

## **Analysis of Mobility Management Schemes & Study on Pointer Forwarding for Wireless Mesh Networks**

**Santosh Amshala, Narayana Rao, Kethavath Narender, G Rama Devi**

**Abstract**— The efficient mobility management schemes based on pointer forwarding for wireless mesh networks (WMNs) with this to reduce the overall network traffic incurred by mobility management and packet delivery. The proposed schemes are per-user-based, i.e., the optimal threshold of the forwarding chain length that minimizes the overall network traffic is dynamically determined for each individual mobile user, based on the user's specific mobility and service patterns. We analyze proposed models based on stochastic Petri nets to evaluate the performance of the proposed schemes. We demonstrate that there exists an optimal threshold of the forwarding chain length, given a set of parameters characterizing the specific mobility and service patterns of a mobile user. We also compare that our schemes yield significantly better performance than schemes that apply a static threshold to all mobile users. A comparative analysis shows that our pointer forwarding schemes outperform routing-based mobility management protocols for WMNs, especially for mobile Internet applications characterized by large traffic asymmetry for which the downlink packet arrival rate is much higher than the uplink packet arrival rate.

**Keywords** – Wireless Sensor Networks, Dynamic Host Configuration, Network Layer,

### **INTRODUCTION I**

Wireless mesh networks are attracted much attention as a quick and cheap solution to offer wide wireless coverage for the last-mile. WMN consists of various types such as gateways, mesh routers, access points (AP) and mesh clients. Gateways are the connection points to the wire-line networks. Mesh clients are the terminals users which have no or limited routing function. Wireless APs are the entities in charge of the wireless access for the mesh clients. Stationary mesh routers form a wireless multi hop backbone with long-range high-speed wireless techniques such as WiMAX. In different models a mesh node can contain one or more functional entities, eg., Mesh routers usually implement AP functionalities. When the mobile clients are stationary, with the support of backbone routing, the wireless access for them can be accomplished within a few hops.

Wireless mesh networks mobility management consists of location management and handoff management [1]. Location management keeps track of the location information of mesh clients, through location registration and location update operations. Handoff management maintains ongoing connections of mesh clients while they are moving around and changing their points of attachment. Mobility management has been studied intensively for cellular networks and mobile IP networks. A large variety of mobility management schemes and protocols have been proposed for these types of networks over the past years.

Comprehensive surveys of mobility management in cellular networks and mobile IP networks can be found [4]. Due to some significant differences in network architecture, however, mobility management schemes proposed for cellular networks and mobile IP networks are generally not appropriate for WMNs. The next generation mobile communications networks will provide multimedia services, e.g., voice and video telephony, high-speed Internet access, mobile computing, etc.. Mobility management [5] for providing seamless multimedia communication is one of the most important engineering issues in such a next generation mobile network. The concept of mobility management includes both handoff and location management. Location management is a basic function to deliver incoming calls appropriately to the called mobile roaming from place to place [6]. The handoff, on which we focus in this paper, is an essential function for permitting users to move from cell to cell with an ongoing call. There are two major engineering issues concerning handoff.

WMNs have been looked upon as an upcoming and promising step towards the goal of ubiquitous broadband wireless access. WMNs are interesting not only in the context of small community networks and neighbourhood networks, but also in the area of enterprise-wide networks or wireless backbone networks that can be established in an ad hoc manner, e.g. in disaster recovery scenarios. QoS is a critical issue especially in the latter two scenarios. Mission-critical applications depend on the

provision of adequate QoS support when deployed in the WMN. Network providers who look at WMNs as a cheap alternative to expand their existing wireless network infrastructure without incurring exorbitant deployment costs also look at WMNs as a viable alternative. In such networks, the providers wish to support the integrated services they already offer on their traditional wireless platforms. These applications such as voice and video over IP need to be provided with carrier-grade QoS support. The current modus operandi towards QoS provisioning in the Internet, namely that of over-provisioning of bandwidth and other resources, is not applicable to WMNs. In particular, due to the broadcast nature of the wireless medium, wireless networks need to deal with the fundamental issue of interference and noise, which is not an issue in wired networks. In contrast to traditional single-hop cellular networks, multi-hop networks such as ad hoc networks and WMNs introduce additional challenging issues, which emphasize the problem of interference, simply due to the fact that a multi-hop route needs more transmissions as compared to a single-hop connection. Thus, bandwidth is a precious resource.

