UNIVERSITI PUTRA MALAYSIA

PRIORITY CONTROL IN ATM NETWORK FOR MULTIMEDIA SERVICES

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By

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LIST OF ABBREVIATIONS

ARBSD - Arrival Rate Based State Dependent

ATM - Asynchronous Transfer Mode

BAC - Buffer Access Control

B-ISDN - Broadband Integrated Service Digital Network

CAC - Call Admission Control

CBP+CBS - Complete Buffer Partitioning but Complete Bandwidth Sharing

CBR - Continuous Bit Rate

CLP - Cell Loss Probability

CLR - Cell Loss Ratio

CP - Complete Partitioning

CS+PO - Complete Sharing with Push Out

CSPO+HOL - Complete Sharing with Push Out and Head of Line

EDD - Earliest Deadline Due

EDF - Earliest Deadline First

FCFS - First come first serve

FIFO - First in first out

Gbps - Giga bit per second

HDTV - High Definition Television

HOL - Head of Line

HOL-PJ - Head of Line with Priority Jumping

LIFO - Last in first out

Mbps - Mega bit per second

MLT - Minimum Laxity Threshold

MPQ - Mixed Priority Queueing

NTCD - Nested Threshold Cell Discarding

NTCD/MB - Nested Threshold Cell Discarding with Multiple Buffers

OCF - Oldest Customer First

PBS - Partial Buffer Sharing

PJ - Priority Jumping

PJ-FT - Priority Jumping with Fixed Threshold

PJ-MT - Priority Jumping with Movable Threshold

PO - Push Out

PQC - Priority Queueing Controller

QLT - Queue Length Threshold

QOS - Quality of Service

RAM - Random Access Memory

RSD - Relative State Dependent

SCD - Selective Cell Discarding

TDA - Time Division Access

VBR - Variable Bit Rate

VC - Virtual Channel

VCI - Virtual Channel Identifier

VP - Virtual Path

VPI - Virtual Path Identifier

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PRIORITY CONTROL IN ATM NETWORK FOR MULTIMEDIA SERVICES

by

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Chairman: Prof. Madya Dr. Borhanuddin Mohd. Ali

Faculty: Faculty of Engineering

The communication network of the near future is going to be based on Asynchronous Transfer Mode (ATM) which has widely been accepted by equipment vendors and service providers. Statistical multiplexing technique, high transmission speed and multimedia services render traditional approaches to network protocol and control ineffective. The ATM technology is tailored to support data, voice and video traffic using a common 53 byte fixed length cell based format with connection oriented routing.

Traffic sources in ATM network such as coded video and bulk data transfer are bursty. These sources generate cells at a near-peak rate during their active period and generate few cells during relatively long inactive period. Severe network congestion might occur as a consequence of this dynamic nature of bursty traffic. Even though Call Admission Control (CAC) is appropriately carried out for deciding acceptance of a new call, Quality of Service (QOS) may be beyond the requirement limits as bursty traffic are piled up. So, priority control, in which traffic stream are classified into several classes according to their QOS requirements and transferred according to their priorities, becomes an important research issue in ATM network.

There are basically two kinds of priority management schemes: time priority scheme that gives higher priority to services requiring short delay time and the space priority scheme that gives high priority cells requiring small cell loss ratio. The possible drawbacks of these time and space priority schemes are the processing overhead required for monitoring cells for priority change, especially in the case of time priority schemes. Also, each arriving cell needs to be time stamped. The drawback of the space priority scheme lies in the fact that buffer management complexity increases when the buffer size becomes large because cell sequence preservation requires a more complicated buffer management logic.

In this thesis, a Mixed Priority Queueing or MPQ scheme is proposed which includes three distinct strategies for priority control method -- buffer partitioning, allocation of cells into the buffer and service discipline. The MPQ scheme is, by nature, a non-fixed priority method in which delay times and loss probabilities of each service class are taken into account and both delay times and loss probabilities can be controlled with less dependency compared with the fixed priority method, where priority grant rule is fixed according to the service class, and the priority is always given to the highest class cell among cells existing in the buffer. The proposed priority control is executed independently at each switching node as a local buffer management. Buffer partitioning is applied to overcome the weakness of the single buffer.

Three different types of switch architecture i.e. output queueing switch, input and output queueing switch and shared memory switch, have been used to evaluate the performance of the MPQ scheme using both uniform and bursty traffic sources. In the case of output queueing switch, computer simulation shows that the Quality Of Service (QOS) for each traffic class is improved if the control parameter, α and threshold, T are chosen appropriately. Three performance measures; throughput, delay and cell loss probability (CLP) were taken into consideration. The maximum throughput of the system saturates approximately at 0.80 when the MPQ scheme is implemented. Mean waiting time for each class of traffic is studied against different switch size and a variety of traffic load. It is shown that the MPQ scheme can be implemented on different switch sizes. Later, it is also shown that the MPQ scheme can maintain nearly the same CLP for each class of traffic for a variety of switch size under varying traffic conditions - such as uniform and bursty traffic sources having, burst lengths of 10 and 15 cells.

