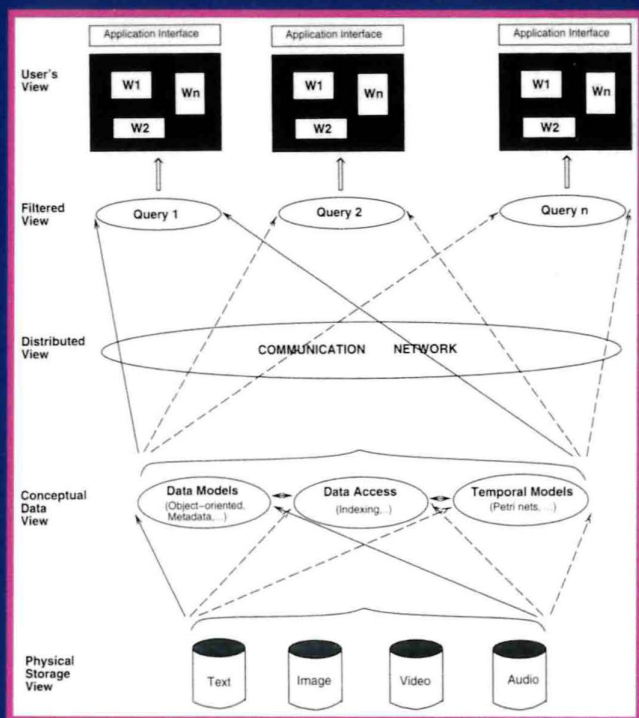


Multimedia Database Management Systems

B. Prabhakaran



Springer Science+Business Media, LLC

Amazon v. Audio Pod
US Patent 10,805,111
Amazon EX-1066

MULTIMEDIA DATABASE MANAGEMENT SYSTEMS

THE KLUWER INTERNATIONAL SERIES IN ENGINEERING AND COMPUTER SCIENCE

MULTIMEDIA SYSTEMS AND APPLICATIONS

Consulting Editor

Borko Furht
Florida Atlantic University

Recently Published Titles:

VIDEO AND IMAGE PROCESSING IN MULTIMEDIA SYSTEMS, by
Borko Furht, Stephen W. Smoliar, HongJiang Zhang

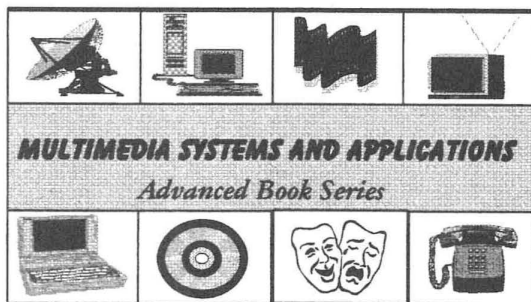
ISBN: 0-7923-9604-9

MULTIMEDIA SYSTEMS AND TECHNIQUES, edited by Borko Furht

ISBN: 0-7923-9683-9

MULTIMEDIA TOOLS AND APPLICATIONS, edited by Borko Furht

ISBN: 0-7923-9721-5



MULTIMEDIA DATABASE MANAGEMENT SYSTEMS

B. Prabhakaran

*Department of Computer Science and Engineering
Indian Institute of Technology, Madras, India
and
University of Maryland at College Park, Maryland, USA*

SPRINGER SCIENCE+BUSINESS MEDIA, LLC

Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available
from the Library of Congress.

ISBN 978-1-4613-7860-0 ISBN 978-1-4615-6235-1 (eBook)
DOI 10.1007/978-1-4615-6235-1

Copyright © 1997 by Springer Science+Business Media New York
Originally published by Kluwer Academic Publishers in 1997
Softcover reprint of the hardcover 1st edition 1997

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher, Springer Science+Business Media, LLC.

CONTENTS

PREFACE	vii
1 INTRODUCTION	1
1.1 Types of Multimedia Information	2
1.2 Multimedia Database Applications	3
1.3 Multimedia Objects : Characteristics	7
1.4 Multimedia Database Management System : Components	10
1.5 Concluding Remarks	21
2 MULTIMEDIA STORAGE AND RETRIEVAL	25
2.1 Multimedia Object Storage	25
2.2 File Retrieval Structures	40
2.3 Disk Scheduling	42
2.4 Server Admission Control	46
2.5 Concluding Remarks	49
3 METADATA FOR MULTIMEDIA	53
3.1 Metadata : Classification	53
3.2 Metadata for Text	57
3.3 Metadata for Speech	62
3.4 Metadata for Images	69
3.5 Metadata for Video	74
3.6 Concluding Remarks	81
4 MULTIMEDIA DATA ACCESS	85
4.1 Access to Text Data	85
4.2 Access to Speech Data	95