## SECTION II

**2.1. Why we need Mobility in Wireless mesh Networks:** The mobility management [5] provides packet delivery without delay to their destinations and routing protocol is the basic requirement. Mobility management include two schemes i.e. location management and handoff management. Handoff management [7] focuses on rerouting concept while location management routing protocol use location of node for enhancing the performance of routing protocol. In wireless mesh networks, searching of efficient path in wireless mesh routing is still challenging research issue due node mobility. Node mobility has impact on the position of nodes and on neighborhood information which is necessary for communication. Also, it can be easily addressed through multihop routing discovery [8] have analyzed and evaluated impact of node mobility for the performance of mesh wireless networks. Further, they have combined this approach with real life situations like speed calculation of pedestrian. Theus Hossman [9] has concluded that there are two possibilities to model the mobility of the nodes in a simulation. The first is that node trajectories are measured in a real network, for instance, node positions can be measured with a GPS device, and then used as input for driving the simulations. However, this method is desirable because node movement is modeled realistically. The second

possibility is to use mobility model, which maintains set of rules of how nodes behave. But mobility model reflects behavior of nodes only to a certain degree. So, these approaches are not sufficient enough to solve these problems and there is need to model the mobility of nodes in simulation by taking care of above discussed problems.

**2.2. Concepts of Mobility:** Mobility models in mesh networks depict [10] movement pattern of mobile users and how their location, velocity, speed, direction and acceleration change over time. In these networks, mobile nodes communicate directly with each other. Communication between two nodes does not produce effective results if both nodes are not in same transmission range. This problem can be resolve by using intermediate nodes with routing. Thus, routing is very important in wireless mesh networks where mobility models must be evaluated with respect to end to end delay and efficient data transmission.

Mobility models are intended to focus on individual movement patterns due to point to point communication in cellular networks [11] whereas mesh networks are designed for group communication. Such models [12] are suggested to maintain movement, and efficient transmission among nodes in real life applications. In addition to this, these models are mainly focused on the individual motion behavior between mobility era with [11] minimum simulation time in which a mobile node moves with constant speed and direction. These models represent the features of the mobile nodes in an mesh network like speed, direction, distance and node movement. Mobility models can be categorized based on the following criteria which is based on dimension, scale of mobility, randomness, geographical constraints, destination oriented and by changing parameters (discussed in next section). Generally, there are two types of mobility models (i) Trace based mobility models and (ii) Synthetic mobility models. Trace models provide mobility patterns based on deterministic approach whereas synthetic models presents movements of mobile nodes.

**2.3. Mobility Network-Layer Management:** To support the host mobility in the wireless mesh networks.

**2.3.1. Mobile IP** – Mobile IP and IPv6 are the IP mobility management schemes standardized by IETF, each mobile host has a Home Agent. When the

mobile host is on the HA serves as an indirection point to forward data packets for the mobile host and its communication peer. The HA also functions as a location server that maps the mobile hosts home address to its care-of address location, the mapping here is notified to the peer so the data packets will flow directly between the mobile host and the peer directly.

**2.3.2. HAWAII and Cellular IP:** The problem of mobile IP is the each local movement of the mobile host however small it is triggers global signaling messages to the HA instead of using a macro-mobility management protocol such as mobile IP for each local movement a protocol that localizes mobility signaling messages is more preferable to handle local movements in a wireless mesh networks domain. Two such micro-mobility solutions are cellular IP and HAWAII

**2.3.3. SMesh and iMesh:** SMesh presents a transparent wireless mesh system that offers seamless handover to support VoIP and other real time applications for any unmodified WiFi devices. Seamless handover is achieved by having a group of WiFi access points called client data group in serve each mobile host. This group of access points multicasts traffic to the mobile host during handover transitions which cuts the handover latency to zero at the cost of higher bandwidth use. SMesh is that it requires all the access points to work on the same channel therefore the mobile host can talk to multiple access points simultaneously includes a great cost and the access points can otherwise work on non-interfering channels to significantly increase the access capacity of the wireless mesh network. iMesh adopts an adhoc routing based solutions main drawback is that the routing table size in the mesh routers increases linearly with the number of mobile hosts.

### SECTION III

**3. Problem Domain:** When we are calling to international number, every time it creates the mobile IP is Dynamic Host configuration Routing Protocol in wireless mobility management. The mobile IP provides internet access services for the mobile user and does provide a simple and scalable solution to user mobility, users with high mobility cause a excessive signaling traffic and latency. To avoid the signaling delay and mean bandwidth per call according to the of mobility our work outperforms the DHMIP and MIP strategies.

