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# Emerging Wireless LAN Mobility Protocols

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# 30. EMERGING WIRELESS LAN MOBILITY PROTOCOLS

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## *Abstract*

Wireless LANs have become the dominant device over the last few years. The initial goal was to remove cables from the network, but with the fast pace in technological development wireless networks became popular not only inside organizations, but also as hotspots throughout cities. Major governments are encouraging the institutes to deploy wireless LANs due to the increase in number of Internet users and online applications. Over the past few years, wireless LANs have grown tremendously from a small network to the enterprise level, installed across buildings and organizations to provide mobility. In addition, the mobility and convenience of wireless has been improved by the advanced throughput and range performance available in today's products, extending the reach of wireless LANs to a broad array of applications. This has led researchers to work on protocols which provide smooth mobility to the mobile nodes. It has opened the door to develop protocols which can be used to provide mobility within an organization and between organizations. This paper discusses the existing mobility architecture and reviews some of the emerging wireless mobility protocols—specifically host-based and network-based mobility—with a focus on local and global mobility. It also serves as part of the ongoing research for the PhD program in the department of Computer Science at the Universiti Teknologi Malaysia.

## 1. Introduction

The demand for 802.11 wireless local area networks (WLANs) continues to grow at a rapid pace. Many organizations have opted for the technology simply because of expansion, ease of installation and integration with the existing wired network. Wireless networks support user demand for mobility and connectivity at all times, even during movement from one point to another. Mobility allows users to maintain their communication regardless of their physical location. Mobile users extend their reach by using wireless networks anywhere, whether in the office, at home, at hotspots or while traveling. The use of wireless networks has also initiated the demand for many Internet based services to function over 802.11 networks. These services include email, web browsing, audio streaming, video streaming and voice over IP (VoIP). Most of these services require seamless connection to the network and demand bandwidth, because real-time applications are time sensitive. However wireless networks pose many challenges to network administrators and require some new approaches to tackle mobility, efficiency and the protocols used to change the point of attachment. When the Internet's architecture was designed, the main concentration was on stationary nodes in a local area network, because at the time wireless communication was uncommon (Saltzer, Reed, & Clark, 1984). However, with the advancement of technology, wireless communication has become common, as well as a necessity for some users. The advancements have also led to increased demand for those services which are implemented on a fixed-node network to be implemented on a wireless network. This paper aims to describe and critique the existing mobility architecture. It reviews and draws conclusions about two methods of Internet mobility: host-based and network-based.

# 2. Wireless LAN overview

WLANs provide flexibility to users through the use of radio waves instead of wires to carry data from one point to other. WLAN was originally standardized by the IEEE 802 LAN/MAN committee in 1980 (IEEE 802 LAN/MAN Standard Committee). A wireless commercial standard was introduced by 802 projects and was called 802.11b; this standard provides an 11 Mbps data rate to mobile users. The standard was developed to utilize the Industry, Scientific and Medical (ISM) band at 2.4 GHz shared medium. In this standard, since there is no control over network attachment, the total capacity of the medium is shared among users and decreases as the number of users increases, thus providing lower data rates. However, WLANs are able to switch data rates dynamically as users attach and detach; they also have the ability to switch speed based on the signal strength.

## 2.1. Wireless LAN Topologies

WLANs are designed for flexibility and availability; they are composed of a mobile node or station which consists of a wireless network card and software installed to work with the WLAN. The Access Point (AP) a special type of device which acts as a bridge between the mobile station and the network. Wireless standards define two types of topologies, infrastructure and ad-hoc. The simplest setup is ad-hoc, which is also called an Independent Basic Service Set (IBSS); in which all MNs communicate with each other as peer to peer, with no AP present between them, as shown in Figure 1: Independent Basic Service Set (IBSS) or Ad-Hoc

