


國立交通大學

電信工程研究所

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。

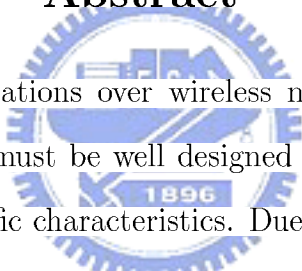
Call Admission Control and Radio Resource Allocation for Multimedia CDMA Cellular Networks

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Abstract

The logo of National Chiao Tung University is a circular emblem. It features a gear-like outer border. Inside the circle, there is a stylized building or structure. At the bottom of the emblem, the year '1896' is inscribed.

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 (CNUU)-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 (CNU)-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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Contents

Chinese Abstract	i
English Abstract	ii
Acknowledgments	v
Contents	vi
List of Figures	viii
List of Tables	xi
1 Introduction	1
1.1 Motivation	1
1.2 Paper Survey	7
1.3 Dissertation Organization	11
2 The Concept of Equivalent Interference in Multimedia CDMA Cellular Systems	15
2.1 Notation List of Chapter 2	16
2.2 The Basic Concept of Equivalent Interference in Uplink Transmission . . .	17
2.3 The Equivalent Interference Estimator for Uplink Transmission over Dedicated Channels	20

2.3.1	Introduction	20
2.3.2	System Model	21
2.3.3	The Derivation of Equivalent Interference Estimator over Dedicated Channels	22
2.4	The Equivalent Interference Estimator for Uplink Transmission over Shared Channels	24
2.4.1	Introduction	24
2.4.2	System Model	25
2.4.3	The Design of Radio Resource Index for Shared Channels	26
2.4.4	Results and Conclusions	30
3	The Call Admission Control for Uplink Dedicated and Shared Channels in Multimedia CDMA Cellular Systems	38
3.1	Notation List of Chapter 3	39
3.2	Introduction	40
3.3	System Model	45
3.4	Intelligent Call Admission Controller	49
3.4.1	Fuzzy Equivalent Interference Estimator	49
3.4.2	PRNN Interference Predictor	54
3.4.3	Fuzzy Call Admission Processor	56
3.5	Simulation Results and Discussion	62
3.6	Concluding Remarks	70
4	The Scheduling Algorithm for Downlink Dedicated and Shared Channels in Multimedia CDMA Cellular Systems	71
4.1	Notation List of Chapter 4	72

4.2	Introduction	73
4.3	System Model	78
4.4	Formulation of The Utility Function	80
4.4.1	Radio Resource Function $\mathcal{R}_i(t)$	80
4.4.2	The QoS Requirement Deviation Function $\mathcal{A}_i(t)$	81
4.4.3	The Fairness Compensation Function $\mathcal{F}_i(t)$	83
4.5	Design of the CNNU-based Scheduler	84
4.5.1	Preliminaries for Cellular Neural Networks	86
4.5.2	Formulation of Cost Function for CNN Processor	88
4.5.3	The Architecture of CNN Processor	89
4.5.4	The Two-Layer Structure for CNN Processor	94
4.6	The Discussion for Stability and Convergence of CNN Processor	94
4.6.1	The relationship between the dynamics each cell and Energy function of CNN	94
4.6.2	The Stability of Designed CNN	95
4.6.3	Concluding Remarks of Designing Energy Function Based CNN by Lyapunov Method	106
4.7	Simulation Results and Discussion	109
4.8	Concluding Remarks	114
5	Conclusions and Future Works	116

List of Figures

1.1	The block diagram of packet based admission controller.	5
1.2	Three design aspects of scheduling algorithm in wireless networks.	6
2.1	The analytical model of the uplink connection i in WCDMA.	25
3.1	System model.	46
3.2	Structure of the PRNN interference predictor.	55
3.3	The i th small RNN module in the PRNN interference predictor.	56
3.4	The mean number of accommodation users versus traffic intensity for ICAC with and without PRNN interference predictor.	63
3.5	The mean number of accommodation users versus traffic intensity of ICAC with and without link gain L variable.	64
3.6	The mean number of accommodation users versus traffic intensity of ICAC with and without FEIE.	65
3.7	Outage probabilities versus traffic intensity.	66
3.8	The forced termination probabilities versus new call arrival rate.	67
3.9	The number of accommodation users (a) and the new call blocking proba- bility (b) versus traffic intensity in low mobility case.	68
3.10	the number of accommodation data users (a) and the blocking probability of data users (b) versus the new call arrival rate of data users where voice arrival rate is fixed at 0.1 per frame time.	69

4.1	The block diagram of CNNU-based scheduler.	85
4.2	The two-layer structure of CNN processor.	93
4.3	The average system throughput	110
4.4	QoS performance measures of \bar{P}_D and \bar{R}_m	111
4.5	The ratio ϕ_{P_D} for RT connections and the ratio ϕ_{R_m} for NRT interactive connections	112
4.6	The fairness variation index for NRT connections	114



List of Tables

2.1	Notation List of Chapter 2	16
2.2	The theoretical and simulation results.	32
3.1	Notation List of Chapter 3	39
3.2	Rule structure for the fuzzy capacity requirement estimator.	53
3.3	Rule structure of the fuzzy call admission processor for the new call request.	59
3.4	Rule structure of the fuzzy handoff admission processor for the handoff call request.	61
4.1	Notation List of Chapter 4	72