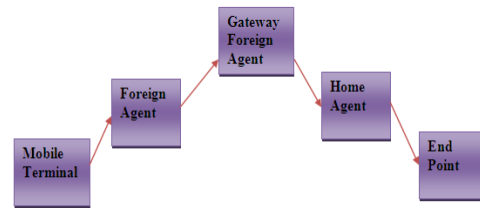


Figure 1 represents the Architecture of Dynamic Host Configuration.

### 3.1. Performance Schemes of Mobility Pointer forwarding in Wireless Mesh Networks:

**3.1.1. MIP:** In the MIP protocol, Mobile Terminal (MT) registers with its home network from which it gets a permanent address (home address). This address is stored in the Home Agent (HA). It is used for identification and routing purpose. If MT moves outside the home network visiting a foreign network, it maintains its home address and obtains a new one from the Foreign Agent (FA). This Foreign address is called Care-of-Address (CoA). To allow continuity of ongoing communications between the MT and a remote end point, the MT shall inform the HA of its current location when it moves outside the home network. The HA delivers to MT the intercepted packets by tunneling them to the MT's current point of attachment.

**3.1.2. DHMIP Approach:** The DHMIP approach has been proposed to reduce the location update messages to the HA by registering the new CoA to the previous FA and building a hierarchy of FAs. Hence, the user's packets are intercepted and tunneled along the FAs hierarchy to the MT. The hierarchy level numbers are dynamically adjusted based on mobile user's mobility and traffic load information

**3.1.3. Multicast-based Mobility Approaches:** Another alternative that reduce the signaling load in Mobile IP network is to use a multicast-based mobility approaches. These approaches have been proposed to reduce the mobility signaling delay by setting a multicast group. The MTs address update processes are concentrated into the multicast network nodes. Hence, MHMIP mobility approach is proposed to reduce the signaling delay using multicast groups

**3.1.4. Multicast Hierarchical Mobile IP:** In this approach, we propose to build hierarchical multicast groups. In each group, FAs are connected

to each other through a GFA. A set of GFAs are connected to an HA. When an MT moves through FAs belonging to the same group, the GFA of this group multicasts the received packet (coming from the HA) to the MT. When the MT moves outside a group, the new CoA is registered to the GFA of the new group to which the MT is currently belonging. This GFA sends this CoA to the HA. This latest tunnels the packet to the new GFA which will multicast the received packets within the new FAs group. This approach reduces the frequency of the location update to the HA.

#### SECTION IV

**4.1. Proposed System Analysis:** Wireless mesh network consists of two types of nodes: mesh routers (MRs) and mesh clients (MCs). MRs are usually static and form the wireless mesh backbone of WMNs. Some MRs also serve as wireless access points (WAPs) for MCs. One or more MRs are connected to the Internet and responsible for relaying Internet traffic to and from a WMN, and such MRs are commonly referred to as gateways. In this paper, assume that a single gateway exists in a WMN. The central location database resides in the gateway. For each MC roaming around in a WMN, an entry exists in the location database for storing the location information of the MC, i.e., the address of its anchor MR (AMR). The AMR of an MC is the head of its forwarding chain. With the address of an MC's AMR, the MC can be reached by following the forwarding chain. Data packets sent to an MC will be routed to its current AMR first, which then forwards them to the MC by following the forwarding chain. Packet delivery in the proposed schemes simply rely on the routing

protocol used. The concept of pointer forwarding [12] comes from mobility management schemes proposed for cellular networks. The idea behind pointer forwarding is minimizing the overall network signaling cost incurred by mobility management operations by reducing the number of expensive location update events. A location update event means sending to the gateway a location update message informing it to update the location database. With pointer forwarding, a location handoff simply involves setting up a forwarding pointer between two neighboring MRs without having to trigger a location update event.

