A QoS Prediction Management System in Distributed Multimedia Networks

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Abstract

User's qualities of services (QoS) are the basic requirements involved in distributed multimedia systems. Considering ATM network, ATM adapter cannot control the end -to-end connection satisfying the user's QoS.

This paper describes the new concept of a QoS prediction management system in the distributed network and the configuration of it's QoS prediction management architecture and also discusses it's algorithm.

1. Introduction

Requirements of network service from user will be eligible to get the quality of service (QoS) for multimedia data streams like video and audio. (1)

These continuous media have the characteristics of time constrain to process the data streams.

To satisfy these requirements in the CPU and network adapters have to guarantee the network facilities and processor's resources.

For the narrow band network and small capacity of CPU resource, user's QoS must degrade their quality to maintain this time constrains.

While multiple continuous media sessions are processing in the same time, the arbitration of resource reservation and QoS specification between these sessions are necessary.

For solving the problems of resource management of continuous media, a new architecture model of QoS prediction management system in distributed multimedia networks is introduced.

Using this scheme, resource reservation of multimedia networks and processors can be managed and adaptation of resource usage will be accomplished.

2. Definition of QoS level

In general, the quality of service (QoS) in the distributed multimedia network required by user are not the qualitative value but the quantitative characteristics.

On the other hand, the quality of service specified by networks are the special terms, such as delay, jitters, throughput, and error rate.

Therefor, QoS management in the distributed multimedia networks can be done under the mapping from user's QoS into network QoS.

As QoS parameters, user can easily define the conceptual terms like media freshness of video conference that corresponds to delay characteristics, media continuity of smoothness of video images that corresponds to jitters' characteristics, media resolution of special and temporal resolution of video that corresponds to throughput characteristics, and media reliability of compressed continuous data streams that corresponds to error rate characteristics. Scalability of continuous media depends on the characteristics of media, such as video and audio.

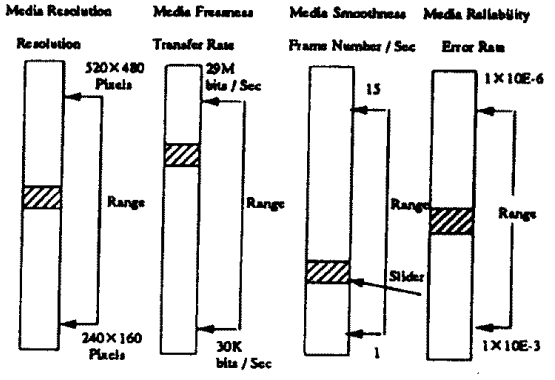

Fig. 1 QoS User Interface

User interface displaying QoS parameters adopts the sliding window method as shown in Fig. 1. (2)

3. Resource management of continuous media

For processing continuos media data streams upon the computer network, it needs to keep the time constrain of media data during processing them.

In addition, the resource reservation of process has to guarantee the times constrain after the contract between user's QoS and network characteristics.

However, when user cannot reserve sufficient resources, cannot estimate the staus of usage of resources, or is difficult to reserve the resources under the network congestion, user has to adapt the amount of resources after lowering QoS level depending on the contents of the process.

Furthermore, for the process of multiple continuous media session, sharing of resources is an important issue.

To solve this problem, new mechanism of resource reservation is needed instead of fair share discipline of management.

Requirements of new resource management are as follows:

1) Sharing of resources and negotiation

Flow control in traffic depends on QoS parameters.

During the transmission of continuous data streams from end-to-end peer, user's QoS parameters have to share system resources with their negotiation.

2) Reservation of resources

Eligible service disciplines allocate the resources delivering multimedia data streams upon the QoS level.

3) Adaptation for availability of resource

Required resources to process continuous media vary depending on the capability of CPU and the variation of media data flow.

Hence, when the lack of resources of reservation occurs, user's QoS have to degrade it's level according to the availability of resources.

4) Sharing of resources assignment between multiple media

When the multiple media have to process in the same session, sharing of resources assignment have to process depending on the priority level of each media.