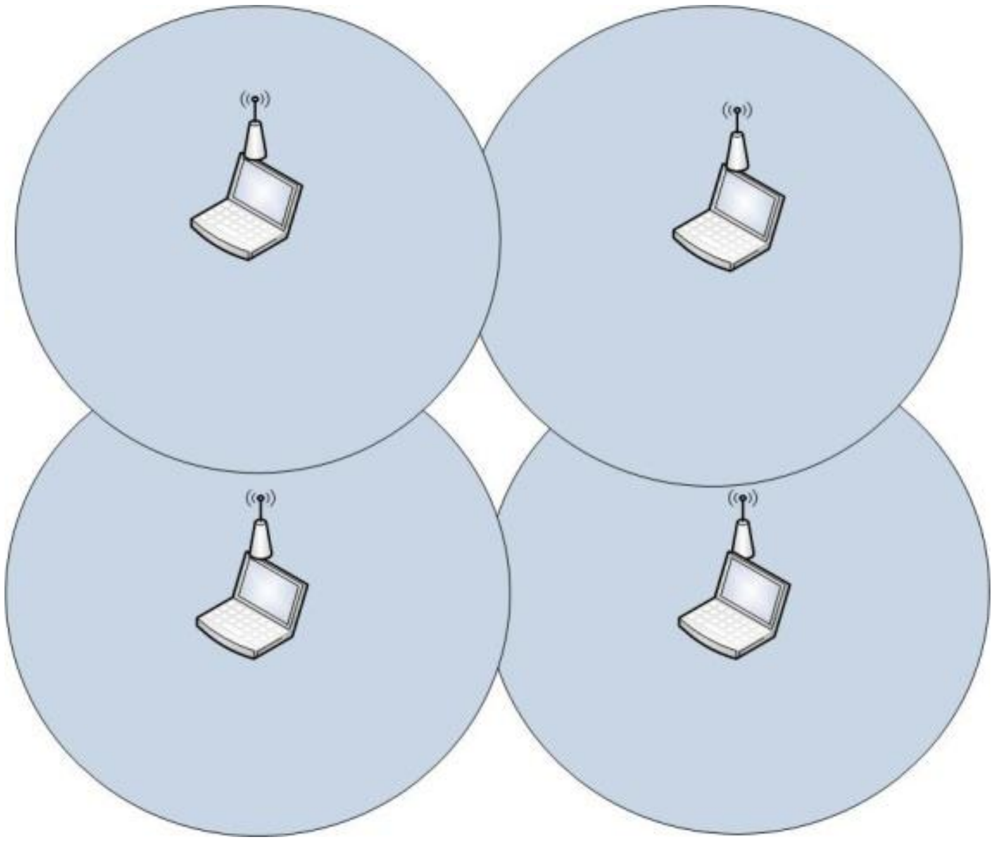

**Figure 1:** Independent Basic Service Set (IBSS) or Ad-Hoc

The Basic Service Set (BSS) is the foundation of the Infrastructure mode, in which there is at least one AP connected to the wired network and all MNs are connected to the AP access network services through this AP, as shown in Figure 2: **Basic Service Set (BSS)**

