國 立 交 通 大 學

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博 士 論 文

多媒體分碼多重接取蜂巢式網路之允諾控制與無線資源配置技術

Call Admission Control and Radio Resource Allocation for Multimedia CDMA Cellular Network

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中文摘要

為了在無線通訊網路上提供多媒體服務，我們必須設計精良的無線資源管理（Radio Resource Management）機制來提供屬性多而不同的服務品質要求(QoS requirements)以及各式各樣客製化的訊務源特性。而在分碼多重進接系統裡，由於上下行鏈路特性不同，因此，為了有效提供多媒體服務，我們將針對不同的無線資源管理機制作討論與設計。在上鏈路裡，連線允諾控制是很重要的機制，而在下鏈路中，由於中心式資源控制可行，因此無線資源的排程控制將成為最重要的議題。本論文中，我們提出了一套上鏈路的智慧型連線允諾控制、以及下鏈路以蜂巢式類神經網路與效用函數為基礎（CNNU-based）所設計的排程控制。

為了發展上鏈路連線允諾控制，我們首先提出了一套估測上鏈路連線傳輸之等效干擾機制，以根據連線的服務品質要求、訊務源特性來估計為了滿足所有連線服務品質所需要使用的系統容量。藉由這樣的轉換函數關係，我們將能有效簡化許多上鏈路無線資源配置管理的設計複雜度。

基於等效干擾的概念，我們提出了一套智慧型連線允諾控制（ICAC）機制，來保障系統之服務品質、合理的系統負載、並盡可能將系統容量最大化。智慧型連線允諾控制的架構中，包含了一個乏晰等效干擾估測器(FEIE)來估測連線要求的負載；平行串列遞迴類神經網路（PRNN）干擾預測器可根據量測之干擾量預測未來系統之平均干擾量；而乏晰連線允諾控制器將集合 FEIE 與 PRNN 干擾預測器之結果、以及系統量測之服務品質效能評估指數，進行新的連線要求、與連線交遞要求之允諾控制。模擬結果顯示，ICAC 能確保服務品質並有效提升系統容載。

在下鏈路中，我們提出了 CNNU-based 排程控制器，使系統能提供多樣化的多媒體服務。CNN 技術能快速的進行最佳化的運算，使得排程演算法能快速的完成精準決定；而效用函數式的排程設計，能綜合無線資源使用效率、服務品質達成狀態、以及資源分配公平性來估計最佳的資源配置順位。結果顯示，CNNU-based 排程控制器能提供較大的系統傳輸速率、較大的服務品質保證區域、以及較好的公平性。

Call Admission Control and Radio Resource Allocation for Multimedia CDMA Cellular Networks

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Abstract

To support multimedia applications over wireless networks, sophisticated radio resource management mechanisms must be well designed for the challenge of diverse QoS requirements and customized traffic characteristics. Due to the quite different characteristics of uplink transmission and downlink transmission, call admission control is essential in the uplink to avoid the congestion condition for each type of service and scheduling is critical in the downlink to improve the throughput and ensure the QoS requirements efficiently as much as possible. In this dissertation, we propose an intelligent call admission control architecture for uplink transmission and a cellular neural network and utility (CNNU)-based scheduler for downlink to provide the differentiated QoS requirements and customized multimedia applications.

To develop the call admission control mechanism in the uplink, the equivalent interference estimators are proposed to estimate the capacity required for a call connection in WCDMA cellular systems. We associate the equivalent interference with the traffic source characteristics and the radio resource defined by the power. Then, the equivalent interference estimator in the dedicated channels and shared channels are obtained, which

can transform traffic parameters and quality-of-service (QoS) requirements of the call connection into a measure of resource in a unified metric, while keeping QoS requirements of existing calls guaranteed.

Based on the equivalent interference estimator, we propose intelligent call admission control for wideband CDMA cellular systems to support differentiated QoS requirements, guarantee the forced termination probability of handoffs, and maximize the spectrum utilization. The intelligent call admission controller (ICAC) contains a fuzzy call admission processor to make admission decision for a call request by considering QoS measures such as the forced termination (drop call) probability of handoff, the outage probability of all service types, the predicted next-step existing-call interference, the link gain, and the estimated equivalent interference of the call request. The pipeline recurrent neural network (PRNN) is used to accurately predict the next-step existing-call interference, and the fuzzy logic theory is applied to estimate the new/handoff call interference based on knowledge of effective bandwidth method. Simulation results indicate that ICAC achieves system capacity higher than conventional CAC schemes and can cope with the unpredictable statistical fluctuation in wireless environment; it always fulfill QoS requirements for all service types and keep the forced termination probability satisfied, while conventional CAC schemes does not.

For the downlink, a cellular neural network and utility (CNNU)-based scheduler is proposed for multimedia CDMA cellular networks supporting differentiated quality-of-service (QoS) and variant traffic parameters. The cellular neural network is powerful for complicated optimization problems and has been proved that it can rapidly converge to a desired equilibrium; the utility-based scheduling algorithm can efficiently utilize the radio resource for system and provide QoS requirements and fairness for connections. A relevant utility function for each connection is here defined as its radio resource function further

weighted by both a QoS requirement deviation function and a fairness compensation function. The CNNU-based scheduler determines a radio resource assignment vector for all connections so that the overall system utility is maximized and the system throughput can be achieved as high as possible. At the same time, the performance measures of all connections are kept closed to their QoS requirements in an efficient way. The simulation results show that CNNU-based scheduler has higher system throughput and larger QoS guaranteed region than other scheduling algorithm.

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