Chapter 16
Impact of Cross-Layer Adaptations of Mobile IP on IEEE 802.11 Networks on Video Streaming

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ABSTRACT
The OSI network layer model provides a strictly separated stacked architecture to abstract the behavior of one layer from the other. Although this model has a lot of advantages, it also makes it easy to lose the bigger picture. In this paper, the authors describe the advantages that can be made by cross-layering the link layer and networking layer to optimize handovers. The performance gain of these cross-layer adaptations will be analyzed using a simulation scenario and compared to the results from a real-life video streaming test. The authors will show that the performance gain in network parameters cannot be directly mapped on the gain of the video quality.

INTRODUCTION
IEEE 802.11 (Committee, 1997, 1999a, 1999b, 2001) networks are becoming the de facto wireless networks in home and office environments and even outdoor coverage by operator managed hotspots are becoming more popular. On the other hand, devices equipped with 802.11 network cards are not only portable, but small enough to be fully mobile. Such devices are no longer only statically used where access is available, but users tend to move while being connected to the network. Being mobile, the user will change his/her point of attachment and in doing so, the assigned IP address will change. This would cause a service disruption, as a change in IP address will break active network sessions. This is where Mobile IP (MIP) (Perkins, 1998; Perkins, 2005) comes into play. MIP is developed to ensure that an active connection will be unaware of a change in IP address.

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Various scenarios can be constructed which require a Mobile IP enabled IEEE 802.11 foreign network. The most straightforward way of implementing this would be an IEEE 802.11 access network with a distribution system in which one Foreign Agent (FA) resides. This is illustrated in Figure 1, which would be the typical architecture for corporate deployed wireless access networks or ISP deployed hotspot networks. Within these types of networks, an L2 handover between two access points (APs) occurs more frequently without the need of an L3 handover. Only when leaving one distribution system and the associated IP subnet and joining another one, a Mobile IP handover is performed. In case of the ISP (Internet Service Provider) hotspot networks, this would for example occur when changing from one provider to another or when hotspots are clustered within larger subnets and a user leaves one such cluster and enters another one.

In smaller environments, like residential or SOHO networks, the networking architecture is likely to be reduced to only one device: the access router. This device provides a wireless and wired access network, building the distribution system, and functions as a router and gateway to the provider’s network. An architecture as illustrated in Figure 2 would be more than likely in these types of networks in order to support mobility. Each handover is a combined IEEE 802.11 /Mobile IP handover and the FA functionality is combined with the AP and router functionality of the access router. Home Agent (HA) functions could also be implemented on this same device or a central server could exist. When we consider mobile users moving through a city, multiple combined handovers are now likely to occur. With popular large scale deployments of shared home networks, like FON (n.d.), mobility enhancements would guarantee continuous access and connectivity over large areas. The combination of MIP on top of IEEE 802.11 networks does however not offer the expected quality of experience as expected. As we will explain in the next section, a handover can be realized, but will still introduce a service disruption.

**MOBILE IP ON TOP OF IEEE 802.11**

In Figure 3 the various stages of a combined L2/L3 handover process are shown. A handover starts with an \textit{L2 movement detection phase}(a). This is the time needed for a station (STA) to react on...