Service Delivery in Multimedia Traffic Communications.

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ABSTRACT

This paper exposes current proposals to develop a relationship between user perceptions of quality and the factors which must be addressed by the telecommunications operator to provide an acceptable level of service. The characteristics of a multimedia traffic that makes service delivery difficult shall be addressed. Also problems of the internet as a delivery medium for multimedia traffic based application is studied with the attendant revelation of serious deficiencies as a communication medium shall be discussed.

(Keywords: multimedia traffic, quality of service, QoS parameters, congestion control, cell arrival rate, internet variable bit rate)

INTRODUCTION

The quality and quantity of any data sent to a user is limited by the quality and quantity which the underlying data transfer system(s) can support. It is also true that in general, there is a mismatch between the theoretical maxima and those which are available in practice. Due to factors such as the sharing of resources with other users, the overheads generated by the various communication tasks, etc. The implications of this from other user's perspective are that other applications which rely on the transfer of data are limited by the ability of the data transfer system in terms of speed, reliability and accuracy.

This places a places a requirement on the developers of these applications to have an awareness of the impact of these limits, and to design their systems accordingly. However, the situation is made more complex by the fact that the quality of quality (QoS) available varies from network to network, and may also vary overtime on the same system, due to the need to share resources between a variable number of other user. It is therefore important to be aware of the processes by which QoS can be determined, negotiated and varied before or during the operation of an application. This paper will discuss the QoS requirements for multimedia communication systems, the use of source characterization in resource allocation, the characteristics of multimedia traffic, and QoS requirements for multimedia traffic and its classification. Finally, co-ordination between application and network based on QoS is reviewed and general
conclusions are drawn.

SOURCE CHARACTERIZATION IN RESOURCE ALLOCATION

The traffic parameters describe traffic characteristics of the packetized data (or cell) streams. According to the CCITT, the following parameters are important in source characterization [1]:

- Peak arrival rate of the cells when the source is in the active state(peak rate);
- Average cell arrival rate;
- Burstiness - This is defined as the ratio between the peak cell rate and the average cell rate: and
- Average duration of the active state.

The above traffic characterization parameters are used in important network functions such as admission control, usage parameter control and resource allocation. The values of the traffic parameters are negotiated between the user/terminal and the network during the call set-up phase: combined with the traffic characteristics of the aggregate cell arrival stream in the network, they are used for the operation of the admission control function, deciding whether or not a new connection is to be accepted. In the usage parameter control, the algorithm monitors whether the traffic characterization parameters negotiated during the connection establishment are violated by the user during the call. Moreover, for the resource allocation purposes, the traffic parameters are used by the network operator as the basis for allocating resources to user demands.

MULTIMEDIA TRAFFIC CHARACTERIZATION

Source characterization necessitates the precise definition of the behavior of each, and provides network management with the ability to manipulate flexibility the various services in terms of connection acceptance, negotiation of the QoS, congestion control, traffic enforcement and resource allocation.

The feasibility and efficiency of the QoS management architecture are strongly dependent upon the nature of the traffic to be accommodated. Selecting appropriate models of multimedia traffic sources is an important issue because traffic characterization provides network management to manipulate flexibly the various services in terms of connection acceptation, negotiation of the QoS, congestion control, traffic enforcement and resources allocation [1]. The multimedia traffic models range from constant bit-rate (CBR) to variable bit-rate (VBR). In particular, the VBR traffic generated by compressed audio and/or video is not only delay-sensitive but also bursty and long-range dependent [2]. Markov modulated process models, Fractional Brownian motion model[4] and Bounding Interval-Dependent (BIND) model etc. have tried to capture the statistical characterization of the aggregate and heterogeneous multimedia traffic. Further investigation and comparison of these traffic models is important. The target is to set up a better determination traffic model associated with a tighter traffic constraint function which in turn results in higher network utilization.

Our studies [2] have shown that multimedia traffic differs from 'traditional' network traffic in the following ways:

- A requirement for real-time transmission of continuous media information (audio and video),
- Substantial volumes of data to be exchanged due to the encoding of continuous media information,
- Distribution-oriented applications; and
- Long-range dependency (or similarity)

These properties impose challenging QoS requirements for multimedia communication systems: furthermore, different multimedia applications present different demands on the network. Our analysis will examine these requirements.

QUALITY OF SERVICE REQUIREMENTS FOR MULTIMEDIA TRAFFIC

Recent experience with the indicates that it is not well suited to time and loss sensitive multimedia applications such as voice and video. To support multimedia applications, the following six network criteria are critical:

- Throughput
- Transit delay
- Delay variation
- Error rate
- Multicasting and broadcasting capabilities
- Document caching capabilities

These network criteria are closely associated with quality of service(QoS). According to ITU-T Recommendation E.800, the QoS is defined as follows:

The QoS is the collective effect of service performances which determine the degree of satisfaction of a user of the service.

This implies that the user is the final arbiter of 'good' or 'bad' QoS. Different applications demand different service qualities. Some need minimal delay and reliable response time, while others may need a good image quality. Table 1 summarizes the five categories of QoS parameters. The QoS is a difficult issue in that the relationship between application QoS parameters and network QoS parameters is very complex; QoS must be end-to-end; and the application QoS might change during connections.