4.3	Access to Image Data	97
4.4	Access to Video Data	108
4.5	Concluding Remarks	112
5	MULTIMEDIA INFORMATION MODELING	117
5.1	Object-Oriented Modeling	117
5.2	Temporal Models	128
5.3	Spatial Models	134
5.4	Multimedia Authoring	136
5.5	Concluding Remarks	138
6	QUERYING MULTIMEDIA DATABASES	141
6.1	Query Processing	141
6.2	Query Languages	144
6.3	Concluding Remarks	152
7	MULTIMEDIA COMMUNICATION	155
7.1	Retrieval Schedule Generation	155
7.2	Multimedia Server-Client Interaction	162
7.3	Network Support for Multimedia Communication	168
7.4	Concluding Remarks	173
8	MMDBMS ARCHITECTURE	177
8.1	Distributed MMDBMS Architecture	177
8.2	Implementation Considerations	180
8.3	Concluding Remarks	181
	REFERENCES	183
	INDEX	205

MULTIMEDIA COMMUNICATION

Objects composing multimedia databases can be distributed over computer networks. Accessing distributed multimedia objects necessitates support from the network service providers. Large sizes of media objects influence the bandwidth (or the throughput) required for communicating these objects. Real-time nature of the media objects necessitates guaranteed delivery of objects at specified time instants.

As discussed in Section 5.2, the objects composing a response to a query have to be presented according to the temporal characteristics specified in the database. Hence, a client accessing a multimedia database server has to retrieve the objects in such a way that they can be presented according to the specified temporal schedule. In other words, the client has to determine a retrieval schedule that specifies when it should make a request for an object from the multimedia database server. This retrieval schedule depends on the throughput offered by the computer network.

In this chapter, we identify the possible ways in which a retrieval schedule can be generated, and then we examine the communication requirements of multimedia database applications.

7.1 RETRIEVAL SCHEDULE GENERATION

In a distributed multimedia database application, objects composing a database can be dispersed over computer networks. A client composes a query and com-

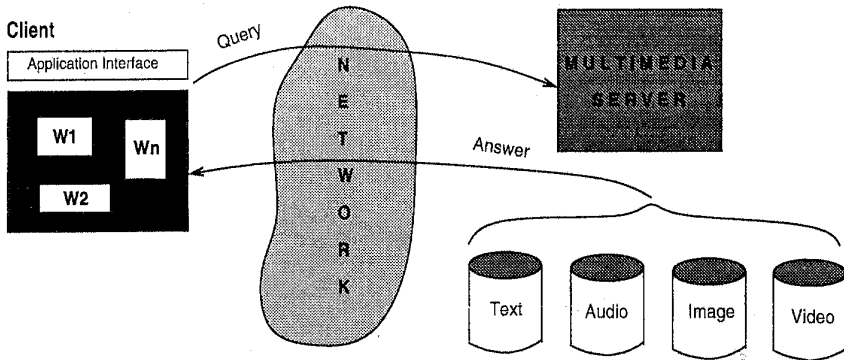


Figure 7.1 Server-Client Interaction : Single Connection

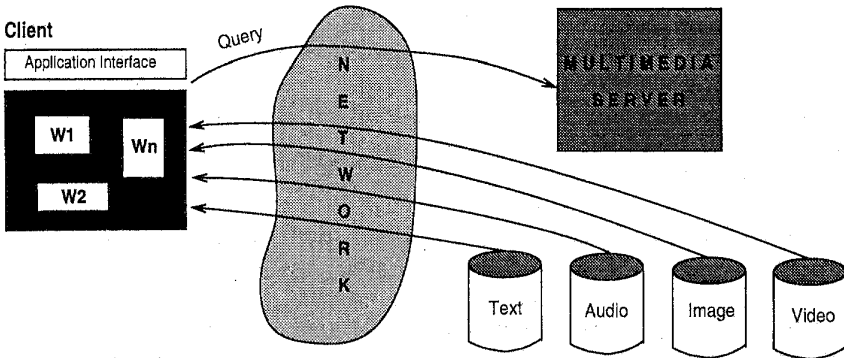


Figure 7.2 Server-Client Interaction : Multiple Connections

municates it to the server. The server processes the query, formulates the response and communicates it back to the client. This interaction between server and client is carried over communication channel(s) (also called *network connections*) established between them. Client-server interaction can be carried over a single communication channel, as shown in Figure 7.1. Here, all the media objects composing the response have to be communicated over the same channel. Alternately, multiple channels can be used for communicating individual media objects, as shown in Figure 7.2. In the case where objects are distributed on different servers, a communication channel might be required between the client and each of the servers, as shown in Figure 7.3.

