UNIVERSITI PUTRA MALAYSIA

ADVANCED MULTIPLE ACCESS SCHEMES FOR MULTIMEDIA TRAFFIC OVER WIRELESS CHANNELS

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OVER WIRELESS CHANNELS

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To My Parents
ADVANCED MULTIPLE ACCESS SCHEMES FOR MULTIMEDIA TRAFFIC OVER WIRELESS CHANNELS

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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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 pembetukan protokol Kawalan Pencapaian Media (MAC) yang mengendalikan perkhidmatan ATM yang pelbagai sementara memberikan penggunaan saluran wayerles yang berkesan. Dalam tesis ini, kami mencadangan satu protokol MAC yang baru, Penempahan 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 saloran wayerles. Perebutan pencapaian slot adalah ditentukan oleh dua protokol baru Aloha keutamaan pseudo-Bayesian dikerangka yang kami perkenalkan dalam tesis in. 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 saloran 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 19th 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.

Name: Mohamed Hadi Habaebi

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>v</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>vii</td>
</tr>
<tr>
<td>APPROVAL SHEET</td>
<td>ix</td>
</tr>
<tr>
<td>DECLARATION FORM</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xxx</td>
</tr>
</tbody>
</table>

## CHAPTER

1 ADAPTIVE RESERVATION TDMA MEDIUM ACCESS CONTROL PROTOCOL FOR WIRELESS ATM NETWORKS
   1.1 Introduction                                                      | 1.1  |
   1.2 Motivations and Objectives                                       | 1.2  |
   1.3 Contributions of this Thesis                                     | 1.5  |
   1.4 Publications                                                     | 1.9  |
   1.5 The Structure of the Thesis                                      | 1.9  |
   1.6 Summary                                                          | 1.11 |

2 WIRELESS ATM TECHNOLOGY                                              | 2.1  |
   2.1 Wireless ATM Concept                                             | 2.1  |
      2.1.1 Wireless ATM Target Environment                             | 2.5  |
      2.1.2 UMTS, IMT2000, and Wireless ATM                             | 2.6  |
   2.2 Wireless ATM Architecture                                        | 2.9  |
   2.3 Summary                                                          | 2.9  |

3 REVIEW OF WIRELESS ATM MEDIUM ACCESS CONTROL (MAC) PROTOCOLS         | 3.1  |
   3.1 Introduction                                                     | 3.1  |
   3.2 Literature Review of MAC Schemes                                 | 3.7  |
      3.2.1 CDMA BASED MAC PROTOCOLS                                     | 3.8  |
      3.2.2 TDMA Based MAC Protocols                                     | 3.8  |
         3.2.2.1 FDD-Based MAC Protocols                                 | 3.11 |
         3.2.2.2 TDD-Based MAC Protocols                                 | 3.17 |
      3.2.3 Other MAC Protocols                                          | 3.21 |
         3.2.3.1 NCPRMA/DQRU-MA/MDRTDMA Hybrid                           | 3.21 |
         3.2.3.2 PBMADP                                                   | 3.22 |
3.3 Proposed MAC Protocols Comparison And Conclusions
3.3.1 Comparison Between CDMA & TDMA MAC Protocols
3.3.2 Comparison Between TDMA Based MAC Protocols
3.4 Conclusion

4 ADAPTIVE RESERVATION TDMA MAC PROTOCOL FOR WIRELESS ATM
4.1 Required MAC Protocol Specifications
4.2 Adaptive Reservation TDMA (AR-TDMA) MAC Protocol
4.3 System Architecture Parameters
4.4 Conclusion