The following two sections explain such issues in detail.

Table 1: The Five Categories of QoS Parameters.

CATEGORY	EXAMPLE PARAMETERS
Performance-oriented	End-to-end delay and bit rate
Format-oriented	Video resolution, frame rate, storage format, and compression scheme
Synchronisation-oriented	Skew between the beginning of audio and video sequences
Cost-oriented	Connection and data transmission charges and copyright fees
User-oriented	Subjective image and sound quality

QUALITY OF SERVICE TRANSLATION

QoS requirements for applications are typically end-to-end requirements which impose corresponding performance demands on both the network and the end-systems/applications. QoS parameters specify the resource quantity allocated to the user/application QoS into network QoS.

The translation between user QoS and application QoS is nontrivial and still an open issue, because the perceptual issues are not completely understood. Application QoS should be translated to the network QoS. The user specifies the application QoS. Then the communication system will map requirements into a set of system, protocol and network QoS specifications. This translation process is illustrated in Figure 1.

Figure 1 clearly shows that a user or an application specifies requirements: a communication system is responsible for meeting these specifications, and possibly requests an appropriate network resource to the network. The relationship between the application QoS and the network QoS is important because the application QoS can be very different from the network QoS.

These QoS differences should be considered in the set-up stage between the user and the network provider. QoS parameters must be mapped to the resource requirements and the required resources must be determined, reserved and allocated along the path between the application and provider/peer application.

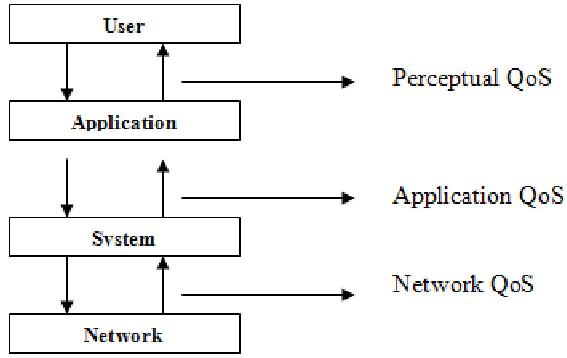

Figure 1: QoS Mapping Diagram.

QUALITY OF SERVICE CO-ORDINATION

To provide applications with end-to-end QoS guarantees, a QoS co-ordination architecture is required in which the QoS specification and QoS mechanism systematically provide application-level QoS requirement and end-to-end QoS guarantee [10]. From this point of view, the multimedia communication system should provide the following features:

- QoS translation captures application QoS requirements and configures system and network QoS specification correspondingly.
- QoS control mechanisms provide real-time traffic control of flows based on requested levels of QoS established during the connection. The basic QoS control mechanisms include traffic shaping, scheduling and flow control.
- QoS management mechanisms ensure the contracted QoS is sustained, which operate on a slower time scale and implement the QoS monitoring, maintenance, renegotiation and scalability.

In principle, the QoS co-ordination should configure, predict and maintain QoS specification to meet the end-to-end QoS. To manage QoS successfully, QoS co-ordination must be able to do the following [3]:

Allow explicit specification of QoS parameters when creating a session for multimedia transmission:

1. Translate application QoS parameters into network layer QoS parameters;

2. Negotiate QoS demands on the application's behavior; reserve the necessary resources at communication systems if negotiation is successful;

3. Perform dynamic QoS management on existing sessions;

4. Employ admission control to check if enough resources are available to satisfy a new application:

5. Regulate and monitor all sessions to protect network resources from misbehaving users

Current network QoS allocation systems are unable to answer these demands because they are incomplete, lack mechanisms to guarantee QoS and do not adhere to an overall framework [4].

No significant work has been reported so far on the integration of multimedia traffic source modeling and network management with emphasis on the quality of service guarantee [5][6]. Moreover, the area of network support for flows remains an unsolved important issue in the QoS management architecture. Therefore, it will be necessary to design and develop an integrated QoS strategy, spanning traffic source modeling and measurement, network scheduling disciplines and resource management mechanisms.

On-line estimation of data flow will be applied to achieve accurate characterization of the active application. This estimation will then be employed to trigger dynamic system and network resource reservation procedures. The current network traffic load and the offered QoS will be reported to the user to allow the choice or adjustment of QoS parameters while the application is running. We intend that the results of our study will promote the support of QoS provision in multimedia communication system.

CONCLUSION

Quality of service is increasingly important for multimedia communication systems. This paper has addressed the important issues of QoS provision for multimedia communication systems: first, understanding multimedia traffic characterization is very important to identify the QoS requirement and implement QoS translation; second, QoS requirement is indispensable for multimedia communication systems; third, QoS translation involves the allocation of system and network resources and this translation should be bi-directional for the purposes of QoS negotiation; finally, QoS co-ordination architecture must be required to provide guaranteed QoS for the multimedia application during the connections. We envisage that these functionalities of QoS will be truly supported in multimedia communication systems in the near future.

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