Pattern Recognition and Prediction of Macro Mobility for Intelligent Quality of Service in Broadband Mobile Networks

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Efficient control of current and future mobile networks is a necessary requirement for the successful competitive positioning of network operators. Information about the next associated cell of moving mobile users delivers an essential indicator enabling advance resource reservation and uninterruptible handovers between cells. This thesis is based on the idea, that users cannot move randomly between cells, but are limited by the spatial topology and specific behavior, leading to piecewise deterministic paths. The **macroscopic mobility** resembles a finger print consisting of radio network coverage, user behavior and spatial topology of road and train networks.

The sequences of cells from all users form a data set, where **movement patterns** can be identified using knowledge discovery algorithms. Five effective pattern detection algorithms have been selected to predict the user's next cell. A sophisticated mobile network simulator has been developed as part of this thesis, which enables evaluation of the complete approach from generating cell transition sequences, pre-processing, pattern detection, post-processing, prediction and resource reservation. The simulator provides realistic and detailed modeling of movement behavior combined with all aspects of modern communication technology.

Several extensive simulation scenarios combining different movement models have been built, where finally a high-load scenario around a soccer stadium features the highest complexity. Even here a prediction accuracy of 90% is possible through elaborate determination of optimal parameterization. Measurements from real world mobile networks have additionally been used **validating the feasibility** of the prediction approach. An accuracy comparable to that of the simulated scenarios could be achieved.

Finally, the concrete application of the predictions has been demonstrated through selection of different reservation methods. Using **bit rate reservation for premium customers** for the most-likely next cell the rate for successful handovers in high-load environments could been raised by more than 20%.

Each necessary action has been deployed in parallel to the simulations in an experimental test bed, consisting of mobile devices and mobile network emulators. This demonstrates the steps and communication protocols mobile network operators need for integration of the prediction technology into their networks.

All results presented in this thesis exhibit a long-term applicability even for future mobile networks, as the methodology's only precondition is a cellular network, which is still valid for the upcoming fourth generation. The **sophisticated process model** provides a complete set of methods and tools to balance network load while maintaining flexibility and customization for data pre-processing, pattern detection algorithm selection, parameterization and resource reservation. The movement models are used beyond this thesis for multi-scale simulations, which combine mobility pattern generation with enhanced radio planning tools.