5 WIRELESS ADAPTIVE FRAMED PSEUDO-BAYESIAN ALOHA (AFPBA)
WITH ADAPTIVE SLOT ASSIGNMENT (ASA) SCHEME
5.1 Introduction
5.2 Literature Review
5.3 AFPBA/ASA Algorithm Theory, Analysis, And Design Synthesis
5.3.1 The Basic Pseudo-Bayesian Algorithm
5.3.2 The AFPBA Algorithm Theory and Analysis
5.3.2.1 Idle Slot Case
5.3.2.2 Success Slot Case
5.3.2.3 Collision Slot Case
5.3.3 AFPBA Algorithm Design and Synthesis
5.3.4 Adaptive Slot Assignment Algorithm
5.4 The Wireless Model Extension Analysis
5.4.1 Idle Slot Case
5.4.2 Success Slot Case
5.4.3 Collision Slot Case
5.4.4 Analysis of the Rayleigh Fading Effect
Simulation Results
5.5.1 AFPBA/ASA Algorithm Evaluation
5.5.2 Wireless AFPBA/ASA Algorithm Evaluation
5.5.3 Rayleigh Fading Effect
5.5.4 Shadowing Effect
5.5.5 Path loss Effect
5.5.6 Capture Effect
5.6 Conclusion

6 THE FRAMED PSEUDO-BAYESIAN ALOHA (FPBA) ALGORITHM WITH
ADAPTIVELY PRIORITIZED CONTROLLED CAPTURE (APCC) USING
LOGARITHMICALLY EQUI-SPACED RANDOM TRANSMITTER POWER LEVELS (LESRTPL)
6.1 Enhancing the FPBA Algorithm
6.1.1 Introduction
6.1.2 The FPBA Algorithm
6.1.3 System Models And Analysis
6.1.3.1 Sub-Optimal Model for Selecting Random Power Levels
6.1.3.2 Wireless Channel Capture Model Analysis
6.1.3.3 Rayleigh Fading Effect Analysis
6.1.4 Simulation Results
6.1.4.1 Random Transmitter Power Levels Effect
6.1.4.2 Random Transmitter Power Levels and the Wireless Channel Effect
6.1.4.3 Random Transmitter Power Levels and the Multipath Fading Effect
6.1.4.4 Random Transmitter Power Levels, Multipath Fading and Shadowing Effect
6.1.5 Discussions and Conclusions
6.2 The APCC Priority Scheme
6.2.1 Introduction
6.2.2 The FPBA Algorithm With The APCC Scheme
6.2.2.1 The FPBA Algorithm
6.2.2.2 The APCC Scheme
6.2.2.3 APCC Scheme Description
6.2.3 Wireless Channel Capture Model Analysis
6.2.3.1 Idle Slot Case
6.2.3.2 Success Slot Case
6.2.3.3 Collision Slot Case
6.2.4 Simulation Results
6.2.4.1 The APCC Algorithm simulation results, discussion and analysis
6.2.4.2 Combined Effect of Rayleigh Fading and the LESRTPL on Algorithm Performance
6.2.4.3 Effect of Shadowing, Rayleigh Fading and LESRTPL
6.2.4.4 Effect of Rayleigh fading, Shadowing, LESRTPL and Path Loss
6.2.5 Conclusion

7 COMPARISON BETWEEN AFPBA/ASA AND FPBA/APCC ALGORITHMS
7.1 Introduction
7.2 Delay Analysis of the Algorithm
7.3 The wireless channel effect on the average access delay
7.4 Robustness and Implementation Issues

8 AR-TDMA/TDD MAC PROTOCOL RESOURCE ALLOCATION ALGORITHM
8.1 Introduction .................................................................................. 8.1
8.2 Wireless ATM Bandwidth Allocation Algorithm .................................. 8.2
  8.2.1 Scheduling Information .................................................................. 8.3
    8.2.2 Literature Review of Scheduling Algorithms ......................... 8.7
      8.2.2.1 Allocation of CBR Traffic ........................................... 8.7
      8.2.2.2 Allocation of ABR Traffic ........................................... 8.9
      8.2.2.3 Allocation of VBR Traffic ........................................... 8.10
    8.2.2.4 Allocation Algorithm for Integrated Multimedia Traffic ......... 8.12
8.3 Characteristics of Multimedia Traffic Source .................................... 8.14
  8.3.1 CBR Traffic Source Model ...................................................... 8.15
  8.3.2 ABR Traffic Source Model ...................................................... 8.16
  8.3.3 VBR Traffic Source Model ...................................................... 8.18
8.4 AR-TDMA Resource Allocation Algorithms .................................... 8.21
  8.4.1 CBR Traffic Slot Allocation Algorithm ..................................... 8.22
  8.4.2 ABR Traffic Slot Allocation Algorithm ..................................... 8.24
  8.4.3 VBR Traffic Slot Allocation Algorithm ..................................... 8.28
  8.4.4 Contention Period Algorithms .................................................. 8.36
    8.4.4.1 AFPBA/ASA Contention Algorithm ............................. 8.40
    8.4.4.2 FPBA/APCC Contention Algorithm ............................. 8.45
  8.4.5 Multimedia Traffic Integration .................................................. 8.50
  8.4.6 Discussion on the AR-TDMA Allocation Algorithms ............. 8.54
8.5 Simulation Results ........................................................................... 8.58
  8.5.1 Results for CBR Traffic Only .................................................. 8.63
  8.5.2 Results for ABR Traffic Only .................................................. 8.69
  8.5.3 Results for VBR Traffic Only .................................................. 8.78
  8.5.4 Results for ABR and CBR Integrated System ......................... 8.85
  8.5.5 Results for ABR, CBR and VBR Integrated System ............... 8.99
8.6 Conclusion ..................................................................................... 8.103