4. QoS Management Disciplines

Dividing broadly into two categories of QoS disciplines in distributed multimedia networks, there are QoS manager using OS and QoS management protocol stack.

QoS management discipline by OS is easily capable to control the single continuous media, such as MPEG video reserving the network throughput and processing it's data flow.

However, multicast communication service of multiple data streams has to have a complex OS managing complicated scheduling mechanism.

Moreover, by the QoS management using communication protocol stack that have been developed recently, lower layer protocol control the bandwidth of traffic and allowable delay.

Upper layer protocol manages the mapping from upper layer QoS into lower layer protocol.

Considering multimedia communication, ATM network have several functions that execute the process depending on the specified value derived at the application layer and connect the virtual circuit (VC) according to the QoS parameters.

Purposes of multimedia network interface are the capability of connection control corresponding to QoS parameters and the establishment of effective data path for the multimedia networks.

Therefore, the effective management of QoS has to separate the connection control of network and the data path control.

At present, the existing ATM adapter, such as AAL 5 adapter only has a function of data segmentation and reassembles for executing the data transfer path.

Accordingly, QoS management for the

multimedia network shares it's role divided into the control of each layer inside QoS architecture by OS and the control of traffic by the network protocol stack.

Hence, assuming the network resources and OS resources as sharing resources, QoS broker that stays between the application layer and OS resources and network protocol stack can manage the resource reservation. (2)

Another QoS management method is the QoS tickets discipline that issue QoS tickets and adapt user's QoS requirement to the availability of network resources. (3)

For this resource reservation management, the mechanism monitoring the status of resources and controlling flow of traffic is necessary. Actually, QoS manager and Q thread library manage the reservation of resources and the adaptation of QoS.

There are three types of QoS guarantee level.

1) perfect guarantee
2) Statistic guarantee
3) Best effort service

Internet protocol is a best effort service model.

Therefore, variations of delay of arriving packets, overload of CPU and packet loss in congested traffic will cause the interruption of audio and breaking off video frame.

On the other hand, flow management acts as controlling buffer size, regulating flow of traffic, and pulling out media data streams from queue according to scheduler after originating the connection manager depending on the user's signaling and flow control protocol.

5. QoS Prediction Management

5.1. QoS Prediction Table Buffer

Required QoS parameters from user have to translate into the specified QoS value of traffic flow by the sliding window manager.

These specified QoS value compare with predicted QoS value according to the QoS prediction table buffer as shown in Fig. 2.

QoS Parameters	Level	Required	Predict	Predicted Information
Bandwidth	High		V	
	Medium	V		V
	Low			
Delay	Long			
	Normal	V	V	V
	Short			
Jitter	Small	V	V	V
	Normal			
	Large			
Reliability	High			
	Normal	V		V
	Low		V	

Fig.2 QoS Predictio Table Buffer

This QoS prediction table buffer includes the QoS predicted information that has extracted from the history of previous execution about several times.

Required QoS parameters are verified with the history of previous QoS value.

This QoS prediction method is similar to Yeh's algorithm as shown in Fig. 3. (4)

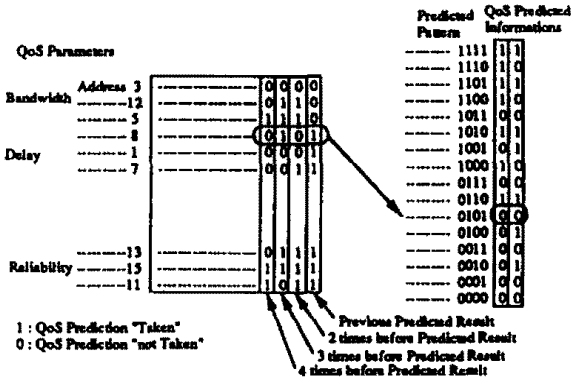

Fig.3 QoS Prediction Method

QoS parameters are stored in the QoS prediction table buffer with each parameter.

During the past four times, each history of predicted results have to be stored inside the table buffer as the QoS predicted informations.

