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# Audio/Video Synchronization Protocol for Distributed Compressed Media Services

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## 1 Introduction

In this research, we propose continuous media transmission protocol which provides QoS functions according to user's requirement and available computing or network resources while transmitting compressed audio/video data. In this paper, we designed synchronization protocol considering the combination of audio/video synchronization and frame rate control for dynamic extra load change.

## 2 System Architechture

In order to realize continuous media transmission, we have introduced client/server architechture model based on our packet audio/video system(PAVS) consisting of three layers; synchronization, data transform and media flow control layers between the application layer and transport layer as shown Figure 1. This system architecture contains the functions requred to smoothly provide continuous media data to users and guarantee QoS from the application through the network layer. We have integrated these three layers into one layer as the media coordinate system layer[1].

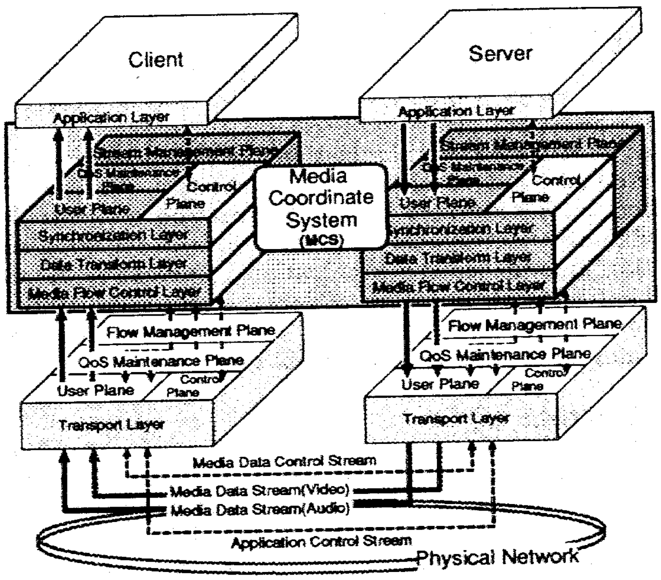


Figure 1: **System Architechture**

In this system architecture, we had introduced inter/intra synchronization methods[2] on synchronization layer and dynamic rate control methods[3] including packet rate control and frame rate control as QoS control methods for dynamic extra load change on the each of media flow control layer and synchronization layer.

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圧縮を考慮したメディア転送のための同期プロトコル
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## 3 Synchronization Referece Model

In this paper, we adopted synchronization reference model[4] to easily realize synchronization methods for many complicated synchronization problems.

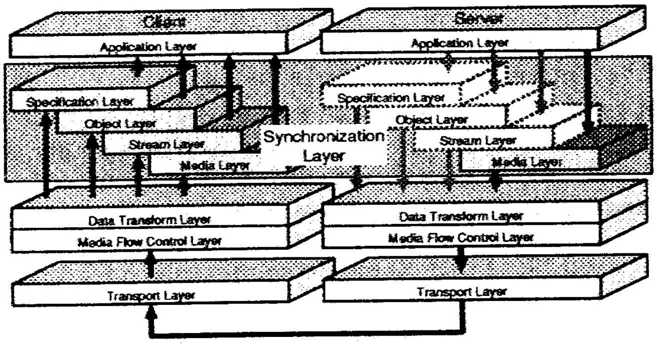


Figure 2: **Synchronization Reference Model**

Synchronization model is consisted of four sublayers, media, stream, object and specification layers as shown Figure 2.

**Media Layer** Intra-media synchronization and frame rate control are performed.

**Stream Layer** Audio/video lip synchronization is performed.

**Object Layer** Integration of distributed media data, considering multimedia and scheduling techniques.

**Specification Layer** Several multimedia information and these reference is managed.

We describe the detail of media layer and stream layer in the following section.

## 4 Media Layer

In the media layer, intra-media synchronization method refers to the time relation of continuous media stream, and frame rate control[3] method realizes normally display video data for dynamic load changes, are performed.

### 4.1 Intra-media Synchronization

Logical data units(LDU)[4], which are a sequence of information units consisting contunuous media data, such as video frames, are adjusted at suitable point on the time axis as shown Figure 3. On the receiver side, intra-media synchronization adjusts LDU time interval equality. For an example, in order to display video frames with 30[$fps$], each video frames must be transmitted for 33.3[$msec$]. In order to adjust LDU interval on suitable points, we consider to use "time stamp" and "numbering" to each LDU data. Time stamp is effective for realtime video transmission, and numbering is effective for stored video transmission. However, these methods are expected to use together because they can easily to detect LDU loss and delay.

