Cost Analysis of Paging in IP Micro-Mobility Networks

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Wireless mobile communication networks need more signaling to maintain routing state than traditional wired networks. As a trivial solution, maintenance of routing state can be provided by continuous location tracking of mobile hosts. In this case mobile hosts update their location each time they move to a new base station. However, there can be extended periods of time when a mobile host has neither incoming nor outgoing traffic. During that time it is not essential for the network to know the mobile host's exact location. Since location updating consumes bandwidth and battery power, mobility related signaling should be minimized.

If a mobile host does not update its location at every new base station, the amount of signaling is decreased. On the other hand, in this case the network has to search for the mobile host when it has incoming traffic. To find the host, a group of base stations broadcasts special *paging* messages over the air interface. If the host receives one of these messages, it updates its location information by answering the paging message. By combining continuous location tracking and paging, mobility related signaling can be effectively decreased.

In this paper we investigate how the number of paging and location update messages can be minimized by controlling a mobile host's transitions between active and inactive states. In this discussion active state corresponds to the time periods where a mobile host updates the network at every movement and inactive state refers to the period where its location is only approximately known. We define *mobility cost* as an abstract value which corresponds to the cost of mobility related signaling messages. Using a combination of analytical tools and simulation methods we analyse how mobility costs depend on key system parameters, such as the size of radio cells and paging areas, the speed of mobile hosts, the rules that govern a mobile host's transitions between active and inactive states and the packet arrival process.

Our first observation is that mobility cost is practically independent of the exact shape of the packet arrival process. We find that it depends only on the mean packet inter-arrival time. This allows the paging process to be adjusted according to the traffic pattern without cumbersome measurements. Finally, we present an adaptive algorithm that adjusts tunable parameters based on measurements of the mean packet inter-arrival time.