9 CONCLUSION ................................................................................... 9.1
  9.1 Summary ..................................................................................... 9.2
  9.2 Topics for Future Investigations .................................................. 9.7

REFERENCES ................................................................................... R.1
APPENDICES .................................................................................. A.1
BIODATA OF AUTHOR .................................................................. B.1
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>Comparison of the protocol</td>
</tr>
<tr>
<td>4.1</td>
<td>AR-TDMA MAC frame parameters</td>
</tr>
<tr>
<td>5.1</td>
<td>Different number of contention slots and their Equivalent POS as permitted by the Pseudo-Bayesian stability condition</td>
</tr>
<tr>
<td>7.1</td>
<td>Comparison between the new proposed algorithms and the reference algorithm</td>
</tr>
<tr>
<td>8.1</td>
<td>CBR voice source model parameters</td>
</tr>
<tr>
<td>8.2</td>
<td>VBR source model parameters</td>
</tr>
<tr>
<td>8.3</td>
<td>Probability distribution of the packet generation rate of a VBR source</td>
</tr>
<tr>
<td>8.4</td>
<td>AR-TDMA MAC frame parameters</td>
</tr>
<tr>
<td>8.5</td>
<td>VBR connections parameters</td>
</tr>
<tr>
<td>8.6</td>
<td>Parameters for data and voice integrated system simulations</td>
</tr>
<tr>
<td>8.7</td>
<td>CBR, VBR and ABR connection parameters</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.1</td>
<td>The structure of this thesis</td>
</tr>
<tr>
<td>2.1</td>
<td>Wireless/wired ATM network Concept</td>
</tr>
<tr>
<td>2.2</td>
<td>Protocol stacks for full integration of mobile ATM terminals into a fixed ATM network</td>
</tr>
<tr>
<td>2.3</td>
<td>Relationship Between Future Public Networks and Wireless ATM</td>
</tr>
<tr>
<td>3.1</td>
<td>Scenario of Minimum Access Delay</td>
</tr>
<tr>
<td>4.1</td>
<td>AR-TDMA wireless ATM MAC protocol frame structure</td>
</tr>
<tr>
<td>4.2</td>
<td>Uplink wireless ATM cell format</td>
</tr>
<tr>
<td>5.1</td>
<td>Wireless ATM frame structure</td>
</tr>
<tr>
<td>5.2</td>
<td>Waiting times in slots of the AFPBA Protocol, TDMA and the normal Pseudo-Bayesian</td>
</tr>
<tr>
<td>5.3</td>
<td>Waiting time of the AFPBA protocol in frames</td>
</tr>
<tr>
<td>5.4</td>
<td>Waiting time in frames of the AFPBA protocol. Number of contention slots is varied and so is the arrival rate</td>
</tr>
<tr>
<td>5.5</td>
<td>Waiting time of the AFPBSA/ASA protocol with (9,1) combination of fixed slot assignment. Arrival rate is varied</td>
</tr>
<tr>
<td>5.6</td>
<td>Waiting time of the FPBSA/ASA protocol with (8,2) combination of fixed slot assignment. Arrival rate is varied</td>
</tr>
<tr>
<td>5.7</td>
<td>Waiting time of the AFPBA/ASA protocol with (7,3) combination of fixed slot assignment. Arrival rate is varied</td>
</tr>
<tr>
<td>5.8</td>
<td>Waiting time of the AFPBA/ASA protocol with (6,4) combination of fixed slot assignment. Arrival rate is varied</td>
</tr>
<tr>
<td>5.9</td>
<td>Delay percentile of the AFPBA/ASA protocol with several number of contention slots. Arrival rate is 1 packet per frame</td>
</tr>
</tbody>
</table>
5.10 The delay percentile of the AFPBA/ASA protocol with several number of contention slots. Arrival rate is 2 packets per frame..............................................................5.50

