Information Systems Department
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Handoff Management Protocols for Wireless Networks

THESIS
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ABSTRACT

The field of cellular networks has witnessed a growth in research and development. One area of research in cellular networks is reserving a high quality of communication service (QoS) provided to the subscribers. QoS is proposed to capture the qualitatively and quantitatively defined performance contract between the service provider and the user of this service.

A way that is useful to produce such satisfied QoS is mobility prediction. Mobility prediction is an important issue in QoS as knowing the next position of the mobile station helps in providing service in advance reducing the degradation in the connection. This degradation occurs due to transferring the responsibility of the mobile station service from the one base station to another due to the mobile station handoff process.

In this thesis, the research is oriented to the problem of Quality-of-Service improvement through the improvement of mobility prediction algorithms performance. The goals and research activities are outlined as follows:

١. Overview of the handoff algorithms.
٢. Theoretical study of cell prediction algorithms that based on the users' mobility patterns.
٣. Improving a next cell prediction algorithm.
٤. Simulating the improved algorithm, in order to explain the improvement.

Based on these goals, a number of modifications were proposed to enhance the performance of two mobility prediction algorithms. The first mobility prediction algorithms are Adaptive Channel Reservation (ACR), where four modifications are proposed, namely, (a) Adaptive, (b) Sectorized, (c) History, and (d) Guarded. Combinations of these modifications are experienced investigating their effects over mobility prediction performance.

The second mobility prediction algorithm is a Data mining-based Mobility Prediction, where two modifications are proposed, namely, (a) Transition Matrix prediction and (b) Data mining-based Mobility Prediction using weighted paths

Simulations are performed for the original algorithms and the modified algorithms in order to evaluate and clarify the modifications effects over performance. The main results of the performance evaluation made are summarized:

The results of first algorithm modifications are:

- Adaptive ACR In this modification, simulation is produced and its performance is measured.
    - The simulation results show a reduction in the handoff dropping probability in average ٤٩.٨% with respect to the original scheme.
    - The results also shows a degradation in the new call blocking probability in average ١٩.٠% with respect to the original scheme

- Sectorized ACR In this modification, simulation is produced and its performance is measured.
    - The simulation results show degradation in the handoff dropping probability in average ١٢.٤% with respect to the original scheme.
    - The results also shows a reduction in the new call blocking probability in average ١٢.٧% with respect to the original scheme

- History ACR In this modification, simulation is produced and its performance is measured.
    - The simulation results show a reduction in the handoff dropping probability in average ٥٤.٧% with respect to the original scheme.
    - The results also shows a degradation in the new call blocking probability in average ٢٤.٠% with respect to the original scheme
- Guarded ACR In this modification, simulation is produced and its performance is measured.
    - The simulation results show degradation in the handoff dropping probability in average ١٢.٤% with respect to the original scheme.
    - The results also shows a degradation in the new call blocking probability in average ٧.٨% with respect to the original scheme

The results of second algorithm modifications are:

- Transition Matrix prediction

Results show that using transition matrix in prediction improved Recall w.r.t. maximum number of predicted cells by ٥.٦%, while degradation in Precision by ٠.٢%. An improvement in Recall w.r.t. corruption factor by ١.٧%is measured, while degradation in Precision by ١.٤%. For outline percentage degradation in both Recall and Precision by ٢.٤% and ٠.٩%, respectively is measured.

- Data mining-based Mobility Prediction using weighted paths

Results show that using weighted paths in prediction improved Recall w.r.t. maximum number of predicted cell by ١١.٣%, while degradation in Precision by ٥.٣٧%. An improvement w.r.t corruption factor ratio by ٨.٢٢% is measured, while degradation in precision by ١٤.٦%. For outline percentage degradation in both Recall and Precision is measured, ٢.٨٢% and ١١.٧٤%, respectively.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter ١

١. MOTIVATION, RESEARCH GOALS, AND OUTLINES

١.١ Motivation

The evolution of radio and mobile core network technologies over the last two decades has enabled the development of the personal communication services, which can provide the mobile user with voice, data, and multimedia services at any time, any place, and in any format.

Quality-of-Service is an important issue it refers to the quality of the communication. One aspect of the quality of service is the seamless communication. This aspect is affected by the mobility of the user and the frequent handoff occurs during this mobility. The seamless communication has been more important with the decrease of the cell sizes and the more handoff and more degradation met during communication.

A way to cover this degradation is by providing the knowledge of the mobile user next move in order to forward its received packets in advance to its new location. This is done by predicting the mobility of the user. Mobility prediction is a way to provide a seamless communication and so achieving improvement in quality of service. There are many algorithms proposed to provide the mobility prediction. Some based on the signal strength and the other based on mobility history.

Mobility prediction faces some problems such as the limited resources in predicted cells, the number off cells to be predicted as trade off between success in prediction and saving resources, and false reservation. On purpose mobility prediction based on mobility history has difficulties represented in mobility randomness and the fast reflection of the change in a user's mobility pattern.

١.٢ Research goals

The Quality-of-Service support in mobile ad-hoc networks is very difficult and complicated process that requires a combination of software and hardware support. Routing functions have to work closely to the other network functions such as packet scheduling, resource reservations, and transport protocols and schemas to achieve and provide acceptable Quality-of-Service applications. In this research, some assumptions have been proposed to focus on the Quality-of-Service routing support rather than focusing on the other Quality-of-Service provisions. These assumptions are as follows:

- A suitable Resource reservation protocol exists, that manages both required network and host resource reservation during network operations.
- A suitable Scheduling protocol exists for organizing data transmission sending and receiving, and host resources.
- The Medium Access Control layer and its transportation protocols are available and well combined with other assumed protocols.
- Communication links between mobile hosts or nodes are undirected, this assumption can be carried out by enforcing some radio transmission properties of the hosts.

In this thesis, the research is oriented to the problem of Quality-of-Service improvement through the improvement of mobility prediction algorithms performance. The goals and research activities are outlined as follows:

١. Overview of the handoff algorithms.
٢. Theoretical study of cell prediction algorithms that based on the users' mobility patterns.
٣. Improving a next cell prediction algorithm.
٤. Simulating the improved algorithm, in order to explain the improvement.

١.٣ Thesis outlines

The work in this thesis is organized as follows:

In chapter ٢, an introduction to wireless mobile environment is introduced. It gives an overview for wireless networks with its two divisions, cellular and ad hoc networks. A survey on QoS is presented. This survey covers QoS definition, QoS components, and QoS management. Then, the QoS support for mobile networks is presented.

In chapter ٣, the mobility prediction is presented in details with many examples of algorithms.

In Chapter ٤, Adaptive channel reservation is presented which is based on another algorithm, Predictive Channel Reservation. Modifications are proposed for that algorithm, leading to better performance.

In chapter ٥, a data mining approach used in mobility prediction is presented. A description of the algorithm is presented with introducing modifications on it.

Then conclusions and future work are drawn in chapter ٦.

Chapter ٢

٢. MOBILE NETWORKS AND QOS