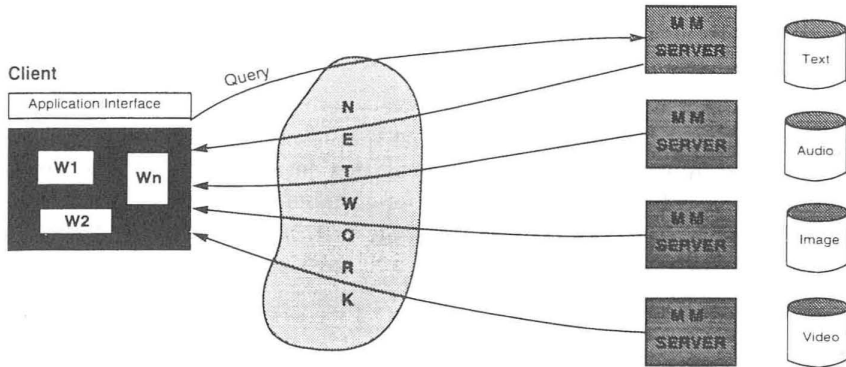


Figure 7.3 Servers-Client Interaction

The objects composing the response to the query, have to be retrieved from their server(s) and presented to the user. With the storage place acting as a *server* and the retrieving system as a *client*, the retrieval process is initiated by the client (as opposed to the server just *delivering* the objects following some schedule of its own). Hence, this retrieval process is composed of the following phases :

- Identify a *presentation schedule* that satisfies the temporal specifications associated with the multimedia database
- Identify a *retrieval schedule* that specifies the time instants at which the client should make a request to the server(s) for delivering the objects that compose the response

7.1.1 Presentation Schedule

Specification of temporal relationships among objects composing a multimedia database was discussed in Section 5.2. These relationships have to be *translated* into a presentation schedule that specifies the time instants and durations of object presentations. For hard temporal models, this presentation schedule is the same as that of the specification. However, for flexible temporal models, the specification has to be *solved* to determine a presentation schedule. As an example, consider the following temporal specification discussed in Section 5.10.

- Show the video of the movie *Toy Story* SOMETIME BETWEEN 10.58 AM and 11.03 AM, till the audio is played out

We can derive a presentation schedule that specifies the start time of presentation of object A as 10.59 AM. If the presentation duration of audio object is 15 minutes, then video will also be played for 15 minutes. Derivation of presentation schedule for an object has to be done by keeping in mind its temporal relations to other objects.

7.1.2 Retrieval Schedule

The retrieval schedule specifies when a client should retrieve an object from its server so that the object can be delivered according to its presentation schedule. As an example, in the above temporal specification for the movie *Toy Story*, if we know that the delay for retrieving the video object from its server is 3 minutes, then the retrieval schedule can be fixed at 10.56 AM (so that the movie presentation can be started according to its presentation schedule at 10.59 AM). The derivation of retrieval schedule is constrained by the following factors :

- Throughput (or the bandwidth) of the communication channel between the server and the client (i.e., the amount of data that will be sent through the network per unit time. It is specified in terms of bits per second.)
- Buffer availability in the client for retrieved objects
- Size(s) of the object(s), in terms of bytes, that is(are) to be retrieved from the server
- Time duration available for retrieval

In the above set of constraints, the throughput of the communication channel and the buffer resources are system dependent. The available throughput can vary depending on the type of network and the load on it. The buffer resources are dependent on their availability in the client system. The last two constraints : sizes of the objects and the time available for retrieval, are application dependent. The sizes of the objects depend on the type of media as well as the desired *quality* of presentation. For example, an image object may be retrieved as a thumbnail sketch or as a full image. The time available for

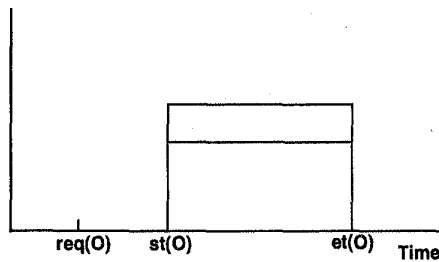


Figure 7.4 Single Object Retrieval

presentation depends on the derived presentation schedule from the temporal specification. While deriving the retrieval schedule, the following issues might have to be kept in mind.

1. Multiple objects can be retrieved over either :
 - The same network channel (as shown in Figure 7.1)
 - Different network channels (as shown in Figures 7.2 and 7.3)
2. Network provides a maximum throughput Th_{max} for each channel. Hence, this available throughput has to be shared by different objects in case their retrieval from a server has to be done simultaneously over the same channel. This throughput offered by the network service provider can vary with time, depending on the network load.
3. The client provides a maximum buffer Buf_{max} to the multimedia application for storing the retrieved objects before their presentation.
4. Depending on the media type, objects might have to be either completely or partially retrieved before the start of their presentation. For example, objects such as images have to be completely retrieved before their presentation. For objects such as video, a chunk of frames may be retrieved before the start of the entire video presentation. The rest of the frames can be retrieved as the presentation progresses.

Based on these assumptions, we now discuss how a retrieval schedule can possibly be determined.

Single Object Retrieval : As the simplest case, let us consider the retrieval of a single object as shown in Figure 7.4. The object O has to be presented by

the client at time $st(O)$. Let us assume that the retrieval of the object has to be completed before $st(O)$, as in the case of images. The client makes a request at $req(O)$ to the server for the transfer of the object ($req(O)$ must be *before* $st(O)$). Here, the retrieval schedule of object O , $req(O)$, depends on :

- Time required for transferring the object from the server to the client ($\frac{sz(O)}{Th_{max}}$, where $sz(O)$ is the size of the object)
- Round trip time required for sending the request to the server and receiving the response (Δt)

Hence, for retrieval of objects such as images (whose retrieval needs to be completed before their presentation), $req(O)$ can be defined as : $req(O) = st(O) - \{\frac{sz(O)}{Th_{max}} + \Delta t\}$.