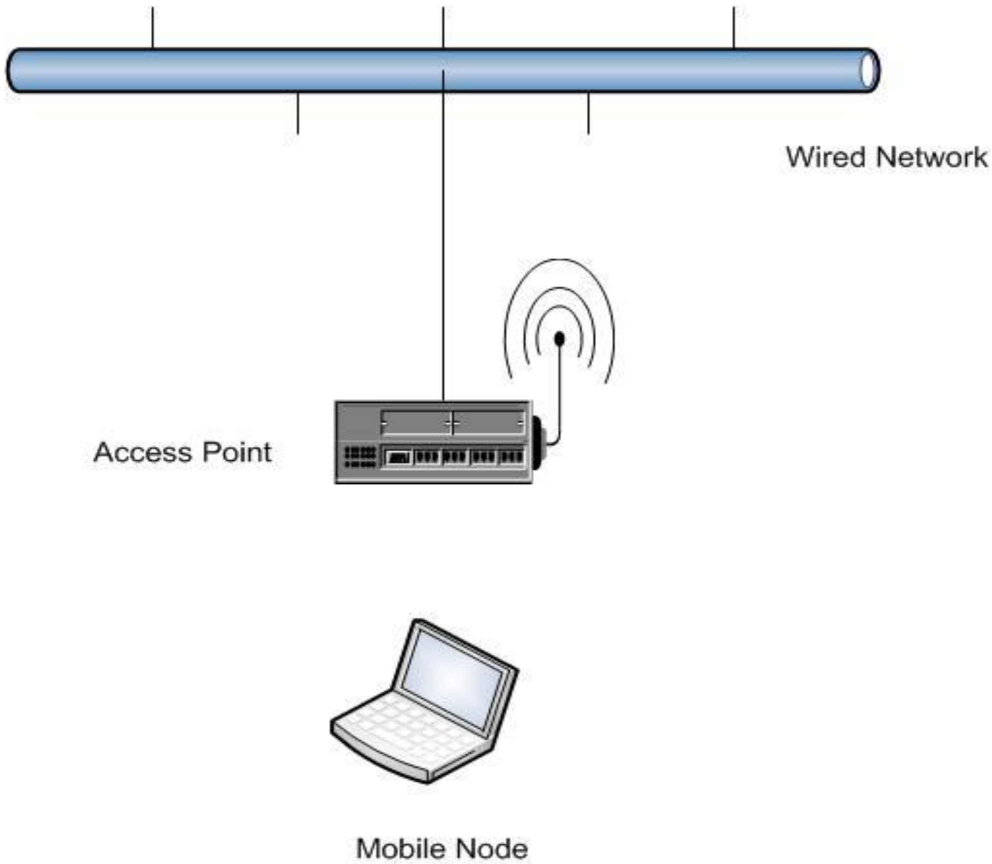


**Figure 2:** Basic Service Set (BSS)

As mentioned before, wireless is a shared medium and it has a tendency to degrade data rates based on the number of users and signal strength; a network can deploy an Extended Service Set (ESS) in which more than one AP is connected to the wired network. This provides coverage of large areas and roaming between access points. This topology demonstrates connecting multiple BSS to a wired network. A user moves within the BSS and between BSS to perform mobility. This setup also provides users with adequate signal strength and load when the number of users increases, as shown in Figure 3: **Extended Service Set (ESS)**

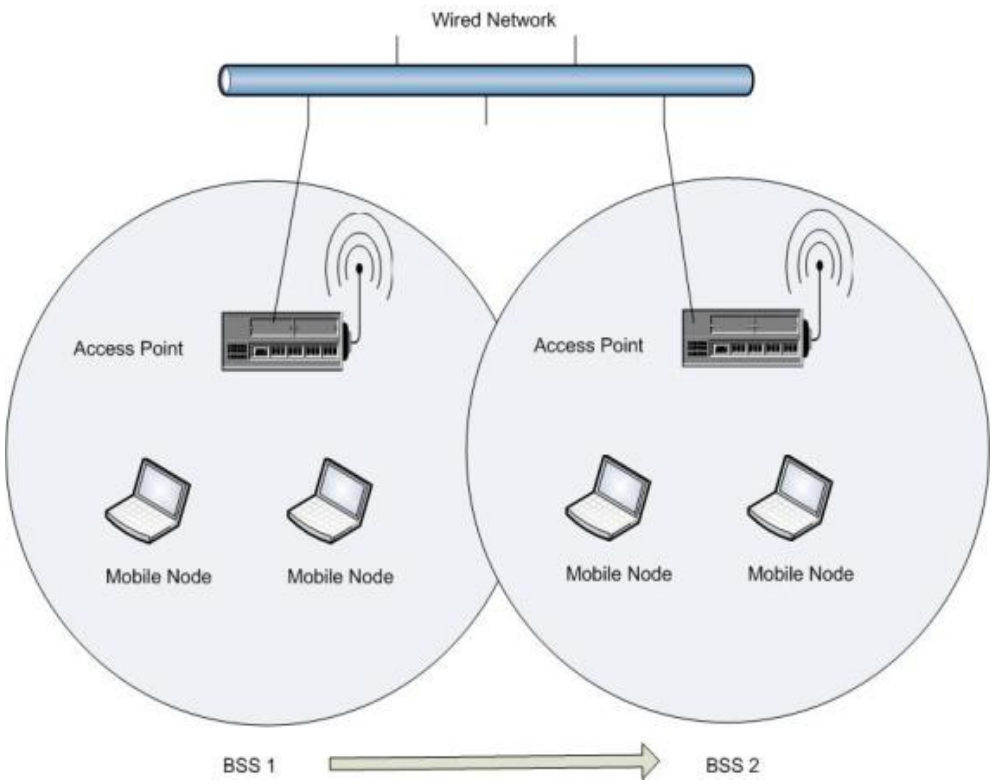


**Figure 3:** Extended Service Set (ESS)

When users roam between BSS, they will find an AP and attempt to connect based on the signal strength available. ESS introduces the possibility of forwarding MN traffic from one BSS to another though a wired network by providing minimum disruption; this is because both APs are connected to the same wired network or a network switch. This introduces the concept of mobility, in which a MN moves or changes its point of attachment between APs connected to different networks.

To achieve successful mobility, a MN must perform Layer 2 (L2) and Layer 3 (L3) functions. L2 mainly depends on MAC address exchange between MN and AP. L3 depends on changing the IP address of the MN; however, L3 cannot be processed until the L2 process is finished successfully (Koodli & Perkins, 2007). Since the L2 process is hardware dependent, it is mainly controlled by the manufacturer of the wireless network interface card (WNIC) and the driver; it may also depend on the signal strength or other environmental conditions. A passive scanning process at the WNIC driver level helps MN find APs within the range and switch to a certain AP when required. However, the process of L3 switchover requires IP change and infrastructure participation and configuration. This involves network devices to send signals to other devices when the MN moves (between old and new networks?). These devices are called access routers, and are connected through a common network; thus they are able to send MN information. To cater to mobility, the concept of the mobile IP protocol was standardized by IETF (Perkins, 1996).