The forwarding chain length of an MC significantly affects the network traffic cost incurred by the mobility management and packet delivery, with respect to the MC. The longer the forwarding chain,

the lower rate the location update event, thus the smaller the signaling overhead. However, a long forwarding chain will increase the packet delivery cost because packets have to travel a long distance to reach the destination. Therefore, there exists a trade-off between the signaling cost incurred by mobility management versus the service cost incurred by packet delivery. Consequently, there exists an optimal threshold of the forwarding chain length for each MC. In the proposed schemes, this optimal threshold denoted by  $K$  is determined for each individual MC dynamically, based on the MC's specific mobility and service patterns. We use a parameter named as the service to mobility ratio (SMR) of each MC to depict the MC's mobility and service patterns. For an MC with an average packet arrival rate denoted by  $\lambda_p$  and mobility rate denoted by  $\lambda$ , its SMR is formally defined as  $SMR = \frac{\lambda_p}{\lambda}$

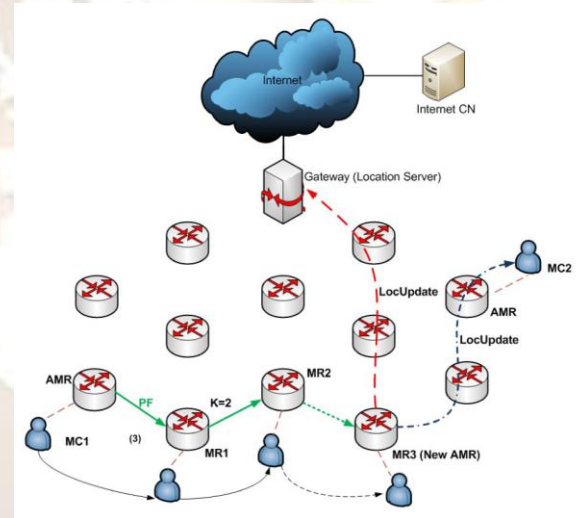


Figure 2: Pointer Forwarding Schemes

The traffic between MRs and the gateway, dominates peer-to-peer traffic in WMNs because WMNs are expected to be a low cost solution for providing last-mile broadband Internet access. Thus, we assume that for any MC, the Internet session arrival rate is higher than the Intranet session arrival rate, and the average duration of Internet sessions is longer than that of Intranet sessions. We use a parameter  $\gamma$  to signify the first assumption, and another parameter  $\delta$  to signify the second assumption. More specifically  $\gamma$  denotes the ratio of the Internet session arrival rate to the Intranet session arrival rate, and  $\delta$  denotes the ratio of the average duration of Internet sessions to the average duration of Intranet sessions.

**4.2. Comparative Study:** The mobile IP can provide continuous Internet access services for the mobile user and does provide a simple and scalable solution to user mobility. Yet, mobile IP is not a good solution for users with high mobility because it may cause excessive signaling traffic and long latency. The hierarchical mobile IP (HMIP) protocol was proposed to employ the hierarchy of foreign agents (FAs) and the gateway FAs (GFAs) to reduce the number of registration operations and to reduce the signaling latency. However, since user mobility characteristics and network traffic load are always in changing, the centralized and pre-planned network topology of HMIP would become invalid or even lead more signaling cost if no adjustment to be adopted. This paper introduces a novel distributed and dynamic mobility management strategy for mobile IP where the signaling burden is evenly distributed and the regional network boundary is dynamically adjusted according to the real-time measurement of handover strength or traffic load in the networks.

Hence, we propose an analytic model to evaluate the mean signaling delay and the mean bandwidth per call according to the type of MT mobility. In our analysis, the MHMIP outperforms the DHMIP and MIP strategies in almost all the studied cases. The main contribution of this paper is the analytic model that allows the mobility management approaches performance evaluation.

## CONCLUSION V

In our work the two mobility management schemes based on pointer forwarding for wireless mesh networks, namely, the static anchor scheme and dynamic anchor scheme. The proposed schemes are per-user-based, in that the optimal threshold of the forwarding chain length that minimizes the total communication cost is dynamically determined for each individual MC, based on the MC's specific mobility and service patterns characterized by SMR. We analyze analytical models based on stochastic Petri nets to evaluate the performance of the proposed schemes. We also compare the proposed schemes with existing baseline schemes and with the WMM scheme. our schemes perform significantly better than the baseline schemes, especially when SMR is small and 3) the dynamic anchor scheme is superior to the WMM scheme when the network traffic is dominated by mobile Internet applications characterized by large traffic asymmetry for which the downlink packet arrival rate is much higher than the uplink packet arrival rate. We extend our plan to investigate how our proposed schemes can be

extended to WMNs that have multiple gateways. In addition, we plan to investigate the proposed schemes under more realistic mobility models other than the random walk model. We will also investigate how caching of location information of MCs can be used to reduce the signaling cost incurred by our proposed schemes.

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