For objects such as video, $sz(O)$ can represent the chunk of frames that needs to be retrieved before the start of presentation (since whole video objects might require large buffer spaces). In the case where multiple objects are to be retrieved, the above procedure can be used if multiple communication channels are used for transferring them (i.e., one channel is used for transferring one object at a time).

Simultaneous, Multiple Object Retrieval : In many cases, multiple objects might have to be retrieved simultaneously over the same communication channel. In this case, the available throughput and the buffer resources have to be shared among the objects to be retrieved. The constraints that must be obeyed by the objects sharing the same communication path are the following:

- **Throughput :** Each communication channel has a maximum bandwidth, Th_{max} . Hence, the sum of the throughputs required by the objects that share the same path should be less than this maximum value. If objects $o_1 \dots o_n$ with throughput requirements $th(o_1) \dots th(o_n)$ are to be retrieved simultaneously over the same network channel, then $th(o_1) + \dots + th(o_n) \leq Th_{max}$.
- **Buffer :** Let the client's maximum available buffer space be Buf_{max} . If objects $o_1 \dots o_n$ are retrieved over the same network channel simultaneously and $buf(o, t)$ denotes the buffer usage of object o at time t , then $buf(o_1, t) + \dots + buf(o_n, t) \leq Buf_{max}$.

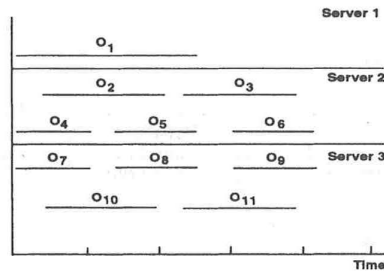


Figure 7.5 Simultaneous, Multiple Object Retrieval From Multiple Servers

Simultaneous, Multiple Object Retrieval From Multiple Servers:

Figure 7.5 shows how objects composing a multimedia database presentation are retrieved from different servers. Here, separate network connections will be used for retrieving objects from the servers. Throughput constraints for multiple object retrieval have to be satisfied for each network connection separately. However, buffer constraint is the same as the entire retrieval is handled by the client.

7.1.3 Summary

In distributed multimedia database applications, a client issues a query. The response from the server(s) may be composed of multimedia objects. These objects have an associated temporal characteristics (as discussed in Section 5.2). Based on these temporal characteristics, a presentation schedule for presenting the objects has to be derived. The client has to retrieve objects composing the response from the servers so that this derived presentation schedule can be satisfied. This retrieval schedule depends on the following:

- Presentation schedule
- Sizes of the objects
- Throughput offered for the communication channel(s)
- Buffer available at the client

Figure 7.6 shows the block diagram of a simple retrieval schedule generator. The retrieval schedule algorithm takes as input the temporal relationships and

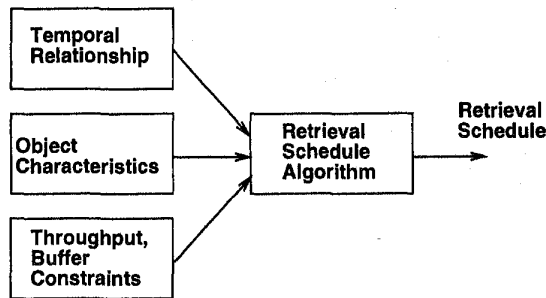


Figure 7.6 Components of Retrieval Schedule Generator

the object characteristics (the size of the object, whether the object has to be retrieved in full as in the case of images or in parts as in the case of video). Based on the system constraints such as throughput and buffer availability, the retrieval schedule algorithm computes a retrieval schedule.

7.2 MULTIMEDIA SERVER-CLIENT INTERACTION

We discussed the issues in generating retrieval schedules so far. The retrieval of multimedia information can be done using a single communication channel or by using multiple channels, as shown in Figures 7.1 and 7.2 respectively. Group of multiple network channels are termed as *channel groups*. Multimedia information, in response to client's query, can also be retrieved from multiple servers, as shown in Figure 7.3. Depending on the type of media information that is retrieved, the requirements of the channels might vary. These requirements are characterized by the following set of parameters, termed the Quality of Service (QoS) parameters.

1. *Traffic throughput* : This QoS parameter is related to the amount of data that will be sent through the network per unit time, specifying the traffic communication needs in terms of the bandwidth required.
2. *Transmission delay* : This parameter specifies the delay that a transmitted data unit can suffer through the network. This parameter may be expressed either in terms of an absolute or a probabilistic bound. In ad-

dition to a delay bound, a bound on the delay variation, called the *delay jitter*, can also be specified.

3. *Transmission reliability*: This parameter is primarily related to the buffering mechanisms involved in data transmission along the network. Because of the limited size of these buffers, some packets might be lost due to traffic congestion. A probabilistic bound on such losses influence the amount of resources required for the establishment of a communication channel.
4. *Channel group relationship*: Another consideration for multimedia applications is that a group of channels might be required simultaneously for transferring different media objects. In some cases, synchronization has to be provided among channels when they are used for transferring media such as audio and video. Relationship among the channels can be specified in terms of inter-channel bounds on QoS parameters (bounds on delay jitter, in the case of audio and video channels).

