



**UNIVERSITI PUTRA MALAYSIA**

**ADVANCED MULTIPLE ACCESS SCHEMES FOR MULTIMEDIA  
TRAFFIC OVER WIRELESS CHANNELS**

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**Thesis Submitted in Fulfillment of the Requirements for the Degree of  
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*To My Parents*

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
fulfilment of the requirement for the degree of Doctor of Philosophy

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By

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**November 2001**

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To meet the anticipated demand for wireless access to the broadband Asynchronous Transfer Mode (ATM) network, the concept of wireless ATM has been proposed in 1994 [1]. One of the main challenges in the design of a wireless ATM network resides in the conception of a Medium Access Control (MAC) protocol that will handle the different ATM services while providing an efficient utilization of the wireless channel. In this thesis, we propose a new Adaptive Reservation TDMA (AR-TDMA) MAC protocol for wireless ATM networks. AR-TDMA combines the advantage of distributed access and centralized control for transporting Constant Bit Rate (CBR), Variable Bit Rate (VBR) and Available Bit Rate (ABR) traffic efficiently over a wireless channel. The contention slots's access is governed by two novel framed pseudo-Bayesian priority Aloha protocols that we introduce in this thesis. Either one of these protocols can minimize the contention delay and provide different access priorities for heterogeneous traffic. Analytical and

simulation results indicate that the framed pseudo-Bayesian priority Aloha protocols offer a significant delay improvement for high priority packets with Poisson traffic, while low priority packets only experience a slight performance degradation. A detailed comparison and discussion of implementation and robustness issues is presented in this thesis to help the design engineer choose the right protocol that suits the application scenario. In the context of the AR-TDMA protocol, results show that the priority algorithms improve real-time traffic Quality-of-Service (QoS). The AR-TDMA resource allocation algorithm grants to terminals reserved access to the wireless ATM channel by considering their requested bandwidth and QoS. We propose scheduling algorithms for CBR, VBR and ABR traffic. Furthermore, we also introduce a method to dynamically adjust the number of uplink control slots per frame as a function of the estimated contention traffic. Finally, an algorithm is proposed to integrate these algorithms to provide ubiquitous wireless ATM services. Performance results show that the AR-TDMA MAC protocol can achieve high throughput in the range of 90 to 95% while maintaining reasonable QoS for all ATM services.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**SKIMA PENCAPAIAN BERBILANG TERMAJU UNTUK TRAFIK  
MULTIMEDIA DI ATAS SALORAN WAYERLES**

Oleh

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**November 2001**

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Untuk memenuhi permintaan untuk pencapaian tanpa wayar kepada rangkaian Mod Perpindahan Taksegerak (ATM), konsep ATM wayerles telah dicadangkan pada 1994. Salah satu dari cabaran dalam merekabentuk rangkaian ATM Wayerles terletak dalam pembetulan protokol Kawalan Pencapaian Media (MAC) yang mengendalikan perkhidmatan ATM yang pelbagai sementara memberikan penggunaan saluran wayerles yang berkesan. Dalam tesis ini, kami mencadangkan satu protokol MAC yang baru, Penempatan Adaptif TDMA (AR TDMA) untuk ATM Wayerles. AR-TDMA menggabungkan kelebihan pencapaian tertabur dan kawalan berpusat untuk mengangkut trafik Kadar Bit Malar (CBR), Kadar Bit Berubah (VBR), dan Kadar Bit Ada (ABR) dengan berkesan melalui saluran wayerles. Perebutan pencapaian slot adalah ditentukan oleh dua protokol baru Aloha keutamaan pseudo-Bayesian dikerangka yang kami perkenalkan dalam tesis ini. Salah satu dari protokol ini dapat

mengurangkan kelengahan perebutan dan memberi keutamaan pencapaian yang berbeza untuk trafik berbilangjenis. Hasil analitikal dan simulasi menunjukkan bahawa protokol Aloha keutamaan pseudo-Bayesian dikerangka menawarkan pengurangan kelengahan yang signifikan untuk paket keutamaan tinggi dengan trafik Poisson, manakala paket keutamaan rendah hanya mengalami sedikit penurunan prestasi. Suatu perbandingan yang mendalam dan perbincangan perlaksanaan dan isu ketahananlasak adalah dibentangkan dalam tesis ini untuk membantu jurutera rekabentuk untuk memilih protokol yang sesuai untuk senario aplikasi tersebut. Dalam konteks protokol AR-TDMA, hasil keputusan menunjukkan bahawa algoritma keutamaan meningkatkan Kualiti Perkhidmatan (QoS). Algoritma pengagihan sumber AR-TDMA memberikan kepada terminal pencapaian khas kepada saluran ATM Wayerles dengan mengambil kira lebarjalur permintaan dan QoS. Kami mencadangkan algoritma penjadualan untuk trafik CBR, suara, VBR dan ABR. Lebih lebih lagi, kami juga memperkenalkan suatu kaedah untuk mengubahsuai dengan dinamik bilangan slot kawalan keatas per kerangka sebagai fungsi trafik perebutan anggaran. Akhir sekali, suatu algoritma adalah dicadangkan untuk menggabungkan algoritma ini untuk memberi perkhidmatan ATM wayerles yang meluas. Hasil prestasi menunjukkan bahawa protokol MAC AR-TDMA dapat mencapai truput yang tinggi dalam jeda 90 hingga 95% sambil memastikan QoS yang munasabah kepada kesemua perkhidmatan ATM.

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I Certify that an Examination Committee met on 19<sup>th</sup> November 2001 to conduct the final examination of Mohamed Hadi Habaebi on his Doctor of Philosophy thesis entitled “Advanced Multiple Access Schemes for Multimedia Traffic over Wireless Channels” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. Members of the Examination Committee are as follows:

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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.



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