Mobile-Controlled Handover in Wireless LANs

Attila Weyland Günther Stattenberger Torsten Braun

{weyland | stattenb | braun}@iam.unibe.ch

Department of Computer Networks and Distributed Systems, Institute of Computer Science and Applied Mathematics, University of Berne, Neubrückstr. 10, CH-3012 Bern

While the wireless LAN technology spreads more widely, available Mobile IP implementations do not yet handle handovers satisfactorily. The design of Mobile IPv4 is restricted by the abilities of IPv4 and leaves a lot of room for improvements. Especially the reduction of the handover latency is a topic widely discussed. For applications relying on QoS, the well timed transfer of network management information (i.e. flow descriptors) to the new point of attachment is very important. This can only be guaranteed, if control over the link layer handover process is provided to these applications.

Only a few of the proposed solutions implement inter-layer communication, most of them define rather complex extensions to the mobility support in IPv4 and IPv6 (as in [4], [3], [1] and [2]). Unfortunately, when used in a proposal, link layer triggers are not specified in detail. Also, most solutions add additional administrative overhead or put short high peak load on the wireless network, which still is short of bandwidth.

The need to rely on link layer information to allow certain means of synchronization between the handover processes of the link and the network layer is understood. The most obvious parameters that influence the wireless LAN hardware's behavior are indicators of the signal quality. These quality parameters are usually provided by the driver of the wireless LAN hardware and can be gathered easily. This leads to the main idea to continuously monitor the signal quality and, upon exceeding or falling below certain thresholds, alert concerned applications. With these abilities a mobile node can control the handover process and perform fast handovers. By taking over control, a mobile node is also responsible to conduct the handover by itself. Therefore, parts of the hardware's functionality need to be transfered to the implementation of our concept.

The resulting first step has been to determine and validate the Signal-to-Noise Ratio thresholds used by wireless PCMCIA cards to initiate a layer 2 handover (the Cell Search threshold). As no standard thresholds have been prescribed each manufacturer uses its own values. Depending on the configured density of APs in the wireless network we measured the corresponding thresholds (Low = 10.5 dB, Medium = 23.5 dB, High = 30.5 dB). The wireless equipment used in the tests is manufactured by Lucent and available documentation allowed the verification of the obtained results.

The operational design of our approach is based on a program which provides services to entities in need for them. This allows other programs (service users) to directly supervise the handover process and immediately obtain the results. The service user sends a list of available wireless cells (i.e. ESSIDs) to the service program. The service program itself resides on the MN and constantly monitors the signal quality of its current

wireless link. It reacts upon a change of these values (e.g. falling below a threshold) and alerts the affected service user. The service user in turn orders the search for potential new links. The service program queries the surrounding APs by their provided ESSIDs and sends the results to the service user. Next the service user can dispose the change to the new location (i.e. the handover) with a certain delay. Having performed the change, the service program informs the service user about the results. It then continues to monitor the link quality, waiting for it to fall again below the threshold. The service user can send a new list of wireless cells to the service program at any time to adjust to a changing environment.

The proposed concept has been implemented under Linux in C++. Two daemons are responsible for monitoring the signal quality and interacting with the service user. The handover times have been evaluated and are currently being optimized.

Giving the service user the possibility to delay the handover, enables him to execute all necessary network management functions for a fast handover. Furthermore, other entities, which do not reside on the mobile node itself, can take advantage of the provided handover control. An example would be a smooth handover procedure which involves buffering mechanisms at the mobile node's current point of attachment.

This approach provides the necessary instruments to monitor and control the handover process without adding new extensions to the already existing Mobile IP standard. Instead it uses what already exists, the quality parameters of the wireless link and the wireless LAN hardware's specification. By providing this functionality we allow the convenient usage of QoS in mobile networks.

References

[1] Andrea De Carolis et al. *QoS-Aware handover for Mobile IP: Secondary Home Agent*. Internet-Draft, IETF Mobile IP Working Group, April 2001.

[2] Gopal Dommety et al. *Fast Handovers for Mobile IPv6*. Internet-Draft, IETF Mobile IP Working Group, July 2001.

[3] Karim El Malki et al. *Low Latency Handoff in Mobile IPv4*. Internet-Draft, IETF Mobile IP Working Group, October 2001.

[4] Charles E. Perkins and Kuang-Yeh Wang. *Optimized Smooth Handoffs in Mobile IP*. Proceedings of the Fourth IEEE Symposium on Computers and Communications, July 1999.