Communication between a multimedia server and a client comprises of the following phases, as shown in Figure 7.7.

- Channel establishment
- Data transfer
- Channel release

Channel Establishment Phase : During this phase, the client specifies the type of QoS needed for the communication channel to the multimedia database server. The specification of the QoS parameters have to be agreed upon by the client, the server, and the network service provider. This tripartite agreement implies that sufficient resources have to be reserved by the client, the server and the network service provider in order to provide the required QoS. This process of reaching an agreement for the required QoS is termed as *QoS negotiation*. Group of channels, if required, need to be established during the connection establishment phase.

Data Transfer Phase : involves communication of multimedia information between the server and the client, as shown in Figure 7.7. The rate of data transfer should follow the throughput agreed upon during the connection establishment phase.

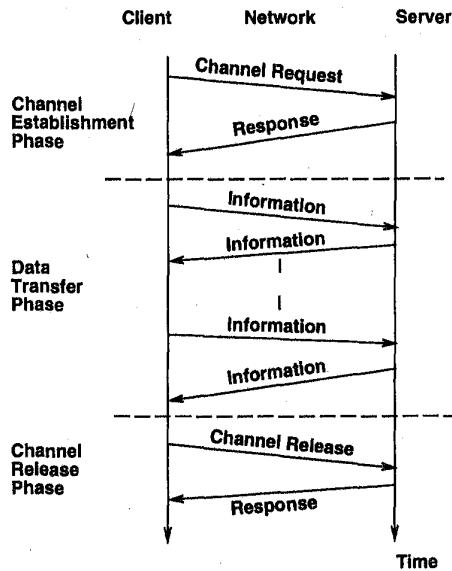


Figure 7.7 Phases in Multimedia Server-Client Communication

Channel Release Phase : involves the release of the resources held by the client, the server, and the network service provider.

The above phases are true for any server-client communication. However, for multimedia database applications, the following issues have to be addressed by the network service provider:

- QoS Negotiation
- Channel group services
- Synchronization of object transfer

7.2.1 QoS Negotiation

For demanding QoS support from the network service provider, a multimedia client should first determine the following QoS requirements.

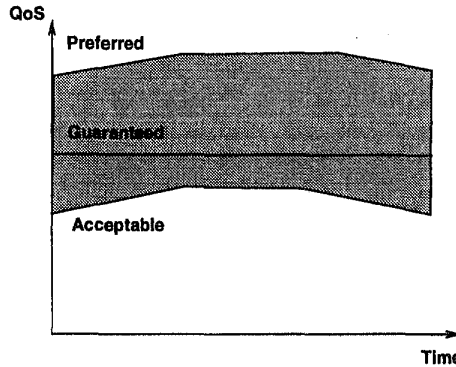


Figure 7.8 QoS For A Communication Channel

- **Preferred QoS values :** These refer to the ideal conditions for the application, say with respect to the buffering required as discussed in Section 7.1.2.
- **Acceptable QoS values :** These refer to the minimum values that are required for carrying on with the application.

Once the client determines the required QoS parameters, it has to interact with the network service provider for establishing communication channels with the required QoS parameters. The client initially makes a request for the *preferred* QoS. The network as well as the multimedia server (to which the communication channel is requested), depending on the existing load conditions, can provide the requested parameters or offer a **possible** set of QoS parameters. In the case of network offering a *possible* set of QoS parameters, the client should check the *possible* QoS with the *acceptable* values to determine whether it can tolerate the modification. If the modification is acceptable to the client, the network can establish the communication channels thereby enabling the client to carry on the communication with the server. The preferred and acceptable values denote the maximum and minimum values of the QoS spectrum, as shown in Figure 7.8. The guaranteed QoS, arrived at after negotiation with the network service provider, will be somewhere in this spectrum.

Dynamic QoS Modification : The QoS guarantees can be soft or hard. In the case of hard guarantees, the network service provider offers *deterministic* values for the QoS parameters. Here, the network cannot modify the offered QoS afterwards. In the case of soft guarantees, the network service provider of-

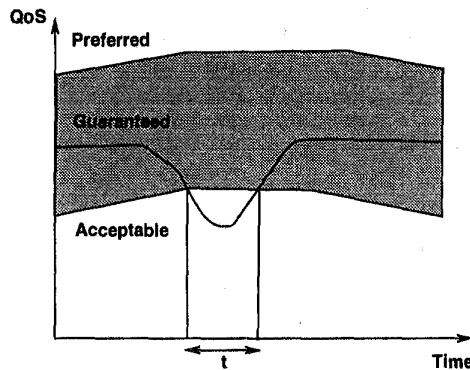


Figure 7.9 Dynamic QoS Modification By Network Service Provider

fers probabilistic values. If the guarantees are soft, the network service provider may modify the offered QoS parameters dynamically, depending on the load. The client should then be able to handle the dynamic modification of the QoS parameters. Figure 7.9 shows an example where modification of QoS is made dynamically by the network service provider. During the time interval t , the guaranteed QoS falls below the acceptable limit. When the modification falls within the *safe* range (between the preferred and acceptable QoS), the client can proceed smoothly. Otherwise, the application has to use other options for continuing the presentation, such as employing more buffers, slowing down the speed of presentation or dropping a media object. Some of these options can be employed only with the concurrence of the user. In the case of a dynamic modification, the client may try to *re-negotiate* its QoS requirements.

