# Concepts of Distributed Multimedia Systems

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**Abstract**
Distributed multimedia systems consist of multimedia databases, proxy and information servers, and clients, and are intended to for the distribution of multimedia content over the networks. Multimedia applications generate and consume continuous streams of data in real time. They contain large quantities of audio, video and other time-based data elements, and the timely processing and delivery of the individual data elements is essential. In this paper we presented a brief overview of Distributed Multimedia systems and discussed Quality of Service Management and Key Technologies and Solutions in the Design of a DMS (Distributed Multimedia Systems)

**Keywords**
DMM, QoS, VoD, Architecture, characteristics of DMS.

## I. Introduction

Definition: Distributed multimedia systems consist of multimedia databases, proxy and information servers, and clients, and are intended to for the distribution of multimedia content over the networks.

Multimedia applications generate and consume continuous streams of data in real time. They contain large quantities of audio, video and other time-based data elements, and the timely processing and delivery of the individual data elements is essential. In distributed system, data transmission is pre-requisite. So the main topic in distributed multimedia system is how to transfer multimedia data within the demanded quality.

The existing standards and platforms about the distributed system, such as RM-ODP, CORBA and DCE, mainly focus on the discrete data transmission. The introduction of multimedia computing puts a large number of new requirements on distributed system.

Firstly, the distributed multimedia system should be able to provide support for continuous media types, such as audio, video and animation. The introduction of such continuous media data to distributed systems demands the need for continuous data transfers over relatively long periods of time. For example, playing a video from a remote website implies that the timeliness of such media transmission must be maintained in the course of the continuous media presentation.

The second requirement of distributed multimedia applications is the need for sophisticated quality of service (QoS) management. In most traditional computing environments, requests for a particular service are either met or ignored. But in multimedia system, there are more contents, which can be classified into static QoS management and dynamic QoS management.

Yet another requirement of distributed multimedia applications is the need for a rich set of real-time synchronization mechanisms about continuous media transmission. Such real-time synchronizations can be divided into two categories: intra-media synchronization and inter-media synchronization.

A further requirement is to support multiparty communications. Many distributed multimedia applications are concerned with interactions between dispersed groups of users, for example, a remote conference application. So it is important for distributed multimedia system to support multiparty communication.

In this paper we focused on the second major requirement which is QoS management.

## II. Architecture

The architecture is presented at the level of abstraction suitable for the content of the paper. A distributed multimedia system consists of three different basic components: an Information server, a wide area network and a multimedia client on the user site. The user interface or the multimedia client deals with the issues related to presentation and manipulation of multimedia objects and the interaction with the user. The network provides the communication mechanism between the user and the server. The server is responsible for managing multimedia databases and also composing general multimedia objects for the user. The composition of the object is a complex process of integrating and synchronizing multimedia data for transport, display and manipulation. The system usually consists of multiple users, servers and networks as shown below.

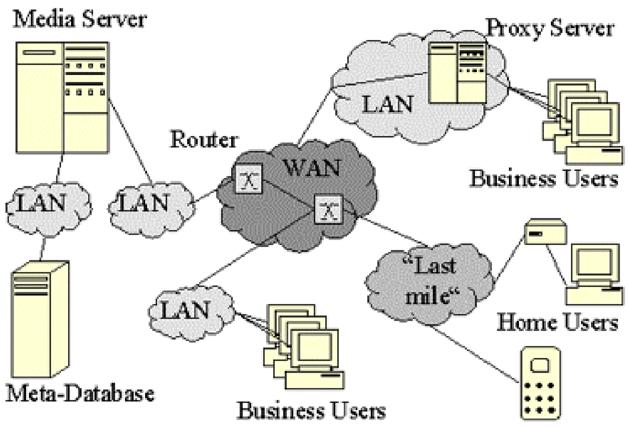


Fig.1: Architecture of DMS

## III. Characteristics Of Multimedia Data

### A. Spatiality

Similarly, images, graphics, and video data have spatial constraints in terms of their content. Usually, individual objects in an image or a video frame have some spatial relationships between them (on the left of, on the right of, next to etc.). Such relationships usually produce some constraints when searching for objects in a database. These relationships organize the data's visual layout on a virtual page or medium. The virtual medium may exist across multiple machines. Within a spatial presentation, users can move around inside the boundaries defined by the virtual medium and move and restructure the data. Spatial structures may include 3D or virtual environments. Spatial constraints control 3D-object movement and inter object spatial relationships. Special tools can define spatial relationships using graphical user interfaces. Instead of providing semantically rich spatial relationships, some systems support spatial grammars, which are closer to scripting languages.

