Enhanced QoS Control Mechanisms for Distributed Multimedia Applications

Mirza Anwarullah Baig, Syed Abdul Sattar

Abstract*-- *Distributed multimedia applications make use of high-speed networks to transmit data packets and the processing is done at the end-systems. In such an integrated multimedia environment where assured quality of service is to be delivered to the clients and high availability predictability reliability and timeliness is required. To provide seamless quality of service support and data stream control in a truly end-to-end fashion the need for integration of network and transport service arises. An appropriate control mechanism support is required for unified processing and communication of continuous multimedia data streams.

Keywords: multimedia, bandwidth, delay, jitter

I. INTRODUCTION

Due to advancement in the computing technologies, improved power of microprocessors, increasing bandwidth and speed of the underlying network over the recent years, the distributed multimedia applications have emerged and became an important branch in modern computing applications. To meet these new application demands, many projects about distributed multimedia systems have been developed. Multimedia system has to transmit and process large amount of data in real time, hence they are always concerned about the data flows they deal with. Multimedia basic functions involve establishment, control, maintenance and release of the continuous data packets which flows along the various network paths from the sources to the end users. The major QoS specifications involved are delay, jitter, bandwidth, and reliability [1, 2]. Their tasks have deadlines however missing a particular deadline is not final. Multimedia applications are resource intensive and require quality of service (QoS) supports. The admission control and resource reservations are related with the establishment of flows. The dynamic QoS is required with the flow control and maintenance. Such QoS control mechanism is a significant task.

II. QoS REQUIREMENTS

The ability to guarantee traffic throughput rates, delay, jitter and loss rates are particularly important in networks supporting distributed multimedia applications. These performances based Metrics are likely to vary from one application to other. The relative importance of these parameters for a particular flow is also application dependent.

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To be able to commit transport and network resources the QoS-A must have prior knowledge of the expected traffic characteristics associated with each flow. Many continuous media applications require soft real-time guarantees as selected by the statistical service commitment. In the case of statistical commitment the performance parameter values in the flow spec are interpreted as a target for the QoS-A which may be violated if resources become scarce. An important distinction between the guaranteed and statistical commitments is that the guaranteed commitment is based on fixed resource allocation where no resource gain is feasible and the statistical commitment is based on shared resource allocation which encourages a high degree of resource utilization [3]. This is because of that the future pricing policy should inspire users to select statistical commitment over the guaranteed commitment when at all possible. Together the flow spec and the commitment class are used by the flow reservation and admission control functions of the flow management plane to establish end-to-end QoS. In a QoS-A, resource reservation and admission control are conducted at each layer of the architecture.

III. CONTRIBUTION

This paper detailed the importance of QoS control, QoS maintenance and management in distributed multimedia systems and proposed an enhanced QoS control mechanism for distributed multimedia applications.

IV. LITERATURE SURVEY

Integration of multimedia processing into conventional computer systems as well as support for development of distributed multimedia applications is addressed in several projects. The Chorus micro-kernel is extended to support continuous media and quality of service control in an operating system [4]. The focus, however, is on operating system issues, not so much on high-level abstractions for developing and configuring distributed multimedia applications. The problem of configuring distributed applications by using software components interconnected by linked ports is addressed by J Kramer and J Magee [5, 6], however without focusing on real-time features of multimedia processing specific abstractions for controlling multimedia data streams have been proposed. General requirements that should be met by architectures supporting distributed multimedia applications are specified in the Request for Technology [7] of the Interactive Multimedia Association. In response to this abstraction to structure and control distributed multimedia environments while using multi-vendor processing equipment is proposed in [8]. The proposal assumes generic multimedia processing elements producing and consuming multimedia data via ports that are associated with formats. However, the nesting of processing

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elements is not supported and, the grouping is used to handle resource acquisition, but how to specify the synchronization relationships between the data streams is not provided.

Some protocols have emerged which are designed specifically to meet the requirements of continuous media. The Esprit OSI project proposed an enhanced transport service and protocol called TPX [9] provides support for connection-oriented services with sequenced delivery, with negotiation, re-negotiable and error notification. The enhanced connection-oriented service takes QoS parameters relating to throughput, delay, delay jitter, error selection policy and relative priority. The Tenet Group at the University of California at Berkeley has developed CMTP [10] which operates on top of RTIP [11] and provides sequenced and periodic delivery of continuous media samples with QoS control over throughput delays and error bounds. Notification of all undelivered or corrupted data can be provided if the client selects this option. The HeiTS project [12] at IBM Heidelberg has developed a transport system which has concentrated on the integration of transport QoS and resource management, and has given importance to optimized buffer pool which minimizes copying and also allows efficient data transfer between local devices. Other significant work has come from Schulzrinne, Casener and Van Jacobson they had developed application RTP [13] a transport protocol for real-time for the Internet suite of multimedia tools [14].