Network support for handling QoS requirements involves the following :

- Specification of the QoS required for a communication channel to a server, by a client
- Negotiation of QoS with the server

7.2.2 Channel Group Services

When media objects are retrieved over separate channels, the channels might have to be treated as a *group*. QoS negotiation and connection establishment

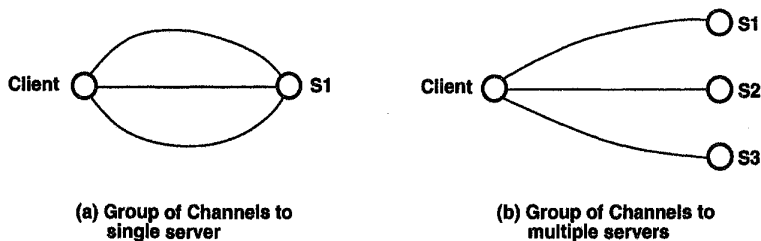


Figure 7.10 Group of Channels : Example

might have to be done for the group as a whole. This treatment of channels as a group might be necessary due to the following reasons. If one or more channels in the group cannot be established (due to any reason), then multimedia information retrieved over other channels may not make much sense. Also, objects retrieved over different channels might be related (as in the case of audio and video objects which have to be presented simultaneously).

Hence, channel group services are needed by most multimedia database applications for establishing a group of channels between server(s) and client. Group of channels can be established between a client and a server as shown in Figure 7.10(a), if all the required objects are available in the same server. Alternatively, group of channels can be established between a client and multiple servers, as shown in Figure 7.10(b). Network support for a group of channels has to be provided in terms of the following factors.

1. Creation of channel groups. This involves the following :

- Specification of the number of channels to be established
- Server(s) to which the channels are to be established
- QoS required for each channel
- Relationships, if any, among the channels

2. Joining a channel group. This feature allows a new communication channel to join an existing group.

3. Leaving a group. This feature allows a channel to be removed from an existing group.

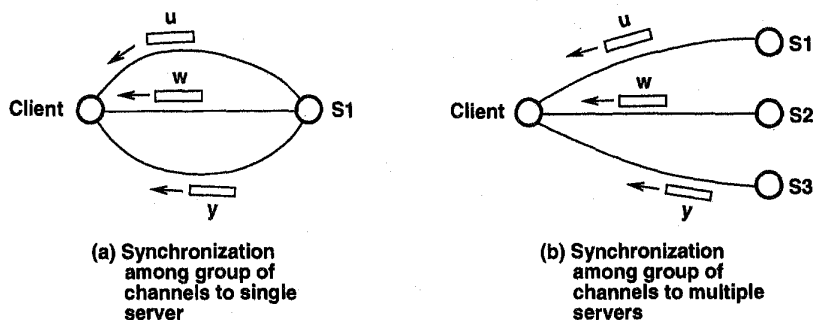


Figure 7.11 Synchronization Among Group of Channels

7.2.3 Synchronization of Object Transfer

When a group of channels are used, the transfer of media objects in different channels might have to be synchronized. For instance, video objects have to be delivered at the client along with the corresponding audio objects. Hence, the transfer of audio and video objects have to be synchronized. Figure 7.11 shows transfer of objects over channel groups. If we assume that objects u , w and y are to be delivered simultaneously at the client system, then the transfer of these objects has to be synchronized. If these objects are stored in different servers (as shown in Figure 7.11(b)), then synchronization of object transfer involves coordination of all the participating systems (client and the servers : S1, S2 and S3). Network support for synchronization of objects transfer involves :

- Specification of the objects to be transferred and the channels over which their transfer are to be synchronized

7.3 NETWORK SUPPORT FOR MULTIMEDIA COMMUNICATION

Figure 7.12 shows the components involved in providing network support to multimedia applications. The network support for multimedia applications needs to be provided in terms of the following.

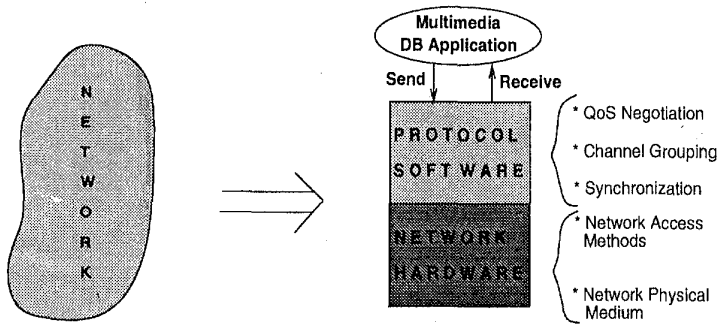


Figure 7.12 Network Support for Multimedia Communication

- **Network Hardware :** The components of the hardware, physical medium and the corresponding access method used, influence the QoS that can be offered to multimedia applications.
- **Network Protocol Software :** support has to be provided for QoS negotiation, group of channels, and synchronization of object transfer.

