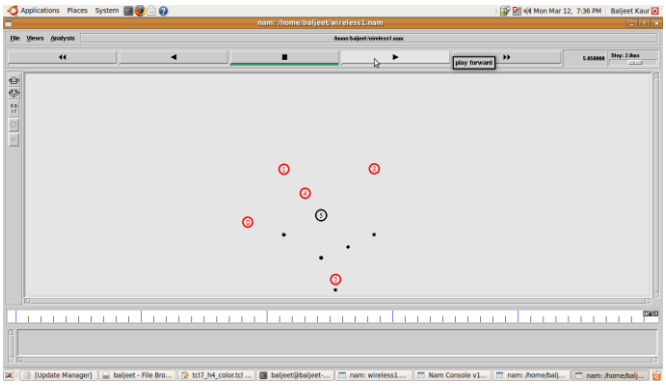
a) Scenario I: All nodes follow a random behavior



b) Scenario II: All nodes follow a predefined Mobility Pattern.



c) Scenario III: All nodes follow a predefined pattern considering the already existing hotspots as a part of environment. [i.e. node 5 is fixed hotspot]



All three scenarios were tested for different number of connections between the nodes. All the scenarios used the following set of TCP connections for communication:

Table 1: Connection Details

SET NO.	Number of Communication Pairs	(TCP)Communication Pairs
1.	2	(0-3).(0-1)
2.	3	(0-3).(0-1),(1-2)

3.	4	(0-3).(0-1),(1-2),(2-3)
4.	5	(0-3).(0-1),(1-2),(2-3)(4-2)

The model parameters that have been used in experiments are summarized in Table 2.

Table 2: simulation Parameters

Parameter	Value
Simulator	NS- 2.34
Protocol Studied	AODV
Simulation Time	5 Sec
Simulation Area	600 X 600
Transmission Range	250 m
Bandwidth	2Mbps
Traffic Type	TCP
Data Payload	1040 bytes

Performance Indices: Packet throughput Ratio is used for evaluation of performance of MANET. Packet throughput Ratio is the ratio of total number of data Packets received.

4. SIMULATION RESULTS AND OBSERVATIONS

The simulation results are shown in the following section in the form of line graphs [Figure 2].

Identifying mobility pattern of mobile nodes allows us to approximate the topology of entire network, but also proposes a way to handle mobility of individual nodes. Finally, identifying such a pattern provides a means to control the random nature of mobile nodes. The information is crucial for guarantying QoS as well. It is clear from the analysis of number of packet received in all three scenarios that, considering random behavior of nodes does not gives actual performance of the network. Performance given by Scenario II (which copies the actual Mobility Pattern of nodes) has large difference from performance given by Scenario I (which considers the random behavior of nodes). By observing the performance of the Scenario III (which consider fixed hotspots as the part of environment), it is clear that already available hotspot nodes in the environment effect the performance of the network. At this point, we can't say that presence of fixed hotspots will improve the performance of network because performance will depend on the positioning of the fixed hotspot in the network.

5. MOBILITY PATTERN AWARE MANET@MGOV

Mobile Governance is at implementation stage in various countries including India. The m-Governance environment need low cost infrastructure which must also provide high quality transmission and constant connectivity. Due to infrastructure less and self-organizing nature of MANET, this network can be used in m-Governance. Emerging wireless technologies are expected to significantly influence design and implementation of MANET in m-Governance environment. As 4G provides the concept of convergence, the future wireless networks will take help of each other to provide anywhere, anytime, anyhow connectivity. Thus many networks can overcome their loopholes by converging and using the services of other networks to solve the constraints of

MANET@MGOV. 4G can be implemented with MANET which results in 4GMANET@MGOV concept [4].

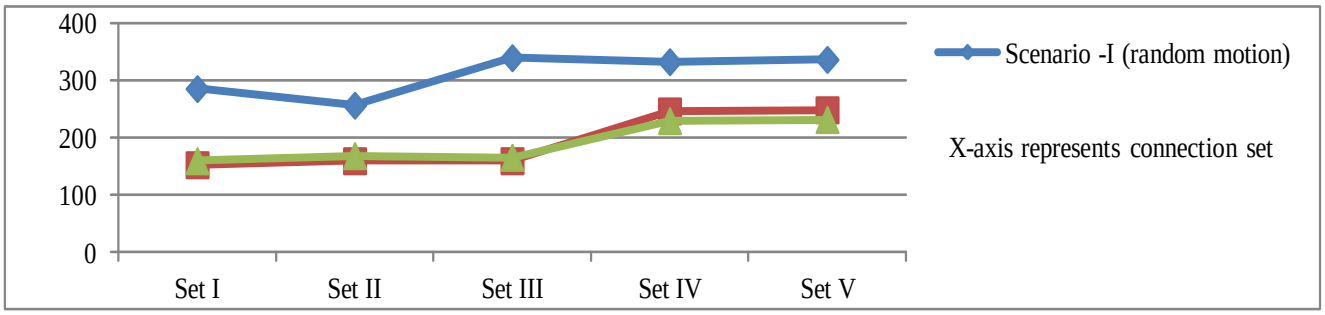


Figure 2: Number of packets received verses number of connections

each other. States like Kerala already have infrastructure to support e-Governance and m-Governance. In Bangalore and Mysore, Wi-Fi hotspots are installed by government to administer traffic and for providing different m-Government services. In future when MANET will be implemented in m-Governance, we cannot ignore the presence of existing infrastructure (i.e. Wi-Fi hotspots or wired network hotspots) cannot be ignored. Before commercializing these networks in m-Governance performance of MANET@MGOV has to be checked considering the presence of already existing hotspots.

6. CONCLUSION

Movements in MANET are highly influenced by both intrinsic characteristics and some properties of environment object. The main purpose of this simulation is to show that performance of ad hoc network protocol is not only influenced by mobility models but also significantly affected by environment objects which are abstracted from real environment. With the advancements in the technology, the number of wireless networks is growing. So there will be no surprise if in future MANET will be deployed in a place where already some hotspots are installed in the environment. Availability of these hotspots can significantly affect the performance of network.

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