### B. Need for Storage Space and Fast Transmission

Huge volumes of data also characterize multimedia information. For instance, to store an uncompressed image of 1024:728 pixels at 24 bits per pixel requires a storage capacity of about 2 Mbytes. With a 20:1 compression ratio, the storage requirement could be reduced to about 0.1 Mbytes. A 10-minute sequence of the same image at 30 frames per second requires about 38 000 Mbytes of storage, reducible to about 380 Mbytes with a compression ratio of 100:1. The potential for huge volumes of data involved in multimedia information systems become apparent when you consider that a movie could run as long as two hours and a typical video repository would house thousands of movies.

### C. Need for Content-Based Access

The representing multimedia information as pictures or image sequences poses some problems for information retrieval due to the limitations of textual descriptions of a multimedia experience and the massive information available from it. The potential information overload means that users may find it difficult to make precise requests during information retrieval. The limitations of textual descriptions also imply the need for content-based access to multimedia information. Users need multiple cues (such as shape, color, and texture) that are relevant to the multimedia content.

### D. Collaborative Support Environment

Another characteristic of multimedia information is that interaction involves long duration operations (such as with video data), and sometimes, with more than a single user (as is typical in collaborative support environments). However, in collaborative environments, it is expected that most multimedia data are likely to be accessed in a read-only mode. This assumption can be used to facilitate the provision of concurrency control algorithms.

Table 1: Characteristics of DMS

Characteristics of typical multimedia streams

| | *Data rate (approximate)* | *Sample or frame size* | *frequency* |
|---|---|---|---|
| Telephone speech | 64 kbps | 8 bits | 8000/sec |
| CD-quality sound | 1.4 Mbps | 16 bits | 44,000/sec |
| Standard TV video (uncompressed) | 120 Mbps | up to 640 × 480 pixels × 16 bits | 24/sec |
| Standard TV video (MPEG-1 compressed) | 1.5 Mbps | variable | 24/sec |
| HDTV video (uncompressed) | 1000–3000 Mbps | up to 1920 × 1080 pixels × 24 bits | 24–60/sec |
| HDTV video (MPEG-2 compressed) | 10–30 Mbps | variable | 24–60/sec |

## IV. Quality Of Service Management

The requirement of distributed multimedia applications is the need for sophisticated quality of service management. In most traditional computing environments, requests for a particular service are either met or ignored. But in multimedia system, there are more contents. Quality of service management encompasses a number of different functions, and we can classify them into two types of aspects: static aspects and dynamic aspects.

### A. Static aspects

Static QoS management functions are carried out when a given service is initially established. The goal of these functions is to ensure that the appropriate steps are taken to attain the desired quality of service.

### B. QoS specification

The QoS specification refers to the creation of the QoS contract using an appropriate means to express the QoS requirements. For example, the QoS contract could state the concrete demands on different measurement dimensions such as the timeliness, volume and reliability.

### C. QoS negotiation

The QoS negotiation refers to achieving an agreement on the QoS contract between all involved parties. This function will focus on establishing the concrete quality of service for each of the involved components and ensuring that the whole quality of service can satisfy the acceptable bounds defined in the contract.

### D. Admission control

In order to ensure whether or not the system can provide desired QoS, we usually carry out an admission control test. The admission control test will determine if the system can deliver the required service at that precise moment. If the test is passed, the system will then guarantee that the quality of service can be met. The admission test puts some concrete demands on different resources such as memory and the network, so it is necessary to combine the admission test with resource reservation.