7.3.1 Network Hardware Considerations

Better network hardware platform is needed in order to offer high bandwidth. The network hardware provides access to the physical network medium. The physical network medium can be optic fibre, copper wire, etc. The type of the physical medium determines the maximum possible amount of information that can be carried in a unit time by a network. For example, optic fibre networks operate in the range of Gigabits per second while copper wire networks operate in the range of Megabits per second. The physical medium is shared by the computers connected to the network. Hence, the access to the physical medium for a computer (server or client) has to be regulated in order to ensure fairness. This access regulation is termed as the *Medium Access Protocol*. The following characteristics of the network medium and the access methods have a distinct bearing on the offered QoS parameters :

- Network topology
- Network bandwidth
- Network access control mechanism

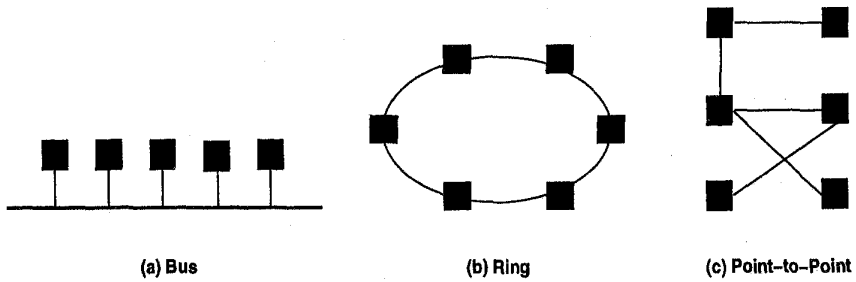


Figure 7.13 Popular Network Topologies

■ Priority control schemes for network access

Throughput guarantees by the network service provider depend on the bandwidth offered by the network hardware as well as the regulated access to the physical medium. The network bandwidth typically ranges from medium speed (operating at a few Mbits/s) to very high speeds (operating at several hundreds of Mbits/s). The delay guarantees depend on the medium access control methods and the availability of priority control schemes to access the physical medium. Now, we discuss some popular network topologies and network access protocols.

Network Topology

Network topology refers to the way in which the computers are connected to form the network. The popular network topologies are bus and ring topologies. Figure 7.13 (a) and (b) show possible bus and ring topologies. Ethernet and Token Bus networks use bus topology while Token Ring and FDDI (Fiber Distributed Data Interface) use ring topology. Figure 7.13 (c) shows a point-to-point network topology. This network employs switches to transfer data from one node to another. ATM (Asynchronous Transfer Mode) networks use this point-to-point network topology.

Network Access Protocols

The network topology influences the type of access to the network medium. For example, in the point-to-point networks, the network medium is shared by the computers *only* through the switching nodes. Hence, the access to the

network is regulated by the switching nodes. In the bus and ring topologies, the medium is directly shared by the computers and hence the access control strategies are different.

Bus and Ring Topologies : The commonly used access control protocols for the bus and ring topologies are :

- Random access control
- Token based access control

The random access control method is used by networks such as Ethernet. The strategy for random access is called *Listen While Talking*. Here, computers connected to the network are allowed to communicate data *whenever* (i.e., random) they need to. The computers also listen to the network while they are communicating. This strategy of random access results in collisions of information when *multiple* computers *decide* to communicate data *simultaneously*. Since the computers also listen while they are communicating, they can detect the occurrence of collisions. When such collisions are detected, the computers stop the communication. They wait for a random period of time before retrying the communication. However, collisions can possibly occur when the computers retry to communicate the information. Due to the possibility of repeated collisions, it is difficult to guarantee delivery of information. Hence, it is difficult to guarantee QoS parameters such as throughput and delay to multimedia database applications, using random medium access control.

Token based access methods are used by token ring and token bus networks. Here, a permit to communicate information, in the form of a token, circulates in the network. A computer is allowed to communicate information *only when* it has the token. The communication of information is done only for an allotted time period. After the allotted time period, the token is passed to the *next* computer. The token based access methods provide a regulated access to the network medium and hence it is possible to guarantee QoS parameters, such as throughput and delay to multimedia database applications. Token based access control is used by FDDI networks. Priority schemes for circulating the tokens can also be employed to provide better control to network medium. Systems with higher priorities may be allowed to transmit data more often than others. This facility can help in transmitting data (such as video) in such a way that its real-time requirements are met.