5.11 The delay percentile of the AFPBA/ASA protocol with several number of contention slots. Arrival rate is 3 packets per frame..............................................................5.50

5.12 The number of assigned contention slots in the adaptive scheme of the AFPBA/ASA protocol based on the average estimated number of arrival rates. The arrival rate of high priority class is fixed $\lambda_{\text{hi}} = 0.145$ packets/slot ..................5.51

5.13 Waiting time of the AFPBA/ASA protocol based on the average estimated number of arrival rates. The arrival rate of high priority class is fixed $\lambda_{\text{hi}} = 0.145$ packets/slot ..........................5.55

5.14 The number of assigned contention slots in the adaptive scheme of the AFPBA/ASA protocol based on the average estimated number of arrival rates. The arrival rate of high priority class is fixed $\lambda_{\text{hi}} = 0.175$ packets/slot ..................5.56

5.15 Waiting time of the AFPBA/ASA protocol based on the average estimated number of arrival rates. The arrival rate of high priority class is fixed $\lambda_{\text{hi}} = 0.175$ packets/slot ..........................5.57

5.16 Waiting time of the AFPBA/ASA algorithm with and without the effect of the wireless channel. The capture ratio $b = 2\text{dB}$ & 10dB .................................................................5.58

5.17 Waiting time of the AFPBA/ASA protocol with (1,9), (2,8), (3,7), (4,6) and (5,5) combinations of fixed slot assignment respectively. High priority class arrival rate $\lambda_{\text{high}}$ is fixed as follows: (a) 0.324 packets/slot, (b) 0.25 packets/slot, (c) 0.23 packets/slot, (d) 0.216 packets/slot and (e) 0.16 packets/slot. The low priority class arrival rate is varied .................................................................5.60

5.18 The waiting time of the AFPBA/ASA algorithm with the effect of Rayleigh fading only for $b = 2$ and 10dB .................................5.68
5.19 The effect of shadowing and Rayleigh fading on the waiting time of the AFPBA/ASA algorithm with one traffic class for \( b = 2 \) and 10 dB.

6.1 The effect of random transmitter power levels on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 2 \) dB.

6.2 The effect of random transmitter power levels on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 10 \) dB.

6.3 The effect of random transmitter power levels on the access delay of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 2 \) dB.

6.4 The effect of random transmitter power levels on the access delay of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 10 \) dB.

6.5 The effect of random transmitter power levels and the wireless channel combined on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 2 \) dB.

6.6 The effect of random transmitter power levels and the wireless channel combined on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 10 \) dB.

6.7 The effect of random transmitter power levels and the wireless channel combined on the access delay of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 2 \) dB.

6.8 The effect of random transmitter power levels and the wireless channel combined on the access delay of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 10 \) dB.

6.9 The effect of random transmitter power levels and the multipath fading combined on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 2 \) dB.

6.10 The effect of random transmitter power levels and the multipath fading combined on the global throughput of the FPBA algorithm when \( \gamma \) is varied in steps and \( b = 10 \) dB.

6.11 The effect of random transmitter power levels and the
The effect of random transmitter power levels and the multipath fading combined on the access delay of the FPBA algorithm when $\gamma$ is varied in steps and $b = 2$ dB.

The effect of random transmitter power levels, multipath fading and shadowing combined on the global throughput of the FPBA algorithm when $\gamma$ is varied in steps and $b = 2$ dB.