## 2.2. Mobile IP

Mobile IP is a protocol originally designed for stationary nodes to allow communication with the home network while in a visiting network, also called a foreign network. Mobile IP allows data transmission to reach a node with the same IP address even within a foreign network. Mobile IP has four components to perform mobility successfully. A home agent (HA) is a router at the home network which maintains the current information about the node and forward packets to the foreign network. The packets are forwarded from the nodes' permanent IP address, called the home address (HoA) to the temporary IP address called the "care of" address (CoA) at the foreign network. The CoA is obtained in the foreign network by sending a signal to the router in that network, called a foreign agent (FA), as shown in Fig 4.

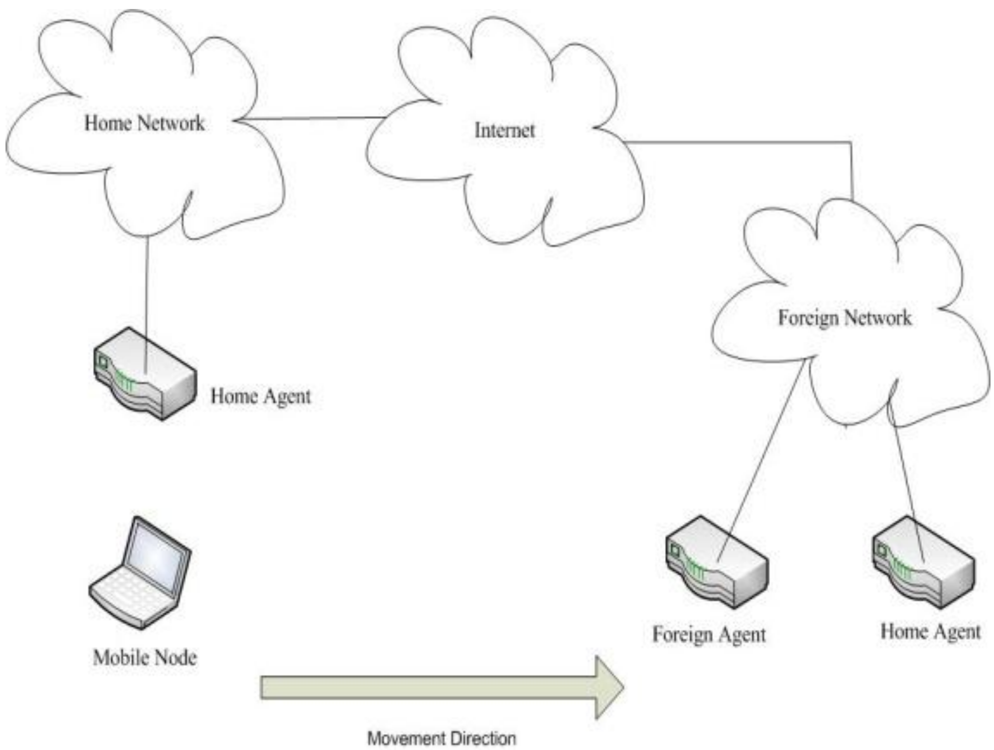


**Figure 4:** Mobility Process

Mobile IP is not a wireless protocol; however, it can be used conceptually with other protocols to support mobility. The mobile IP working group in IETF has standardized other mobility related protocols. These protocols can be classified as host-based and network based mobility protocols.

# 3. Host-Based Mobility Management

A host-based mobility protocol is designed to provide mobility support to the MN, but requires changes in the IP stack of the MN. Most of the efforts are made by the MN to detect a new network, request a CoA and send information about the CoA to the HA. Mobile IP has been standardized by the IETF since 1996; however, it was a concept intended to provide mobility to existing protocols such as IPV4.

Mobile IPv4 (Perkins, 2002) is an additional component for IPv4 installed on the MN to provide mobility support; it has all four functional components discussed in the mobile IP section. However, with the growth of the Internet and the number of nodes accessing the Internet, IPv4 reached a saturation level of IP addresses because of 32-bit address size (Geoff, 2007). Therefore before true mobility could be achieved, the IPv6 protocol (Deering & Hinden, 1998) was introduced by IETF. IPv6 follows Internet hierarchy for address space and is 128 bits long, to provide enough IP addresses for future use and also provide backward compatibility to IPv4 with additional configuration on the access routers.