### E. Resource reservation

The resource reservation is used to guarantee the desired service level to be met by reserving resources to that concrete service, such as network, memory and processor.

### F. Dynamic aspects

Dynamic QoS management functions are used to monitor and control the run-time quality of service. The goal of these functions is to ensure that the appropriate steps are taken to maintain the desired quality of service.

### G. QoS monitoring

This function is used to monitor the level of service being offered by the involved components and report any problems. Here, the user should specify the granularity of the monitoring, for example, how often should the monitoring function execute, every second or every hour?

### H. QoS policing

Besides monitoring the system components to maintain the level of service, we should ensure that the users of the service are adhering to the contract. This function is carried out by QoS policing. For example, the QoS contract demands the users to send videos 30 frames per second in a communication. It is important to ensure that the sending speeds are within the limitation.

### I. QoS maintenance

QoS maintenance is concerned with actions that can be taken to ensure that the level of service is maintained in a concrete process of service. For example, if a decline of QoS is detected, the service can ask for more resources from the system in order to keep the level of service. Usually, such actions are enough to deal with minor fluctuations of quality of service. If the contract of service is clearly broken, we will have to use QoS renegotiation function.

### J. QoS renegotiation

If the contract of service is apparently broken down, it becomes necessary to notice the user of the service and to start a renegotiation of the quality of service. The user at this stage may decide to make a new contract or abort this service.

 ISSN : 2229-4333(Print) | ISSN : 0976-8491(Online)

### K. QoS Manager's Task

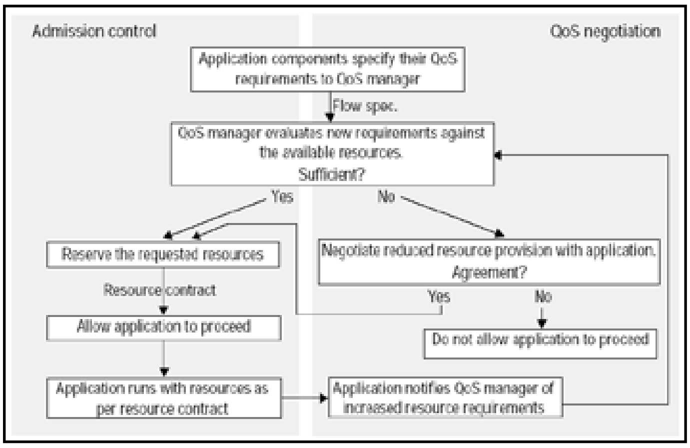


Fig. 2: Manager's Task

## V. Key Technologies and Solutions in the Design of a DMS

Owing to high-bandwidth availability, several applications become reasonable for users that will enforce a continuous work pressure on the media servers on the network. Thus managing resources is indeed a key challenge.

### A. Major Service Categories: Video-On-Demand (VoD) versus Video-On-Reservation (VoR):

VoD and VoR are most commonly used services by network users. VoD is certainly an attractive technology in rendering digital video libraries, distance learning, electronic commerce, etc, as (i) users can request the service any time and from anywhere and, (ii) service allows users to have a complete control of the presentation. Despite continuous research efforts in rendering quality VoD service, the requirement on network resources, such as server bandwidth, cache space, number of copies, etc., are still considered overwhelming owing to an exponential growth in client population. When such fully interactive service demands are met we say that the service is of type True-VoD. While small movie clips rendering, learning and video-conferencing kind of applications are almost now delivering a high-quality service, for long-duration movie viewing with a presentation control still seems to exhibit annoying experiences for users. Contrary to this, when users reserve for a movie presentation in advance VoD manifests in the form of VoR. Under VoR service, system is shown to utilize resources in an optimal manner as user viewing times are known in advance. VoD and VoR are completely orthogonal in their service style. Perhaps VoR is better suited for pay-per-view by SPs for digital TV subscribers. Another type of VoD service is called as Near VoD services (NVoD), and it distributes videos over multicast or broadcast channels to serve the requests which demand the same videos and arrive close in time. These technologies have been successful to provide video services in local area networks, say in hotels.