The effect of random transmitter power levels, multipath fading and shadowing combined on the global throughput of the FPBA algorithm when $\gamma$ is varied in steps and $b = 10$ dB.

The effect of random transmitter power levels, multipath fading and shadowing combined on the access delay of the FPBA algorithm when $\gamma$ is varied in steps and $b = 2$ dB.

The effect of random transmitter power levels, multipath fading and shadowing combined on the access delay of the FPBA algorithm when $\gamma$ is varied in steps and $b = 10$ dB.

The assigned transmission power levels for each priority class when $\lambda_{LO}$ is fixed at 0.15 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$ dB, $V = 11$ transmission power levels. Dotted lines are low priority class assigned transmission power levels and straight lines are high priority class assigned transmission power levels. Neither fading nor path loss is considered here.

The equivalent waiting time for both priority classes examined in Figure 6.17. $\lambda_{LO}$ is fixed at 0.15 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$ dB, $V = 11$ transmission power levels. The dotted line is low priority class waiting time and straight line is the high priority class waiting time in frames. Neither fading nor path loss is considered here.

The global achievable throughput, $S_{LO}$ and $S_{HI}$, for each priority class when $\lambda_{LO}$ is fixed at 0.15 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$ dB, $V = 11$ transmission power levels. Dotted lines are low priority class global achievable throughput $S_{HI}$ and straight lines are high priority class global achievable throughput.
**Slo.** Neither fading nor path loss is considered here.......................6.55

6.20 The Probability /density Function of the capture event for each priority class when $\lambda_{LO}$ is fixed at 0.15 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$dB, $V = 11$ transmission power levels. Dotted lines are low priority class capture probability and Straight lines are high priority class capture probability. Neither fading nor path loss is considered here.....................................................6.57

6.21 The assigned transmission power levels for each priority class when $\lambda_{LO}$ is fixed at 0.1 packets/slot, $\lambda_{MID}$ is fixed at 0.2 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$dB, $V = 11$ transmission power levels. Dashed lines are low priority class assigned transmission power levels, dotted lines are medium priority traffic class assigned transmission power levels and straight lines are high priority class assigned transmission power levels. Neither fading nor path loss is considered here..........................................................6.60

6.22 The equivalent waiting time for both priority classes are examined. $\lambda_{LO}$ is fixed at 0.1 packets/slot, $\lambda_{MID}$ is fixed at 0.2 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$dB, $V = 11$ transmission power levels. The Dashed line is low priority class waiting time, dotted line is medium priority class waiting time and straight line is the high priority class waiting time in frames. Neither fading nor path loss is considered here.......................6.61

6.23 The global achievable throughput, $S_{LO}$, $S_{MID}$ and $S_{HI}$, for each priority class when $\lambda_{LO}$ is fixed at 0.1 packets/slot, $\lambda_{MID}$ is fixed at 0.2 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$dB, $V = 11$ transmission power levels. Dotted lines are low priority class global achievable throughput $S_{HI}$ and Straight lines are high priority class global achievable throughput $S_{LO}$. Neither fading nor path loss is considered here..........................................................6.62

6.24 The Probability density Function of the capture event for each priority class when $\lambda_{LO}$ is fixed at 0.1 packets/slot, $\lambda_{MID}$ is fixed at 0.2 packets/slot and $\lambda_{HI}$ is varied. Simulation parameters are: $b = 10$dB, $V = 11$ transmission power levels. Dotted lines are low priority class capture probability and Straight lines are high
priority class capture probability. Neither fading nor path loss is considered here........................................6.63

6.25 Waiting time in frames using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.35 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). No fading or path loss is considered here........................................6.64

6.26 Global achievable throughput using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.35 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). No fading or path loss is considered here........................................6.65

6.27 Waiting time in frames using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.45 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). Multipath fading and the LESRTPL combined effect is considered here........6.66

6.28 Global achievable throughput using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.45 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). Multipath fading and the LESRTPL combined effect is considered here........6.68

6.29 Waiting time in frames using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.25 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). Multipath fading, shadowing and the LESRTPL combined effect is considered here........................................6.69

6.30 Global achievable throughput using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.25 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). Multipath fading, shadowing and the LESRTPL combined effect is considered here........................................6.70