For example, if the delay parameter of the user's QoS is "long", the QoS predicted information is (0 0)(Predict not taken with high prbability) from the predicted result

of the past four times histories.

Probability of QoS predicted information are divided into four classes as follows :

11 : Predict taken with high probability
10 : Predict taken with low probability
01 : Predict not taken with low probability
00 : Predict not taken with high probability

If QoS predicted information is 11 or 10, resource reservation manager by OS and using network protocol manager stack begin to process the reservation of resources according to QoS parameters.

If QoS predicted information is 01 or 00, resource reservation manager cannot execute any action and ask the user to degrade his QoS parameters.

After the negotiation of QoS prediction is completed, resource reservation manager run in flow management.

These QoS predicted information have to replace it's new information according to it's state diagram as shown in Fig. 4, after several result of QoS prediction have been carried out.

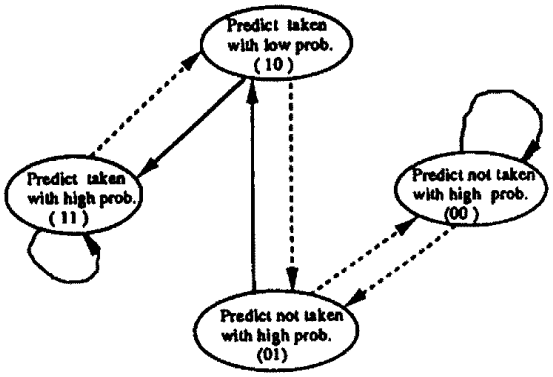

Fig.4 QoS Prediction State Diagram

This QoS prediction algorithm is effective when the events of " predict taken " or " predict not taken " occur in a short period.

The hardware for this QoS prediction buffer as shown in Fig. 5 is similar to the hardware of cache.

The required QoS parameters is matched against a set of QoS predict value.

If the required QoS match each value corresponding to QoS prediction table buffer, QoS prediction is taken.

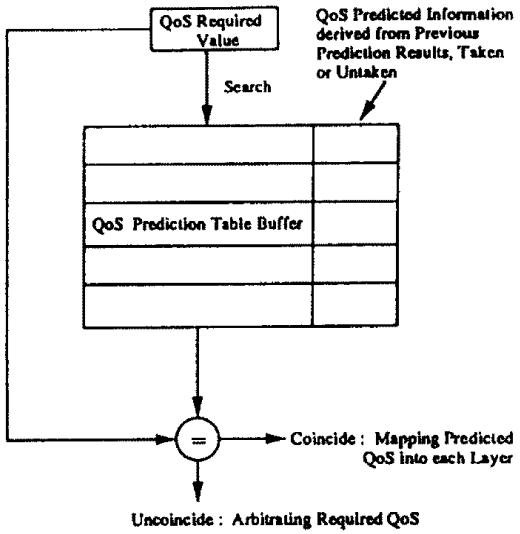

Fig.5 QoS Prediction Buffer Hardware

The second field of this table just tracks whether the QoS parameters has been predicted " taken" or " untaken" and helps to keep the misprediction penalty small.

5.2. QoS Prediction Management Architecture

The QoS architecture is a layered architecture of network services and mechanism for QoS management and control of continuous media flows in distributed multimedia networks. (1)

Flow that carries both multimedia data streams and control data of several messages are simplex but are either unicast or multicast.

The QoS prediction management architecture is shown in Fig. 6.

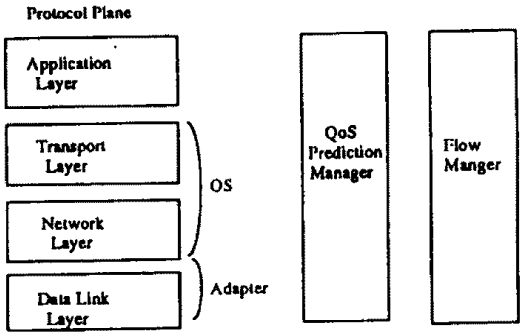

Fig.6 QoS Prediction Management Architecture

Inside the protocol plane, the lower layers including network protocol stack provide connection links and execution of

multimedia data path that does multimedia synchronization services across multiple related application flows and delay jitter correction.

