

# QoE Assessment of Group Synchronization Quality for Remote Education

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## Abstract

*User experience is key parameter to assess the network conditions for improving the remote education services. The Quality of Experience (QoE) may be damaged if the multimedia presentation among multiple destinations is different from each other. Group synchronization is to output each Media Units (MUs) simultaneously at different destinations in multicast communications. The difference in network delay between each terminal is called the group synchronization error. Remote education strongly depends on computer network and multimedia communication with separate location of teacher and students keep teaching lecture through the network. This paper proposed to assess group synchronization quality with human perception for each terminal over the network by using subjective assessment method for remote learning. Furthermore, we are also interested in determining proper group synchronization thresholds applicable to this use case and we assess the comparison of synchronization error by investigating the different language for explanation of lecture as Myanmar and English.*

**Index Terms** — group synchronization, QoE, simultaneous output timing control, remote education.

## 1. Introduction

Now a day, many researchers emphasize the user level QoS of multimedia applications such as networked quizzes, video conferencing and distance education. QoE is the level of user's satisfaction with any kind of multimedia service by using subjective assessment methods.

Remote Learning exists when the learner and instructor, or source of information, are remote by time and distance and therefore cannot need a physical classroom setting. Lecture is typically transmitted via technology such as multimedia and so on.

In this paper, we investigate the QoE assessment for group synchronization quality of distance learning from subjects by using different delay range as recommended from medium synchronization. In our remote education, we examine the one way communication (it no need to change

different role) because when teacher teach some subjects to student, they need to investigate the influence of group synchronization quality of this system.

The authors investigate the simultaneous output timing for distance education according to experiment result delay values to reduce the synchronization error.

The reminder of this paper is collected as follow: we introduce the background of paper in Section 2. In Section 3, we explain group synchronization and subjective assessment method as proposed system. Assessment result is also express in section 3. The last one is the conclusion of the paper as Section 4.

## 2. Background

Multimedia systems produce simultaneously media objects including text, images, audio, and video over the network. Most multimedia applications need to synchronize time. Three types of media synchronization controls are intra-stream, inter-stream, and group (or inter-destination) control. Group synchronization of media stream is same output at multiple destinations in multicast communication. The group synchronization output-timing control is become essential over a (Application Level QoS) for multimedia stream. Users get some subjective feelings which are assessed by QoE. Three types of QoE assessments are subjective, objective and hybrid assessment.

In networked multimedia environment, QoE factor of user dimension are individual property, preference, expectation, requirement and mental mood. When multiple media streams related to such transmitted over a network where QoS is not guaranteed like the Internet, media synchronization is disturbed and QoE among users may seriously be deteriorated owing to the network delay [4].

MUs arrives at media destination at arrival time and MUs is actually outputted at media destination is called output time. Ideal output time may be that MUs should be output when there is no network delay jitter. Target output time is a time at which MUs should be outputted when there are network delay jitters.

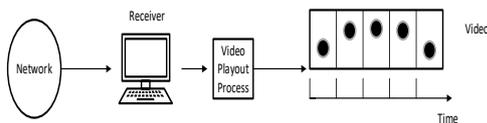
## 2.1. Development Remote Education

By 2015, modern remote education has been started in nearly 200 countries around the world represented by the United States where remote education courses are provided by more than 85% of the universities and the number of students learning through the Internet increases by 130%. Over 95% of universities and colleges around the world have their own network, among which 40% of them launch remote education courses. The distance network teaching model has played a key role in the educational circle [6].

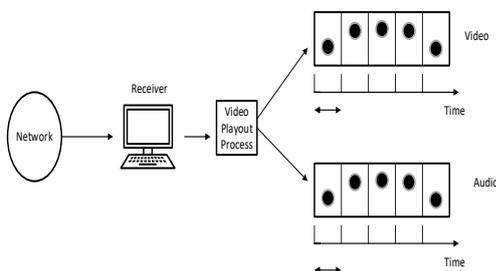
In Myanmar, remote education does not start very well. Some telecommunication companies such as Telenor Myanmar Ltd try to develop digital education in 2017. So we would like to improve the distance education with multimedia communication in our country.

## 2.2. Media Synchronization Control

Synchronization can adjust of output timing between sender and receiver or every destination. There are many types of synchronization control algorithm that can control simultaneous output for each terminal. The intra media synchronization is preserving the timing between single media unit and the inter stream synchronization is the association of timing within multiple MUs.



