



UNIVERSITI PUTRA MALAYSIA

**DYNAMIC FEEDBACK FLOW CONTROL ALGORITHMS FOR
UNICAST AND MULTICAST AVAILABLE BIT RATE SERVICE
IN ASYNCHRONOUS TRANSFER MODE NETWORKS**

ALI MOHAMED ABDELRAHMAN

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By

ALI MOHAMED ABDELRAHMAN

**Thesis Submitted in Fulfilment of the Requirements for the Degree
of Doctor of Philosophy in the Faculty of Engineering
Universiti Putra Malaysia**

November 2000



To my parents, wife & daughter

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

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November 2000

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Faculty: Engineering

Asynchronous transfer mode (ATM) network technology has been adopted to integrate different kinds of traffic, like video, audio and data. It provides several service categories including constant bit rate (CBR), variable bit rate (VBR), available bit rate (ABR), and unspecified bit rate (UBR) service. In particular, the ABR service has been approved to use the bandwidth left by CBR and VBR services, which is ideal for data applications and can perform well for real-time applications with the appropriate implementation. Basically ABR service attempts to guarantee minimum cell rate, achieve fairness, and minimise cell loss by periodically indicating to sources the rate at which to send. Therefore, there is a critical need for an effective flow control mechanism to allocate network resources (buffers, bandwidth), and provide the negotiated quality of service.



This thesis develops dynamic feedback flow control schemes in ATM networks, with primary focus on point-to-point (unicast) and point-to-multipoint (multicast) ABR algorithms. Firstly, it surveys a number of point-to-point schemes proposed for supporting unicast ABR service. Some of these algorithms do not measure the actual ABR traffic load which leads to either overestimates or underestimates of the bandwidth allocation. Others do not monitor the activity of the sources and overlook the temporarily idle sources. The rest may be implemented with additional complexity. Secondly, the research shifts to the problems of point-to-multipoint algorithms by introducing the basic concept of multicasting ABR service and reviewing a group of consolidation schemes, where the compromise between low consolidation noise and fast transient response is the main issue. Thirdly, the design and implementation issues have been addressed together with the major drawbacks of the previous schemes and hence two algorithms have been proposed. A dynamic rate-based flow control (DRFC) scheme has been developed to support ABR service in unicast environment, while an adaptive feedback consolidation (AFC) algorithm has been designed for ABR multicasting. Finally, these schemes are extensively tested and compared with others from the literature using a wide range of network configurations and different types of traffic sources. The simulation results show that the DRFC algorithm allocates the available bandwidth fairly among the contending ABR sources, while achieving high link utilisation with reasonable growth of queues.

The AFC scheme eliminates the consolidation noise with fast transient response as well as minimising the effect of non-responsive branches.

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

**ALGORITMA KAWALAN ALIRAN SUAP BALIK DINAMIK UNTUK
PERKHIDMATAN KADAR BIT ADA PANCAR SEARAH
DAN PANCAR BERBILANG DALAM RANGKAIAN
MOD PEMINDAHAN TAK SEGERAK**

Oleh

ALI MOHAMED ABDELRAHMAN

November 2000

Pengerusi: Profesor Madya Borhanuddin Mohd Ali, Ph.D.

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Teknologi rangkaian mod pemindahan tak segerak (ATM) telah diterima untuk mengendalikan pelbagai jenis trafik seperti video, audio dan data. Ia menyediakan beberapa kategori perkhidmatan termasuk kadar bit seragam (CBR), kadar bit pelbagai (VBR), kadar bit ada (ABR), dan perkhidmatan kadar bit tak tentu (UBR). Secara khusus, perkhidmatan ABR telah diiktiraf untuk menggunakan lebar jalur yang ditinggalkan oleh perkhidmatan CBR dan VBR, yang ideal untuk penggunaan data dan menunjukkan prestasi yang baik untuk penggunaan masa nyata dengan implementasi yang sesuai. Secara asasnya, perkhidmatan ABR cuba menjamin kadar sel minima, mencapai kesamaan rata-rata dan meminimumkan kehilangan sel dengan memberi penunjuk secara berperingkat kepada punca-punca akan kadar yang perlu dihantar. Oleh itu, wujud suatu keperluan kritikal kepada mekanisme kawalan aliran berkesan untuk memperuntukkan sumber-sumber rangkaian (penimbal, lebar

jalur), dan memperuntukkan kualiti perkhidmatan yang telah dirunding.

Tesis ini membina skim kawalan aliran suap balik dinamik untuk rangkaian ATM, dengan fokus utama kepada algoritma ABR titik-ke-titik (pancar searah) dan titik-ke-titik berbilang (pancar berbilang). Pertama, ia mengkaji beberapa skim titik-ke-titik yang telah dicadangkan untuk menyokong perkhidmatan ABR pancar searah. Sesetengah algoritma ini tidak mengukur beban trafik ABR yang sebenar, yang mengakibatkan sama ada ia melebihi jangkaan atau di bawah jangkaan peruntukan lebar jalur. Ada algoritma lain pula tidak mengawasi aktiviti punca-punca dan mengatasi punca-punca yang diam sementara. Selebihnya boleh dilaksanakan dengan kerumitan yang lebih. Kedua, kajian ini beralih kepada masalah-masalah algoritma titik-ke berbilang titik, dengan memperkenalkan satu konsep asas perkhidmatan ABR pancar berbilang dan menilai satu kumpulan skim pengukuhan, di mana tolak-ansur di antara hingar pengukuhan rendah dan tindakbalas fana pantas menjadi isu. Ketiga, isu-isu rekabentuk dan pelaksanaan telah selesai berserta kelemahan-kelemahan utama skim-skim yang lepas dan demikian, dua algoritma telah dicadangkan. Satu skim kawalan aliran berasaskan kadar dinamik (DRFC) telah dibangunkan untuk menyokong perkhidmatan ABR dalam persekitaran pancar searah, sementara algoritma suap balik mudah suai (AFC) telah direka untuk pancaran berbilang ABR. Akhirnya, skim-skim ini telah diuji

secara meluas dan dibandingkan dengan skim terdapat dalam literatu, menggunakan beberapa banyak tatarajah rangkaian dan berlainan jenis punca trafik. Keputusan penyelakuan menunjukkan algoritma DRFC memperuntukkan lebar jalur yang ada dengan adil di kalangan punca-punca ABR yang bersaing, sementara ia mencapai penggunaan paut yang tinggi dengan pengembangan baris gilir yang munasabah. Skim AFC pula menghapuskan hingar pengukuhan dengan tindakbalas fana pantas serta mengurangkan kesan cabang-cabang yang tidak bertindakbalas.

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I certify that an Examination Committee met on 9th November 2000 to conduct the final examination of Ali Mohamed Abdelrahman on his Doctor of Philosophy thesis entitled “Dynamic Feedback Flow Control Algorithms for Unicast and Multicast Available Bit Rate Service in Asynchronous Transfer Mode Networks” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

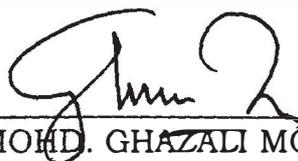
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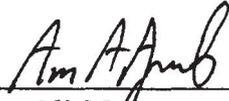
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DECLARATION

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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