HANDOVER MANAGEMENT TECHNIQUES FOR WiMAX BASED WIRELESS MESH NETWORKS

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by

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Certificate

This is to certify that the thesis entitled **Handover Management Techniques for WiMAX Based Wireless Mesh Networks** submitted by **Ms. L. Rajya Lakshmi** to the Indian Institute of Technology Delhi, for the award of the Degree of Doctor of Philosophy, is a record of the original bonafide research work carried out by her under our supervision. The thesis has reached the standards fulfilling the requirements of the regulations relating to the degree. The results contained in this thesis have not been submitted in part or full to any other university or institute for the award of any degree or diploma.

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Abstract

This thesis is concerned with the design and analysis of handover management methods for WiMAX (Worldwide Interoperability for Microwave Access) based wireless mesh networks (WMNs). Even though many mobility management methods are developed for other wireless networks, the special characteristics of WMNs and the radio access technology used by WiMAX make it necessary to develop new methods for WiMAX WMNs. Based on the architectures of WMNs, they can be categorized into three classes: *Infrastructure* WMNs, *Client* WMNs and *Hybrid* WMNs.

In these networks flows are established between the nodes along multihop paths. Since WiMAX WMNs are Time Division Multiple Access (TDMA) based networks, to establish Quality of Service (QoS) constrained flows, routing and scheduling issues need to be addressed together. Whenever either the end nodes or some nodes on the path of a flow perform handover, to support the QoS requirements of the flow, a new path with the required bandwidth needs to be established as quickly as possible or it should be available instantaneously.

For WiMAX Infrastructure WMNs in which the mesh among the static Base Stations (BSs) act as a backbone, we propose a novel handover management technique called PaRtIal path establishment based handover Management tEchnique (PRIME). PRIME handles re-routing and scheduling issues of a handing over Mobile Node (MN) together through a concept called crossover node. In addition, to analyze the performance of PRIME, we propose a multi-dimensional Markov model

and give the theoretical upper and lower bounds on the call dropping probabilities of handoff calls.

In WiMAX Client WMNs, in which only MNs establish wireless meshes, any node on the path of a flow can perform handover. We propose a backup path management method for WiMAX Client WMNs. Each node along the current path between a source and a destination finds out backup paths with the required bandwidth in order to handle failure of the link to its downstream node and its own failure or handover. Also, we prove an important property of our proposed method.

For WiMAX Hybrid WMNs, in which both the static BSs and mobile MNs together establish wireless meshes, we propose a backup parent based handover management method. In these networks, to allocate bandwidth for inter-mesh flows, the BS maintains a routing tree of the mesh network. In our proposed method, to support the QoS requirements of inter-mesh flows in the mobile environments, nodes maintain alternate paths to the BS through a concept called *secondary parent*. Also, we prove two important properties of the proposed method.

In addition to developing handover management techniques for WiMAX WMNs, we also develop a distributed Base Station Cooperation (BSC) based handover management method for WiMAX Point-to-MultiPoint (PMP) networks to provide QoS to handover nodes at the last hop. In this method, the two BSs involved in the handover of an MN coordinate among themselves over the backbone (without any central controller) to continue QoS constrained service flows to the MN. A call admission control (CAC) algorithm is proposed to handle handover calls of various service classes according to their priorities. A bandwidth borrowing scheme which does not starve the lower priority calls is also proposed. A Markov model is developed to analyze the proposed CAC method and to obtain the approximated handover call dropping probabilities of various service classes.

The performance advantages of the proposed methods are established through simulation experiments.

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