The upper layer manages the mapping from user's QoS into application QoS. The QoS prediction managers maintain the level of QoS in the managed flow by means of predicted resource tuning discipline.

The flow manager executes active QoS management and adaptation between the device management, CPU scheduling, communication protocol and network components of the end-to-end data path.

On the other hand, OS handles QoS management that is flow addmission control, resource reservation and QoS based routine, QoS re-negotiation,QoS mapping and QoS adaptation.

5.3 QoS Prediction Management System Hardware

Design of a QoS prediction management system has to optimize the protocol data path at the end-host in the context of multimedia data streams running on an ATM network. (5)

Hardware configuration of a QoS prediction management system is shown in Fig. 7.

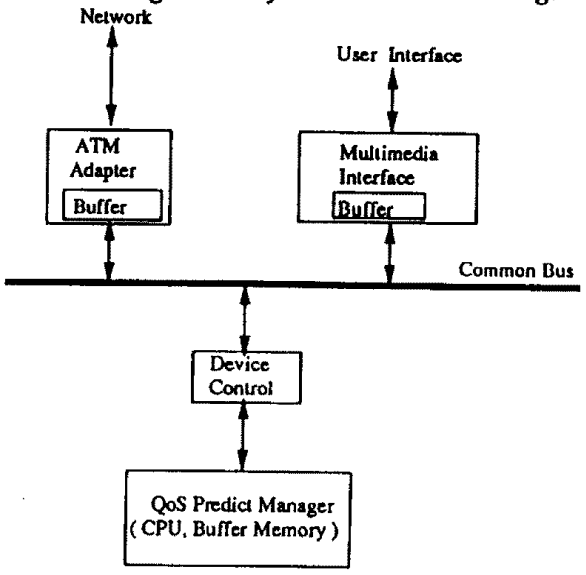

Fig.7 QoS Prediction Management System Hardware

On the transmitting side, user interfaces are connected directly to multimedia interface card that capture, digitize and compress the multimedia data and packetize into buffer memory.

Signaling from user will send the data that is ready to be read from the driver indication. After receiving the signal, multimedia interface card sends it's buffered data over UDP/IP socket connection to it's peer.

Similarly, on the receiver side, multimedia interface card receives data on the UDP socket from the network interface and writes it into the multimedia interface buffer. QoS prediction manager process transmitting and receiving data path.

This is responsible for flow establishment (including flow admission control, resource reservation and QoS based routing), QoS re-negotiation, QoS mapping (which translates QoS representations between layers) and QoS adaptation (which implements coarse grained QoS maintenance control).

6. Related Works

QoS management methods have been investigated in several institutes. Lancaster university proposed the dynamic rate shaping of coded digital video, such as MPEG 2. (6) IBM European Network Center studied the media scaling method with HeiTS protocol. (7) Microsoft Research proposed Rialto OS that contains the resource management. (8) The definition of QoS adopts the benefit function that combines the QoS and the degree of satisfaction. (9) Q thread process model has been studied by North Carolina university as the rate based execution. (10) Futhermore, research works of scheduling mechanism for multimedia processing, (11), (12), and video player with dynamic QoS mechanism. (13)

This QoS prediction management method has to be improved by adopting above mentioned results.

7. Conclusion and Future Work

In this paper I have described in detail a QoS prediction management system with particular emphasis on design of QoS prediction buffer hardware and it's algorithm.

In near future, implementation of this system will be carried out using several workstation adopting an ATM LAN and examined the modification of real time OS especially, the structure of kernels, the API of QoS prediction manager and discussed the compressed data streams, such as MPEG 2.

Furthermore, an on demand multimedia education system as this application using this newly method will be implemented and also even in the congested network and the variation of process of CPU resource, the QoS prediction management system will be evaluated.

When an appropriate network protocol for the multimedia data stream is standardized, the distributed multimedia networks will be managed by user's QoS.

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