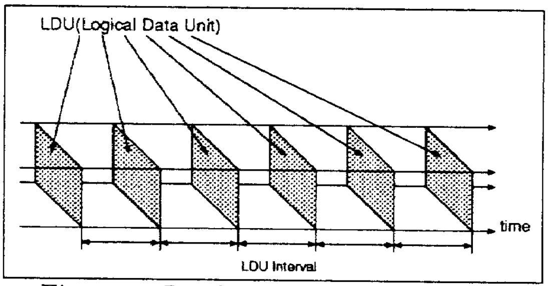


Figure 3: **Logical Data Unit(LDU)**

On the sender side, LDU must be transmitted so as to keep in time at receiver side. We could consider several LDU transmission methods according to transmitted media characteristics as follows.

**Avarage Time Division Transmission :** LDU is transmitted simpley for same interval equality. It is usefull for realtime video transmission.

**Processing Time Division Transmission :** Each LDU is transmitted according to each LDU size. It is usefullness for compressed video transmission.

**Best Effort Transmission :** Available LDU is transmitted in advance. It can reduce the LDU jitter and absorb the difference of each LDU data size. It is usefull stored compressed video trasnsmission.

**Collective Transmission :** Several LDUs are transmitted as one message, such as MPEG group of picture(GoP). It can reduce the processing time for each LDU and the number of the generated packets. However, it is difficult to identify each LDU data in the massage.

## 4.2 Frame Rate Control

The transmitted video frames is controlled to maintain the display frame rate at a constant and keep time constraint of continuous media data for dynamic load conditions. At the sender side, the transmitted frame rate is updated by feedback message from the client station including actual frame rate, $FR_{act}$, considering $FR_{act}$ and setting frame rate, $FR_{set}$.

## 5 Inter-Media(Lip) Synchronization

We proposed audio/video lip synchronization method including strict, relaxed and silence synchronization[2]. User applications can select one of these methods depending on the type and amount of synchronization accuracy required.

In the strict synchronization, the timing between each video LDU and audio LDU is precisely synchronized, as indicated in Figure 4.

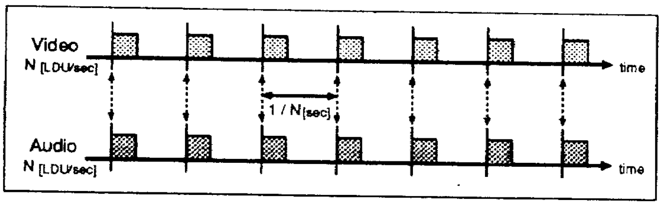


Figure 4: **Strict Synchronization**

In the relaxed synchronization, synchronization is executed only once every several video LDUs and equivalent audio LDU points, as shown Figure 5.

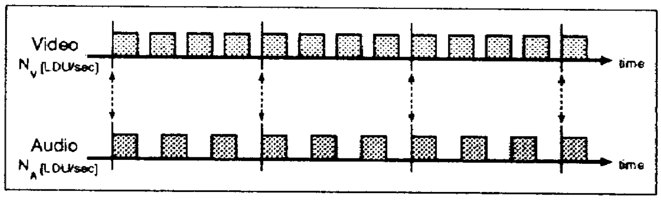


Figure 5: **Relaxed Synchronization**

In the silence synchronization, whether the audio LDUs include a talk spurt or relative silence is detected. Using this method, only the talk spurts are sent from the server station to the client station for synchronization at the beginning of the talk spurt after continuous silence portions are continued, as dipicted in Figure 6

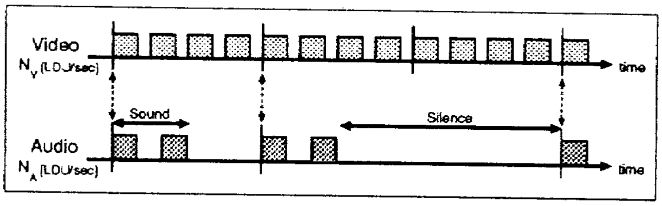


Figure 6: **Silence Synchronization**

We define the point of synchronized audio and video data as synchronization point.

## 6 Conclusions

In this paper, we designed synchronization protocol to easily realize synchronization methods and described intra-media synchronization method as well as inter-media synchronization and frame rate control method for dynamic extra load change. We also described audio/video lip synchronization methods including strict synchronization, relaxed synchronization and silence synchronization. Currently, we are implementing prototype of packet audio/video system to evaluate the performance of various synchronizations and dynamic rate control functions.

## Reference


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