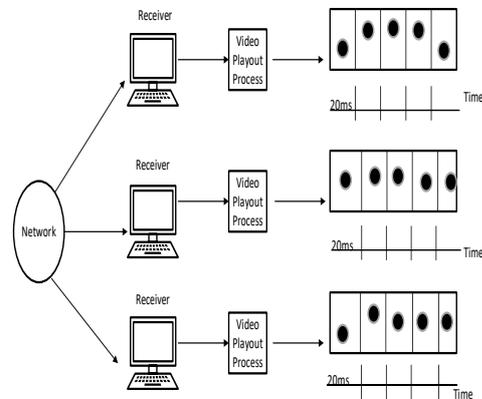
**Figure 1: Intra Media Synchronization**



**Figure 1: Inter Media Synchronization**

Group synchronization is the simultaneous output timing of MUs at every destination. We play the video at the same time each terminal to know inter destination synchronization error and find the difference time between two terminals. The aim is to display the same media unit at all terminals in a group

at the same time as exactly as possible. This receiver may not be only type such that laptop computer or smart phone at differ geographical locations and may have different processing.



**Figure 2: Group Synchronization**

In this section, we explain three types of group synchronization for simultaneous output timing control which output each MUs at all the destination at the same time. These techniques based on the four items: clocks, techniques at sources and those at destinations and methods to determine the output timing of MUs at all the destination [2]. For the group synchronization control, there are mainly three algorithms. First is the master-slave destination scheme, second one is the synchronization maestro scheme, and the other is the distributed control scheme.

In the master-slave destination algorithm, which includes a master destination and slave destinations? The work of the master destination is to determine the target output time, which denotes at which each destination should output each media unit under the group synchronization control when there exists network delay jitters, and notifies all the slave destinations by transmitting control packets to them. When each slave destination receives a control packet, it gradually adjusts its output timing of MUs to the output timing (i.e., the target output time) of the master terminal [8].

In the synchronization maestro algorithm, a unique manager which collects the output timings from all the terminals and the decision of maestro is reference output timing, to which all the destinations should adjust their own output timings, and multicast the information about the reference output timing to all the destinations.

In the adaptive  $\Delta$ -causality control, the value of in this control is dynamically changed owing to network delay and delay jitters.

### 3. Proposed Methods

#### 3.1. Test Bed

The configuration of our remote education system as shown in figure 4. In experiment, the system includes the two terminals (PC1 and PC2) that are connected via network by using TCP. One terminal presents as teacher and other is student. When teacher is explaining the demonstration of video by his/her voice and student is learning this lecture, the student just need to monitor the group synchronization error (Teacher terminal and Student terminal are not the same output video and voice) owing network delay and jitters.

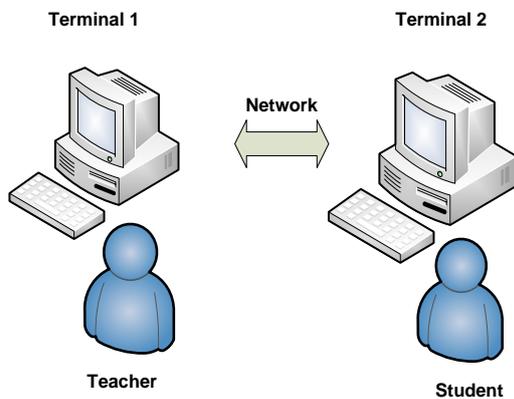


Figure 3: System Configuration

#### 3.2. Quality of Experience

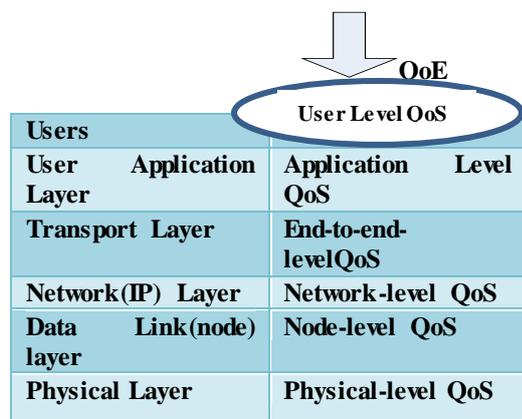


Figure 4: QoS in Internet

The Quality of Experience (QoE) is the measurement of the subjective feeling (delight or

annoyance) of an application or service perceived by the subject (end-user). Subjective QoE assessment is the most fundamental method of evaluating QoE. In the subjective QoE assessment, subjects evaluate the quality of services based on predefined evaluation criteria. QoE just is the user level QoS as shown in following figure.

#### 3.2.1. Subjective Assessment Method

During subjective group synchronization quality assessment, subjects watch and evaluate the perceived the synchronization error of video as teaching a lecture from teacher. There have two different kinds of methodologies can be used for displaying the lecture to the subjects. Double Stimulus (DS) methodology can be shown pairwise such as perfect condition (free synchronization error) and degraded version of it (with synchronization error). They are first presented to the test subjects after which they need to evaluate the quality difference both conditions. Therefore each test sequence is always presented a reference. The second type is called Single Stimulus (SS), present the perfect condition before the assessment. If the subject request, we will show the perfect situation during the assessment [7].

