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Identifying the Effective Parameters for Vertical Handover in Cellular Networks Using Data Mining Techniques

Nadine Kashmar[a,*], Mirna Atieh[b], Ali Haidar[a]

[a] *Department of Electrical and Computer Engineering, Faculty of Engineering, Beirut Arab University, Debbieh, Lebanon*
[b] *Business Computer Department, Faculty of Economic Sciences and Administration, Lebanese University, Hadat, Lebanon*

Abstract

The need for seamless mobility within the heterogeneous environment of cellular networks imposed the need for finding different vertical handover (VHO) mechanisms to select the best network. The selection process is based on different factors, such as: cost, battery status of Mobile Terminal (MT), the capacity of each network link, available bandwidth (ABW), received signal strength (RSS), etc. However, the major problem here is to find the most effective parameters for VHO and their priorities for these decision mechanisms. Besides, it would be useful to know the values of these parameters for data mining (DM). For this purpose, we collected real log data server of two mobile telecom companies in Lebanon, Touch and Alfa for Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) networks. After preprocessing and discretizing the data, frequent patterns (FP) were extracted to summarize the log data files. The summarized data was then analyzed by using descriptive and visualization techniques in order to find the most effective parameters for handover (HO) process. Three effective parameters were obtained: the Received Signal Strength (RxLev/RSCP), the Available Bandwidth (ABW) and the Received Signal Quality (RxQual/EcNo). Results showed that they cooperatively work together to accomplish the same task. This paper provide an effective solution to identify the most valuable factors for vertical handover mechanism in telecommunication area by using frequent pattern mining.

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Keywords: Vertical Handover; Heterogeneous; Data Mining; Cellular Networks; ABW; RSS; Received Signal Quality; Frequent Patterns

* Corresponding author. Tel.: +961-70-710731.
E-mail address: nadine.kachmar@gmail.com

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1. Introduction

The rapid growth of wireless technology imposed the need for the existence of heterogeneous networks, such as: WLANs, GSM, UMTS, WiMAX, LTE, etc. Because there is a variety of base stations (BSs) that are shared within these networks, more intelligent and adaptive HO decision mechanisms to select the best network are needed. The selection process for the best network interface is based on different factors (RSS, ABW, etc.). This paper proposes a systematic new approach for finding the most valuable parameters by applying DM techniques in log data. It consists of three main phases: preprocessing, discovery of frequent patterns, and analyzing patterns. The purpose is to enhance VHO processes, and then avoid ping-pong effects, packet loss, etc. Its importance lies in the fact that it has not been widely studied.

Since DM is the search for significant patterns and due to the expected errors in the nature of the collected data, our approach in this research is to divide the values of a numeric (continuous) attribute into a small number of intervals and map each interval to a discrete value. Consequently, the data is summarized by extracting the useful information from the frequent patterns. Thus, the results are carried out in an approximate manner. For approximation, it is important to take into consideration that beside the existing parameters, we have other important factors that affect the VHO. These factors are the coverage area for a network and the traffic (the number of connected users).

This paper is organized as follows: section II introduces the background of the existing DM techniques in telecommunication. The main DM processes, which are applied to find the effective parameters for VHO are described in section III with a detailed description about the obtained results. Finally in section IV, the conclusion and suggestions for future work are presented.

2. Related Work

The concept of identifying the effective parameters for VHO process in cellular networks using DM techniques has not been widely studied. The only similar topic which is related to the concept of our research is found in[1]. A flow redirection decision mechanism on mobile network and data mining technologies with multiple network attributes is presented. QoS parameters for multihomed networks (WLAN and WiBro) are analyzed. A combined method is proposed, decision tree algorithm (DT) and neural network (NN) as DM, to extract the important attributes by DT which are then used as inputs for NN to generate the decision model and find the needed network interface.

The most existing methods related to DM techniques in telecommunications industry are concentrated on improving marketing efforts, fraud detection, and better managing telecommunication networks[2]. Today, the size of databases in telecommunications companies are increasing rapidly and it is not practical to analyze these volumes of data in traditional manner. For telecom companies, customers are their major assets and their main concern is to satisfy their needs in order to retain them. Researchers in paper[3] address the reasons for applying DM techniques and applications for customer relationship management (CRM) in telecommunications: customer segmentation and churn prediction. The increase of fraud in telecommunication imposes the need to search for DM for fraud detection. A review of DM techniques to detect frauds are presented in[4], which states that most techniques use Call Detail Records (CDRs) to monitor the behavior of users to identify the risk in advance and take the appropriate response. Neural networks, visualization methods and rule-based are some of the discussed methods in the domain. In the same area of research, a probability based method is implemented[5], Naïve Bayesian classification method that classifies users as fraudsters and non-fraudsters. The problem of identifying fraudulent users is solved and thus the risk for losing non-fraudsters users is eliminated.

Concerning telecommunication networks, the use of devices and equipment from different manufacturers in the heterogeneous environment of wireless networks increases the difficulties on network management[6]. In order to improve mobile networks troubleshooting and recognize the occurring failure at the earliest possible moment, authors present a monitoring scheme, a fault diagnosis method, based on the use of rules and decision tree DM classifiers. The presented method denotes optimization solutions and facilitates the correction of faults techniques. Authors in[7] state some unsolved challenges in cellular communication, and presents DM as one of the techniques