Advanced Handover Management in Future Wireless Networks using Prediction of QoS

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This thesis is dedicated to my father,

My father was a great and excellent expert in computer science. I followed in his steps to become a Ph.D student in the field of communication networks.

Unfortunately, my father got gastric cancer when I began my Ph.D in August 2010. He hid his sickness from me, in order to let me freely go abroad and pursue my dream—the Ph.D degree. In November 2011, my father passed away in my arms.

I have worked much harder than I perhaps should, as I promised my father, that I would try my best to finish my Ph.D in time, no matter what happens.

He always supported me in anything I wanted to do, and I know he'd be proud of me.

My dedication to him is a small way of saying thank you and I miss you every day.

Abstract

Nowadays, a wide-range of mobile devices such as laptops, tablets, smart phones, and smart watches come into people's daily life. According to Cisco's report in 2014, almost half a billion new mobile devices have joined the Internet in 2014. The report also forecasts that the total number of mobile devices will increase to 11.5 billion by 2019. These mobile devices change people's lives. Before, people mainly used Internet for searching news or sharing files. Now, people use new mobile devices such as smart watches to record their jogging distance and to measure the amount of consumed calories. Furthermore, these devices can be used to monitor the sleeping quality over night.

These examples make it obvious, that the new mobile devices have a very strong influence on our lives. This will encourage the mobile users to switch to the network that provides more bandwidth and more connection stability than others. Although many service providers can offer services that fulfill these requirements, the services are relatively costly and not always affordable for average mobile users. As a consequence, free wireless network access is gaining increasing attention. This is mentioned in Cisco's report. It claims that globally 46% of total mobile data traffic was shifted to the fixed network through Wireless Local Area Network (WLAN) or femtocell technology in 2014.

During the past several years, the WLAN infrastructure has been developing extremely fast. The sales of global WLAN Cus-

tomer Premises Equipment (CPE) are set to surpass 176 million units by the end of 2014. The company ABI Research estimates that the enterprise WLAN equipment market will generate revenues of 6.3 billion Euros by the end of 2019. Meanwhile, Free WLAN network has been established almost worldwide, more than 70 countries providing free WLAN.

Even though WLAN networks have been available for many years, and its low-cost stable service with high throughput, there are still some challenges. Handover is one of the key issues in the mobile wireless networks that need to be studied thoroughly in order to provide a good QoS. A handover is the procedure, in which a Mobile Node (MN) changes its wireless attachment from one Access Point (AP) to another. This procedure is usually invoked when a MN moves from a place to another, where it is out of the coverage of the current AP. The handover can also be performed when a MN is in the coverage of several APs but wants to change the AP to get a better radio channel quality.

The key point of providing better Quality of Service (QoS) to the MN is to choose the right time to do the handover. This requires to trigger the handover beforehand. To achieve this, a handover management proposal which is based on the prediction of QoS is proposed in this work. This proposal consists of two main parts.

The first part concerns the RSS prediction mechanism based on a Hidden Markov Model (HMM). In other works, the RSS prediction algorithms mainly concentrate on filtering out the noise of the RSS readings, finding out the trends of its changing, then predicting the possible future values. However, the MN can receive the same RSS values sequence with different moving traces, although the future changing trends of the RSS values might be totally different. This increases the difficulty to find out the changing trends of RSS precisely, in the end, it will lead the MN to make

unnecessary handover decisions that will decrease the QoS for the MN. To improve this situation, it is proposed to consider the RSS and the mobile node's location parameters jointly in the prediction model. Therefore, a handover prediction model using HMM is proposed, in which RSS is modeled as the observation states and the locations are modeled as hidden states.

The second part of the proposal concerns the handover decision making mechanism which includes the predicted QoS. Here, the QoS of MN is in terms of throughput.

Conventional handover decision strategies are typically based on a threshold of a measured parameter or a function of various measured parameters such as RSS, power consumption, available bandwidth or monetary cost. More complicated approaches use artificial neural network and fuzzy logic controllers. These approaches can make a good handover decision to choose the best network, but they cannot guarantee a continuous connection during the handover. This is because the handover itself always triggers some signaling operations which impose a handover latency that can cause the connection to break. The handover decision making mechanism proposed in this work making the handover decision considers the future mobility of the MN and also is based on the predicted QoS.

Performance evaluations show that the proposed handover decision scheme in this thesis enhances the QoS of MN while it reduces the number of the handovers.

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