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Chapter XV

Multimedia and Multi-Stream Synchronization

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Synchronization is an important aspect of the design and implementation of distributed multimedia database systems. In this chapter, we first examine the models that have been proposed in the literature to specify multimedia and multi-stream synchronization and the methods to implement synchronization mechanisms in distributed multimedia database systems. Their strengths and limitations have been compared, and the issues about time uncertainty and interactivity in multimedia and multi-stream synchronization specification and implementation are discussed. Moreover, we use an example to show how to incorporate a synchronization agent into a distributed multimedia database system. Finally, we discuss the trend of future research and development of this topic.

INSTRUCTION

In order to facilitate the creation of good distributed multimedia applications, distributed multimedia database system (DMDBS) technology supporting fast indexing and synchronization is essential (Chen, Lin, Wu, and Shen, 1994; Paul, Khan, Khokhar, and Ghafoor, 1994; Rody and Karmouch, 1995; Yoshitaka, Kishida, Hirakawa, and Ichikawa, 1994). DMDBS involves synchronization problems due to data distribution and communications, random human-computer interaction, and hardware performance limitations. To guarantee Quality of Service (QoS) or system usability, therefore, synchronization is needed.

A DMDBS has both temporal and spatial synchronization related to the processing, transport, storage, retrieval and presentation of data, sound, still images and video (Courtiat, Oliveira and Carmo, 1994). These synchronization characteristics are usually specified in the form of pre-defined temporal relations and are stored along with the multimedia database. In the last decade, much research has been conducted on multimedia synchronization and

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various synchronization models have been proposed. These models are useful for centralized multimedia applications or distributed orchestrated multimedia presentation. However, in the distributed database environment, unpredictable delay and user interaction have presented many challenging research problems that remain to be studied.

This chapter examines strategies and methods to solve these problems. We will first introduce the terminology and historical background of multimedia and multi-stream synchronization in distributed multimedia database systems. Next, we discuss the methodologies for multimedia and multi-stream synchronization proposed in the literature. We look at the issues in multimedia and multi-stream synchronization specification and implementation in DMDBSs. Finally, we discuss the trend of future research and development.

TERMINOLOGY AND BACKGROUND

Multimedia, also referred to as hypermedia, is a synthesis of digital media combining text, graphics, audio, animation, and video (Hansen, 1997). A database is a repository of data, traditionally text, numeric values, boolean values, and dates, generically known as "printable" objects (Golshani and Dimitrova, 1998). A multimedia database additionally contains graphical images, video clips, and sound files, generically known as "presentable" objects. Therefore, a multimedia database system (MDBS) can be defined as a software system that manages a collection of multimedia data and lets users query and retrieve multimedia objects. Such a new database system could benefit such areas as concurrency control, data abstraction, transaction, recovery, openness, data access, and access control (Wegener, 1994). Centralized MDBSs have been studied (Adjeroh and Nwosu, 1997; Pazandak and Srivastava, 1997)

A distributed database is a collection of logically interrelated multimedia information distributed over a computer network. The interrelated multimedia information is described as structured data. These data logically belong to one single system while they are physically distributed over different nodes of a computer network. The environment can be a local area network (LAN), or a wide area network (WAN). A distributed database has intrinsic property, such as autonomy and sharing, controllable redundancy, distributed execution of transaction, in addition to the properties of a centralized database. In the mid-eighties, these issues led to many prototype systems, such as SDD-1, POREL, ADA-DDM, SIRIUS-DELTA, MULTIBASE, R* and Distributed INGRES and C-POREL (Ishikawa, Suzuki, Kozakura, Makinouchi, Miyagishima, Izumida, Aoshima and Yamane, 1993).

The incorporation of multimedia data into DDBSs makes them distributed *multimedia* database systems (DMDBSs) managing multimedia data types. However, this development is not just an extension of data types; requirements of managing multimedia data are essentially different from those of managing traditional data. Therefore, we must consider carefully new issues arising with the incorporation of multimedia.

Basic Characteristics of DMDBS

DMDBSs have the following basic characteristics stemming from data distribution and the multimedia data type:

First, in traditional DDBSs, a certain data redundancy is preferred to reduce data communication cost and to enhance the autonomy of local databases. However, storing redundant multimedia data would be a serious strain on resources because of the size of this