Subjective assessment obtains user opinions about QoE (for example, quality of group synchronization). Examples of subjective assessment methods are the rating scaling method, SD (Semantic Differential) method, pair comparison methods, constant method and questionnaire method. The questionnaire survey method collects user opinions by using a series of questions. The questions in a subjective assessment should be relevant, meaningful, and easy to understand for subjects. We used the questionnaire method as the following question.

After monitoring each video sequence, the subjects need to answer this question.

Did you perceived the group synchronization error?

And then the subjects were presented with the Yes (synchronization error) or No (no synchronization error) answer.

As recommended in [7], synchronous distance learning is required medium synchronization (synchronization error between 100 and 500 ms). In this cases in which various related media units are displayed somewhat simultaneous output. Therefore, we randomly set the different delay range in each video sequence. The range of the random delay order sequence shows in following Table1 by using

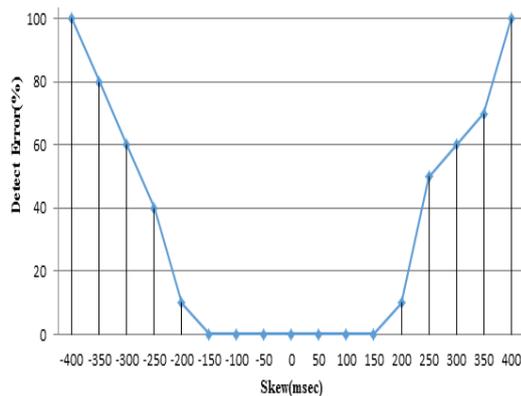
generated pseudo random order program. We used seventeen skews (ms) of delay that come from our experiment.

Sequence	Delay
02	-350
06	-150
04	-250
08	-50
07	-100
14	+250
05	-200
13	+200
10	+50
15	+300
17	+400
16	+350
12	+150
11	+100
03	-300
01	-400
09	0

**Table 1. Different delay range. Minus values denote audio behind video and plus values denote audio ahead of video.**

### 3.3. Assessment Result with English speech for explanation of lecture

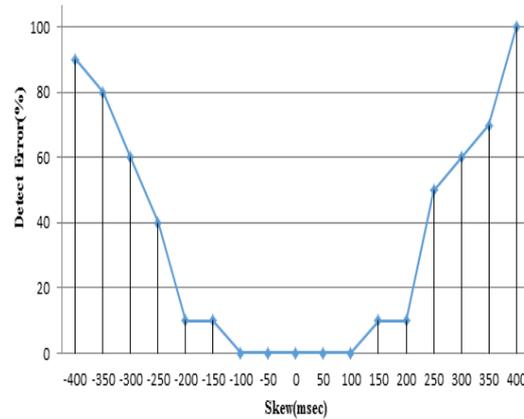
We investigate the influence of network delay on the remote education between two terminals. We used 15 subjects (users) who are 10 females and 5 males and age are above thirty to assess the group synchronization quality of our application. Experiment result show that the group synchronization error starts -200 and +200. According to graph the range of synchronization error is -200 to -400 and +200 to +400.



**Figure 5: Experimental result of group synchronization quality for English speech.**

### 3.4. Assessment Result with Myanmar speech for explanation of lecture

Experiment result show that the group synchronization error starts -150 and +150. According to graph the range of synchronization error is -150to -400 and +150to +400.



**Figure 6: Experimental result of group synchronization quality for Myanmar speech.**

According to our experimental results, starting of synchronization errors are not same in both figures because the first one as figure 5 starts +200ms and -200ms and another one starts +150 and -150ms. And then error rate is gradually increase as long as delay values are increase. In our experiment, comparison of English and Myanmar speech for explanation of lecture are impact on group synchronization error. We found they are not too different because their starting points of synchronization errors are slightly different as 50ms. We can prove that our application can use both language explanations because of these results. Synchronization error cannot change largely because of different language of explanation.

## 4. Conclusion

This paper collected and examined human perception of remote education to assess the subjective feeling of students at terminal. According to quality assessment, we got the different delay range from subjects after the assessment of group synchronization quality. To the best of our knowledge, this investigation is the first attempt that chasing the high quality of group synchronization is related to the quality of experience.

The next step of our research is to improve the high quality of group synchronization error control by using variety of output timing control algorithms and to clarify the QOE for this application or others reason why subjective assessments depend on the type of multimedia services.

## Acknowledgement

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