The subject of providing quality of service guarantees in integrated service networks has been widely covered by Keshav [15]. The multimedia networking community has developed sophisticated traffic models, control and management architectures for multimedia. Comprehensive effort has been done for flow specification, admission control, and resource reservation traffic shaping and queue management schemes. Kurose [16] provides a categorization of the different approaches used in providing QoS guarantee. The work on an integrated services Internet [17] is a significant contribution for providing QoS guarantees on a per-flow basis. There have been extensive contributions to reservation protocols in communication networks which have emerged over the past few years.

The OSI QoS Framework is a simple and high level abstraction for general multimedia applications based on OSI communication architecture. It concentrates on the definition of terminology and concepts that are used in the multimedia systems. However, it doesn't specify the details on the implementation. Lack of concepts, specifications and maintenance on data flow is it's another deficiency.

The Quality of Service Architecture (QoS-A) developed at Lancaster University in 1993, is a layered architecture of services and mechanisms for QoS management and control of continuous media flows in a multi-service network [18, 19]. It uses the notion of flow. Flows are always simplex but can be either unicast or multicast. They may carry a range of data types including both continuous media and control data such as message or RPC packets. In this architecture, the flow concept demands tight integration between the device management, thread scheduling, and communication protocol and the network components on the end-to-end data path.

The end system QoS framework has been developed at Washington University [20] for providing QoS guarantees within the end-system for network multimedia applications. QoS specification is at a high level and uses a small number of parameters to allow applications specifying their own flow requirements. This End System QoS Framework is feasible in practice. It catches the major components in the end-to-end multimedia applications and tries to reduce contexts switching overhead and increase end-system scheduling efficiency. This framework examines the flow scheduling and shaping but doesn't mention about the flow control and synchronization.

V. QoS CONTROL MECHANISMS

Quality of service mechanisms are selected according to user supplied QoS specification and operate on timescales close to media transfer speeds. They provide real-time traffic control of flows based on requested levels of resource availability and management policy. QoS mechanisms are categorized as either static or dynamic. Static resource management deals with flow establishment and end-to-end re-negotiation phases and dynamic resource management deals with the media-transfer phase. The distinction between the former and latter is due to the different time scales on which they operate and is a direct consequence of the asynchronous resource management principle. QoS control distinguishes itself from management in that it operates on a faster more sensitive timescale. The principle QoS control building blocks include flow shaping, scheduling, policing, control and synchronization.

VI. PROPOSED ENHANCED QoS CONTROL MECHANISMS

QoS control mechanisms for media transfer operate on the fastest timescale in a QoS-A and include modules for flow scheduling, shaping, QoS filtering and METS [30] protocol control all modules operate on the media directly and in realtime. The QoS maintenance plane includes flow monitoring and maintenance mechanisms which operate on a timescale close to the protocol timescale. Flow management operates on a slower timescale than all other resource management entities. The signalling QoS mechanism resides in the control plane and includes group management, connection management, and DQM signalling protocols. The division of QoS mechanisms into planes and layers is based on the principles of separation between control and data, and that these multiple timescales operating on communication resources. The time constraints guide the division of functionality between the signalling, control and management modules. The control time domain is the fastest and operates close to the link speed of the network, signalling is at best one end-to-end or round trip away in time, flow management response time is stiffer than the former in that it ranges from one round trip in time to seconds. It should be noted that flow management is distinguished from the broader timescales experienced by

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traditional network management. QoS-A flow management lies in the time domain between signalling and network management and is considered to operate closer to the protocol and signalling speeds than traditional network management.

VII. CONCLUSION

For researchers working on multimedia networking, the primary aim has been to provide performance bounds while exploiting statistical multiplexing of bursty sources to efficiently utilize bandwidth. In this paper the importance of QoS control, maintenance and management in distributed systems has been specified. It has been shown how these functions could be used as building blocks for future QoS frameworks appropriate for the new environment and distributed multimedia applications operating over high-speed networks. The fundamental modules which reinforce thinking on end-to-end QoS have been described and the terminology, principles and concepts which will be used as a basis for developing a QoS-A for continuous media communications have been presented. Furthermore, the important notions of flow and QoS specification have been familiarized as concepts key to capturing, requesting and negotiating end-to-end QoS.

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