6.31 Waiting time in frames using the FPBA algorithm with APCC. High priority class arrival rate is fixed at \( \lambda_{HI} = 0.5 \) packets/slot and Low priority class \( \lambda_{LO} \) is varied. Simulation parameters are \( b = 10 \text{db}, V=11 \). Multipath
fading, shadowing, path loss and the LESRTPL combined effect is considered here.................................6.71

6.32 Global achievable throughput using the FPBA algorithm with APCC. High priority class arrival rate is fixed at $\lambda_{HI} = 0.5$ packets/slot and Low priority class $\lambda_{LO}$ is varied. Simulation parameters are $b = 10$ db, $V = 11$. Multipath fading, shadowing, path loss and the LESRTPL combined effect is considered here.................................6.72

6.33 It shows the Probability /density Function of the capture event for each priority class when $\lambda_{LO}$ and $\lambda_{HI}$ are fixed at 0.3 packets/slot and the mobile node is moving from the center to the border of the cell (i.e., the distance $r$ between the transmitter and receiver is varied). Simulation parameters are: $b = 10$ dB, $V = 11$ transmission power levels. Dotted lines are low priority class capture probability and straight lines are high priority class capture probability. Neither fading nor path loss is considered here.................................................................6.74

6.34 The Probability density Function of the capture event for each priority class when $\lambda_{LO}$ is fixed at 0.35 packets/slot and $\lambda_{HI}$ is fixed at 0.1 packets/slot and the mobile node is moving from the center to the border of the cell (i.e., the distance $r$ between the transmitter and receiver is varied). Simulation parameters are: $b = 10$ dB, $V = 11$ transmission power levels. Dotted lines are low priority class capture probability and straight lines are high priority class capture probability. Neither fading nor path loss is considered here.................................................................6.75

7.1 The average access delay analytical and simulation performance in slots of the two new proposed algorithms over the wireless channel with one global varied traffic stream........7.9

-------- AFPBA-ASA Simulation
------- FPBA-APCC Simulation
xxxxxx AFPBA-ASA Analysis
00000000 FPBA-APCC Analysis

8.1 Bandwidth allocation problem..................................................8.2

8.2 VBR traffic model.................................................................8.20

8.3 Cell arrival algorithm...........................................................8.31
8.4 Traffic Integration Flow Chart.................................................................8.53

8.5 Voice loss rate as a function of the number of voice connections \((R_v = 8 \text{ Mbps})\).................................................................8.65

8.6 Throughput as a function of the number of voice connections \((R = 8.528 \text{ Mbps})\).................................................................8.67

8.7 Mean Uplink ABR Transmission Delay vs. Uplink Throughput for different mean burst sizes. Contention algorithm is AFPBA/ASA.................................................................8.74

8.8 Mean Uplink ABR Transmission Delay vs. Uplink Throughput for different mean burst sizes. Contention algorithm is FPBA/APCC.................................................................8.74

8.9 Mean Uplink ABR Transmission Delay vs. Uplink Throughput for different mean burst sizes. Our AR-TDMA's contention algorithm is AFPBA/ASA and NEC's model contention algorithm is Aloha.................................................................8.75

8.10 ABR VC Transmission Delay vs. Throughput for different mean burst sizes. Contention algorithm is AFPBA/ASA..........8.76

8.11 ABR VC Transmission Delay vs. Throughput for different mean burst sizes. Contention algorithm is FPBA/APCC..........8.77

8.12 ABR VC Transmission Delay vs. Throughput for different mean burst sizes. Contention algorithm is FPBA/APCC. Our AR-TDMA's contention algorithm is AFPBA/ASA and NEC's model contention algorithm is Aloha.................................................................8.77

8.13 VBR cell loss rate as a function of the number of VBR connections (connections #1 and #2).................................................................8.79

8.14 VBR cell delay as a function of the number of VBR connections (connections #1 and #2).................................................................8.80

8.15 Throughput as a function of the number of VBR connections (connections #1 and #2).................................................................8.81

8.16 VBR cell loss rate as a function of the number of VBR connections (connection #3).................................................................8.81

8.17 VBR cell delay as a function of the number of VBR