Mobile IPv6 (Johnson, Perkins, & Jari, 2004) is an extension in the header of the IPv6 protocol to provide mobility support to IPv6 MNs. MIPv6 is probably the most well-known protocol supporting mobility. It addresses many issues inherent in MIPv4 such as delays, routing, and address space restrictions. Although MIPv6 was, at one time, the savior for mobility problems, it now faces a few issues such as handover latency, packet loss, update latency, and signaling overhead. Much research is devoted to resolving these issues and a few extensions to MIPv6 were designed to reduce handover latency—for example, hierarchical mobile IPv6 (Soliman, Castelluccia, El Malki, & Bellier, 2005) and fast handover for mobile IPv6 (Koodli R. , 2005). Implementing these extensions somehow reduces the handover latency for the mobile node, but is still not suitable for real-time applications such as VoIP, streaming audio, and video. Many of these applications require constant connectivity and depend on L3 IP addresses; therefore vendors did not implement the protocol widely because it requires the host stack to be modified. This could complicate the operating system, and may generate more signals and consume more battery power.

# 4. Network-Based Mobility

Network-based mobility was introduced recently by a working group in IETF called Network based Localized Mobility Management (NeTLMM); the task of this group is to design a protocol which provides mobility to nodes without any stack modification. NeTLMM is working (Kempf, "Goals for Network-Based Localized Mobility Management (NETLMM)," 2007), (Kempf, "Problem Statement for Network-Based Localized Mobility Management (NETLMM)," 2007) toward providing the following:

- No stack modification in MNs: The NeTLMM protocol should support unmodified nodes for mobility; therefore, no software modification is required
- Fewer signaling exchanges: There should be a minimal number of signaling exchanges by the NeTLMM protocol and MN should not participate in the signaling exchange
- Fast handover process: The MN should be able to switch between networks without any disruption in the connection
- Wireless resources usage: The NeTLMM protocol should use fewer wireless resources by avoiding tunneling between MN and HA or vice versa

- IPv4 and IPv6 support: The NeTLMM protocol should support IPv4 and IPv6 hosts. Although the main design is based on IPv6, IPv4 should be supported in the future

Based on the requirements discussed above, the NeTLMM working group has standardized a localized mobility protocol called Proxy Mobile Internet Protocol Version 6 (PMIPv6) (Gundavelli, Leung, Devarapalli, Chowdhury, & Patil, 2008). It is a network-based mobility protocol in which most of the signaling process is carried by the network devices rather than MN. Basic signaling concepts (such as HA and AR) for PMIPv6 have been extended from MIPv6. The functional entities of PMIPv6 are the mobile access gateway (MAG) and the local mobility anchor (LMA). The function of a mobile access gateway is similar to that of AR; it detects the MN's movement and initiates the signaling required, performing handover by establishing a tunnel with a local mobility anchor. The function of the local mobility anchor is similar to HA in MIPv6: it provides the addresses by binding updates and maintaining "reachability" to the MN.

# 5. Discussion

Due to the growth in the Internet and wireless technologies, many vendors have started to produce their own proprietary protocols to support mobility. The idea of using proprietary protocols is to maintain pace with the growth in the market; this has led to development of products which do not run standard protocols and thus are not compatible with each other. Some vendors have introduced WLAN switches to provide mobility at L2 to the MNs, but they are not compatible with other protocols. However the advantage of such protocols is to allow seamless handover within the same network domain. The goal of introducing network-based mobility is to allow multiple vendors to share the same protocol and provide mobility support.

# 6. Conclusion

Mobile Internet users demand all-the-time connectivity, even when they move from one network to another, which requires constant communication with the network devices. Mobility is possible using IPv4; however, the growing number of Internet users means that IPv4 is not the best choice because it cannot cope with the rapid growth and does not have all of the required physical and logical structures. In contrast, IPv6 seems to be able to address many IPv4 mobility issues. Both of these protocols have variants to provide mobility, such as MIPv4 and MIPv6. However, handover latency is an issue common to Internet mobility, and both IPv4 and IPv6 are facing it as a major challenge. Handover latency is the result of the time required to execute the handover algorithm. For example, in host-based mobility, each MN is tracked by it's HA. When an MN moves to a new network, a new IP address (CoA) will be provided. This process is common in both MIPv4 and MIPv6; however, to reduce signaling processes, MIPv6 does not have FA. Network-based mobility is working toward support of unmodified MNs, handover latency reduction, wireless resource usage, and IPv4 (Wakikawa & Gundavelli, 2008) and IPv6 (Giaretta, 2008) support, which has been standardized as a PMIPv6 protocol. However, to achieve true global mobility it is necessary to have both host-based and network-based protocols work together.

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