Point-to-Point Topology : ATM is an access control method that is being popularly used for point-to-point networks. Here, switches multiplex the information to various output channels. ATM uses Asynchronous Time Division multiplexing. The unit of multiplexing is called an ATM cell, a small packet of constant length, 53 bytes. Communication channel between a server and a client is established by concatenating several point-to-point links. An ATM Adaptation Layer (AAL) has been defined to enhance the services provided by the ATM layer. The AAL helps in providing different modes of service to the applications. It can provide QoS guarantees such as throughput and delay to multimedia database applications.

7.3.2 Network Protocol Support

The pre-defined format in which the communication exchange between a server and a client takes place is called the network protocol. Standard network protocols such as TCP/IP and ISO Open Systems Interconnection (OSI), as well as proprietary protocols such as DECnet are commonly used for communication between servers and clients. However, network protocol support for multimedia applications are different from those needed for traditional applications, such as file transfer, electronic mail, and remote login. As discussed earlier, network protocol support for multimedia applications is provided in terms of :

- Channel group services
- QoS Negotiation
- Synchronization of object transfer

New protocols or enhancements to existing protocols have been suggested in order to provide communication support for multimedia database applications. Here, we shall discuss in brief the features of the following protocols:

Orchestration Services in ISO-OSI : Orchestration services in ISO-OSI aim at providing channel grouping facility in the existing OSI model (refer [84, 85]). The orchestrator provides services for starting and stopping group of communication channels as well as services for controlling and monitoring individual channel. Controlling a group of channels includes services for dynamically joining/leaving the group and for regulating the QoS needs of individual channels. These orchestration services include provision for specification and

negotiation of QoS parameters as well as their tolerance levels during channel establishment.

ST-II & RSVP : In order to provide services such as QoS guarantees and synchronization of object transfers, network service provider has to reserve buffer resources for the communication channel to be established. Internet Stream protocol version II (ST-II) and ReSerVation Protocol (RSVP) address this issue of resource reservation in internetworks. Interested readers can refer [39, 104] for further details.

7.4 CONCLUDING REMARKS

Communication channels need to be established between server(s) and a client for communication of multimedia information. Multimedia information is generally voluminous in nature, with temporal constraints for the presentation of information. This results in the need for guarantees from the network service provider for Quality of Service (QoS) to the multimedia applications. These QoS parameters are specified in terms of parameters such as throughput, delay, delay-jitter, and packet-loss probabilities. The characteristics of the physical medium influence the maximum throughput that can be supported by the network. The access method employed specifies the mechanism of sharing the maximum possible network bandwidth among the computers connected to the network.

The network service provider interfaces with the multimedia database applications in order to facilitate access to distributed information. A client needs to specify and negotiate its QoS requirements with the network service provider. Multimedia database applications also may need channel group services to communicate individual media information from server(s) to client. Transfer of information such as audio and video might have to be synchronized and this synchronization might have to be enforced between channels carrying the information. The services that are required from network hardware and protocol software for a multimedia database application are summarized in Table 7.1.

Figure 7.14 shows a simple block diagram of a communication manager. The connection establishment module, taking the QoS specification as input, establishes communication channel(s) between the client and the server. It uses the services provided by the network access protocol in order to carry out the

	Technique	Features
Physical Medium		
	Coaxial cables	Order of Mega bits per second
	Fiber optic cables	Order of Giga bits per second
Network Access Method	Random access control	Cannot be used for guaranteeing QoS parameters
	Token based access	Can guarantee QoS parameters
	Asynchronous Transfer	— do —
Network Protocol Services		(i) QoS Negotiation (ii) Channel Group Services (iii) Synchronization of Object Transfer Across Communication Channels

Table 7.1 Network Support For Multimedia Databases

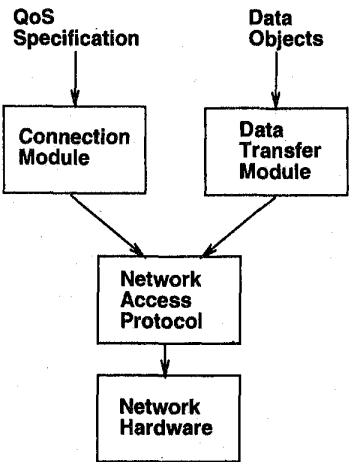


Figure 7.14 Components of Communication Manager

job. The data transfer module then helps in communicating the multimedia information.

Bibliographic Notes

Retrieval schedule generations for multimedia database applications are discussed in [56, 58, 77, 164]. [56, 58, 77] discuss derivation of schedules based on Petri nets specifications of the temporal characteristics. [164] presents techniques for deriving flexible retrieval schedules based on difference constraints specification of temporal characteristics.

Quality of Service (QoS) requirements of communication channels are described in [36, 41, 76, 78, 82]. QoS negotiation issues are presented in [112, 159, 165].

Orchestration services in ISO-OSI are introduced in [84, 85]. Internet Stream protocol version II (ST-II) and ReSerVation Protocol (RSVP) address the issue of resource reservation in internetworks [39, 104]. Requirements of a group of communication channels are discussed in [106]. Synchronization protocols for multimedia database applications are presented in [56, 58]. In [165], Multimedia Application Protocol (MMAP) has been proposed for handling user interactions and for interacting with the network service provider.