### B. Media streaming as a solution to handle large client pool

A straightforward technology to realize streaming is to unicast streams is by allocating dedicated resources for each individual client session. As this is never a cost effective solution and non-scalable, IP-based multicast approaches were proposed. Techniques such as Batching, Patching, Merging, Periodical and Pyramid broadcasting, etc fall into this category. Several variants also exist in the literature to these fundamental schemes. Here, multiple requests share a video stream via the network; thereby the required server network I/O bandwidth can be reduced.

### C. Various types of Media Distribution:

There exist several practical approaches to media distribution, ranging from distributing small sized clips to long movies. The solution attempts include: proxy-based approach, parallel or clustered servers approach, and co-operative server scheduling.
In proxy-based approach, a cluster of proxies are placed at vantage sites which can intercept the client requests or client requests can be redirected to these proxies for balancing the overall load and also to minimize access delays. However, in parallel or clustered servers approach, the system sends each request to all the servers and all the servers participate equally to serve the request. This mechanism is shown to enable to improve the system throughput and balance the load of each server. In the case of co-operative type, servers cooperate in a joint caching and scheduling of streams and the typical problem is in deciding when, where, and how long to cache a stream before it can be delivered to the clients and this caching on-the-fly is done for serving several requests demanding the same stream.

### D. Caching in DMS

Caching is one of the inevitable and powerful solution approaches that influence almost every performance metric under consideration. "Cache-or-not-to-Cache" is often a most common dilemma of the algorithms in place as the decision is based on a combined influence of several parameters. Caching allows nodes to quickly fetch the required documents without incurring annoying delays by circumventing the need to contact the original host. Caching can be at memory/disk level or at node level. Again, performance of a DMS system can also be quantified in terms of local as well in global terms. In memory caching, the high-speed main memory is referred to as the cache of the relatively slow-speed disk, while in disk caching, a near-distance disk (e.g., a proxy) is used as the cache of the far-distance disk (e.g., in original server), or the disk is used as the cache of tertiary storage, e.g., CD, tape. For modern day applications, even acquiring a small amount of an intermediate storage seems a critical issue to account for. Day-to-day storage devices have capacities ranging from 18GBytes cache space (Seagate cheetah) to 250Mbytes (Toshiba Flash memories) and bandwidths in MB/sec in the range of 63.2 to 10, respectively. To improve the cache space of storage devices, Redundant Arrays of Inexpensive Disks (RAID) was proposed in to combine multiple small, inexpensive disk drives into an array of disk drives. This disk array can yield performance exceeding that of a single large disk drive related to space, speed and data protection. Apart from these technology oriented advantages, caching schemes such as Interval Caching, Block caching, Resource-based caching, Multi-policy integrated caching , etc, attempts to maximize the throughput of the system by cleverly caching streams of media either on-the-fly or on demand. Compilation in gives details on some of these techniques.

## VI. Current Trends In DMS

Currently some of the distributed multimedia systems are:

- Video on Demand: The consumer can select a video or any program on demand. The application consists of Interactive features like forward, rewind and pause.
- News and Reference Services: News on Demand is similar to VoD but it provides sophisticated news retrieval and reference services that combine live and achieved video, access to textual data and still photography from various sources. The information is delivered based on a filtering criteria kept by the user.
- Interactive shopping and electronic commerce: Home

shopping provides a customizable shopping environment. Customers can effectively and rapidly focus on the products and services that are of interest to them.

- Entertainment and games: Interactive entertainment has become a frequently used service. Games consist of simple applications that can be downloaded to the set top device thus not incurring the significant cost associated with the use of server and network facilities.
- Distance Learning: Educational interactive programming and distance learning are areas where the research is going on. Current indications are there that these may become popular but might not be of sufficient commercial use to the providers.

## VII. Conclusion

Let us realize the fact that there is still a long way to go in DMS (Distributed Multimedia Systems). A number of advances in the network technology have proved a boon to the advances in Distributed Multimedia Systems. We presented an overview of DMS, discussed the major requirement QoS Management and summarized all the primary issues leading to the design of DMS. Important issues need to be discussed at a broad level.

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