In input and output queueing switch, it is shown that the maximum throughput of the system is approximately 0.87. The switch throughput is found to be almost equal to the input trunk utilization ρ, thus it is worth noting that the efficiency of the MPQ scheme is almost independent of the switch size. During high traffic load the MPQ scheme can control the mean waiting time for delay sensitive cells by allowing these cell to be served before the non-delay sensitive cells. CLP for each class of traffic is measured against switch size and it is found that the size of switch has little effect on the performance of the MPQ scheme.

Using 'Hierarchical Growable Switch Architecture' for shared memory switch, it was shown that the maximum throughput can be increased from 87.23% to 94.27%. The mean delay of the delay sensitive cells is improved when the MPQ scheme is implemented. It is also demonstrated that during very high traffic load, the MPQ scheme can maintain three distinct CLP for three distinct traffic classes according to their QOS requirements even though a change in traffic mix occurs.

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PENGAWALAN KEUTAMAAN DALAM RANGKAIAN ATM UNTUK PERKHIDMATAN MULTIMEDIA

Oleh

SOHAIL AHMED

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Rangkaian komunikasi masa hadapan akan berasaskan teknologi ATM yang telahpun diterima secara meluas oleh pengeluar peralatan dan penyedia perkhidmatan. Teknik pemultipleksan berstatistik penghantaran kelajuan tinggi dan perkhidmatan multimedia menjadikan pendekatan tradisional kepada protokol dan kawalan rangkaian tidak berkesan. Teknologi ATM adalah dibentuk untuk menyokong data trafik, suara and video menggunakan format umum sel panjang tetap 53 byte dengan penghalaan berorientasikan penyambungan.

Sumber trafik dalam rangkaian ATM seperti video yang dikokan dan pemindahan data adalah berletusan. Sumber ini menghasilkan sel pada kadar hampir puncak pada jangkamasa aktif dan manghasilkan sedikit sel pada jangkamasa tidak aktif. Kesesakan rangkaian yang tenat mungkin terjadi akibat daripada sifat dinamik trafik letusan. Walaupun Kawalan Penerimaan Panggilan (CAC) digunakan untuk menentukan penerimaan panggilan baru, Kualiti Perkhidmatan (QOS) mungkin melebehi had keperluan apabila trafik letusan terkumpal. Oleh itu kawalan keutamaan dalam mana trafik dikategorikan kepada beberapa kelas berdasarkan kepada keperluan QOS mereka, dan dipindahkan menurut keutamaan masing masing, adalah menjadi isu penyelidikan penting dalam rangkaian ATM.

Terdapat dua jenis skim pengurusan keutamaan: skim keutamaan masa, yang memberikan keutamaan yang lebih kepada perkhidmatan yang memerlukan kelengahan yang singkat dan skim keutamaan ruang, yang memberikan lebih keutamaan kepada sel sel yang memerlukan nisbah kehilangan sel yang kecil. Masalah yang mungkin timbul dari skim keutamaan masa dan ruang ialah proses 'overhead' yang diperlukan bagi mengawal sel sel untuk pertukaran keutamaan terutama bagi keutamaan masa. Juga setiap sel yang tiba perlu diterapkan masanya. Masalah skim keutamaan ruang adalah kerumitan pengurusan penimbal yang meningkat apabila saiz penimbal bertambah membesar. Ini adalah kerana pemeliharaan jujukan sel memerlukan logik pengurusan penimbal yang rumit.

Dalam tesis ini, suatu skim Pembarisan-gilir Keutamaan Berbilang (MPQ) adalah dicadangkan yang merangkumi strategi yang jelas berbeza bagi kaedah kawalan keutamaan - pemisahan penimbal, pengagihan sel ke dalam disiplin penimbal dan perkhidmatan. Skim MPQ ialah kaedah keutamaan yang tidak ditetapkan, yang mana masa kelengahan dan kebarangkalian kehilangan setiap kelas perkhidmatan adalah diambilkira dan kedua-dua masa kelengahan dan kebarangkalian kehilangan boleh dikawal dengan mudah berbanding dengan kaedah keutamaan tetap yang mana peraturan penganugerahan keutamaan adalah ditetapkan bergantung kepada kelas perkhidmatan dan keutamaan adalah diberi kepada kelas sel yang paling tinggi di kalangan sel yang berada di dalam penimbal. Kawalan keutamaan yang dicadangkan ini dilaksanakan secara berasingan pada setiap nod pengsiusan sebagai pengurusan penimbalan tempatan. Pemisahan penimbal adalah digunakan untuk mengatasi kelemahan penimbal tunggal.

Tiga jenis senibina suis yang berbeza ia-itu; suis baris-gilir keluaran, suis baris-gilir keluaran dan kemasukan dan suis perkongsian ingatan telah digunakan untuk menilai keupayaan skim MPQ menggunakan sumber trafik seragam dan letusan. Dalam kes suis baris-gilir keluaran, simulasi komputer menunjukkan bahawa QOS bagi setiap kelas trafik adalah ditingkatkan jika parameter kawalan α dan ambang T telah dipilih dengan tepat. Tiga penguturan prestasi; kecelusan, kelengahan dan Kebarangkalian Kehilangan Sel (CLP) adalah diambil perkiraan. Kecelusan maksimum sistem tersebut menepu lebilikurang pada 0.80 apabila skim

MPQ dilaksanakan. Masa penungguan min untuk setiap kelas trafik adalah dikaji ke atas saiz suis yang berbeza dan bebanan trafik yang berbasi. Adalah ditunjukkan bahawa skim MPQ boleh diimplementasikan pada saiz suis yang berbeza. Adalah ditunjukkan juga bahawa skim MPQ boleh menyokong hampir CLP yang sama untuk setiap kelas trafik untuk saiz suis yang berbagai dalam keadaan trafik yang berbeza, seperti sumber trafik seragam dan letusan, dengan panjang letusan 10 dan 15 sel.

Dalam suis kemasukan and keluaran, kecelusan maksimum sistem adalah pada anggaran 0.87. Kecelusan suis didapati hampir sama dengan penggunaan trunk kemasukan ρ, oleh itu kekesanan skim MPQ adalah hampir bebas dari saiz suis. Dalam bebanan trafik tinggi, skim MPQ boleh mengawal masa penungguan min untuk sel sensitif-lengah dengan membenarkan sel ini di seris sebelum sel tidak sensitif-lengah. CLP untuk setiap kelas trafik diukur ke atas saiz suis dan didapati saiz suis mempunyai kesan yang sedikit pada prestasi skim MPQ.

Dengan menggunakan Senibina Suis Boleh Membesan Terhirarki, untuk suiz perkongsian ingatan, kecelusan maksimum boleh ditingkatkan dari 87.23% kepada 94.27%. Kelengahan min untuk sel sensitif-lengah adalah dibarikkan bila skim MPQ dilaksanakan. Pada bebanan trafik yang amat tinggi, skim MPQ mampu menyokong tiga CLP jelas-beza untuk tiga kelas jelas-beza mengikut keperluan QOS mereka walaupun perbahan campuran trafik berlaku.

CHAPTER I

INTRODUCTION

Background: Multimedia Services over Broadband ATM Network

The single most significant advance in telecommunications technology in the past few years had been the rapid evolution to broadband networks. From cordless/mobile phone in our bedrooms to electronic mail in our working places, communication networks have abruptly emerged as an important and almost indispensable part of our lives. Due to the recent advances in computer technology and optical fiber, new applications are rapidly coming up and are finding wide use and people acceptance. Wide area networks have evolved separately around the end application. The telephone network, which used to carry voice only, has been developed independently of information networks that can carry data, as a consequence, the technologies involved are significantly different. Voice network are based on Circuit Switching while data network use Packet Switching (e.g. INTERNET). Though these two network served well for the applications for which they were designed, recent trends are pushing diverse and distinct networks towards integrating into a common high speed architecture in order to promote integrated data-voice-video application, popularly known as multimedia. The new multimedia applications, such as video conferencing, which need high bandwidth capabilities require an underlying broadband network to provide the suitable communication infrastructure.

Recent progress in public communication infrastructure has been in high speed integrated services over hardware based high speed switching networks. The goal is to achieve a single network technology capable of supporting all known and anticipated multimedia services. The intense research, experimentation, and standardization efforts resulted in formulation of the concept of the Broadband Integrated Service Digital Network (B-ISDN) (Klienrock (1993)) and acceptance of the Asynchronous Transfer Mode (ATM) as a world-wide standard for public wide-area networks (Prycker (1993)). With advances in computer and communication technology, the demands for providing multimedia services such as voice, data, video, integrated voice and data, and integrated video and voice, etc. are increasing rapidly (Peck et. al. (1987) and Malek (1988). The transfer rates for such services vary widely from a few bit per second to several Gbs. For example, Telemetry data require only up to a few hundred bit per second, and High Definition Television (HDTV) requires 1 Gbs uncompressed and 150 Mbps compressed. Also, the Quality of Service (QOS) such as response time and cell loss ratio, are different for each multimedia service type. Data services are sensitive to cell loss rate, and not necessarily to delay. Most conventional transmission methods used for data services require the channel