Chapter-9

Multimedia System (Pokhara University)

Chapter 9 – Synchronization

The word synchronization refers to time. Synchronization in multimedia refers to the temporal relation between media objects in the multimedia system.

Synchronization between media object comprises relation between time dependent media object and time independent media object. A common example is synchronization between visual and the acoustical information in television.

Notion of Synchronization

Basic Synchronization issues

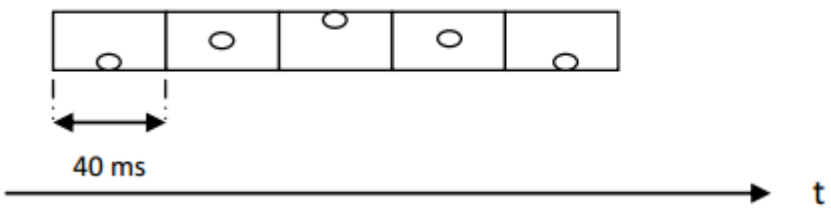
Content Relations
Content relations define a dependency of media objects from some data. An example of content relation is the dependency between a filled spreadsheet and a graphics that represent the data filled in the spreadsheet.

Spatial Relations
The spatial relations that are usually known as layout relationships define the space used for the presentation of a media object on an output device at a certain point of time in a multimedia presentation. If an output device is 2-D, the layout specifies the 2-D area to be used.

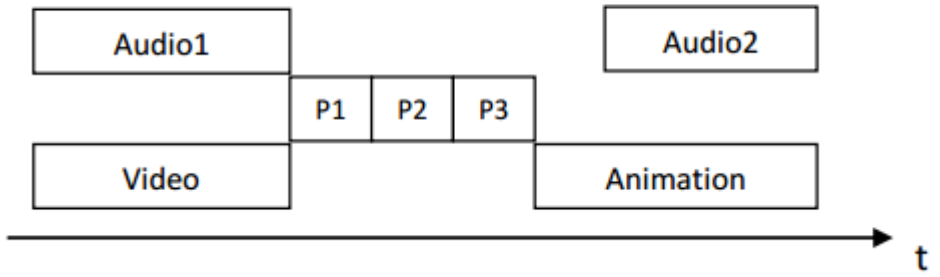
Temporal Relations
The temporal relations define the temporal dependencies between media objects. They are of interest whenever time-dependent media objects exist. E.g., the relation between a video and an audio object that are recorded during a concert.

Intra and inter-object synchronization

Intra-object synchronization
Intra-object synchronization refers to the time relation between various presentation units of one time-dependent media object. An e.g. is the time relation between the single frames of a video sequence of a bouncing ball. For a video with a rate of 25 frames per second, each of the frames must be displayed for 40 ms.



Inter-object synchronization
Inter-object synchronization refers to the synchronization between media objects. An e.g. is the time relations of a multimedia synchronization that starts with an audio/video sequence, followed by several pictures and an animation that is commented by an audio sequence.



Live and Synthetic synchronization

Live synchronization

The goal of the live synchronization is to exactly reproduce a presentation the temporal relations as they existed during the capturing process. E.g. video confererencing.

Synthetic synchronization

In the synthetic synchronization, the temporal relations are artificially specified. E.g. Moving through the path of car race.

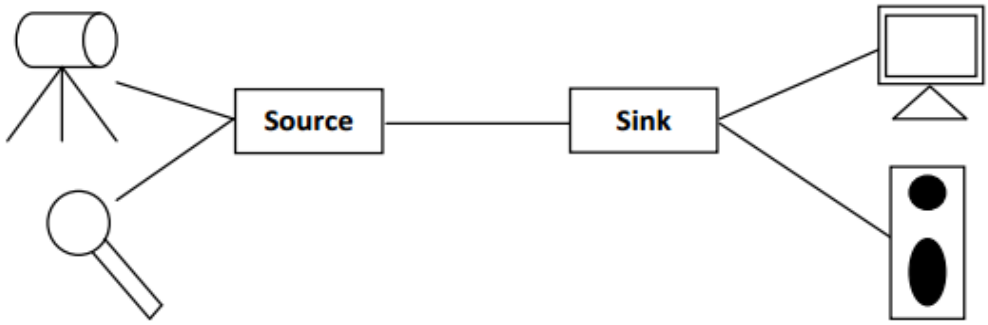


Figure: Live Synchronization without intermediate long-term storage

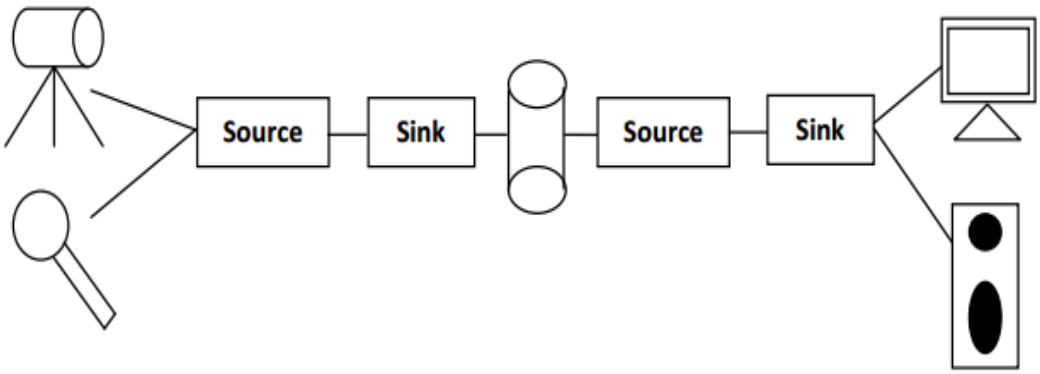


Figure: Live Synchronization with intermediate long-term storage and delayed presentation.

Presentation Requirements

For delivering multimedia data correctly at the user interface, synchronization is essential. A presentation requirement comprises, for intra-object synchronization, the accuracy concerning delays in the presentation of LDUs and, for inter-object synchronization, the accuracy in the parallel presentation of media objects.

Lip synchronization requirements

Lip synchronization refers to the temporal relationship between an audio and video stream for the particular case of human speaking. The time difference between related audio and video LDUs is

known as *skew.* The streams which are perfectly in synchronization have no skew i.e. 0ms. The lip synchronization can be tolerated within skew of -80ms (audio behind video) and +80ms (audio ahead of video).

Pointer Synchronization requirements
In a computer-supported co-operative work (CSCW) environment, cameras and microphones are usually attached to the user's workstation. Using the pointer the speaker pointed out individual elements of the graphics. This obviously required synchronization of the audio and pointer. From the experiments, the synchronization area related to audio ahead of pointing is 750ms and for pointing ahead of audio is 500ms

A Reference Model for Multimedia Synchronization

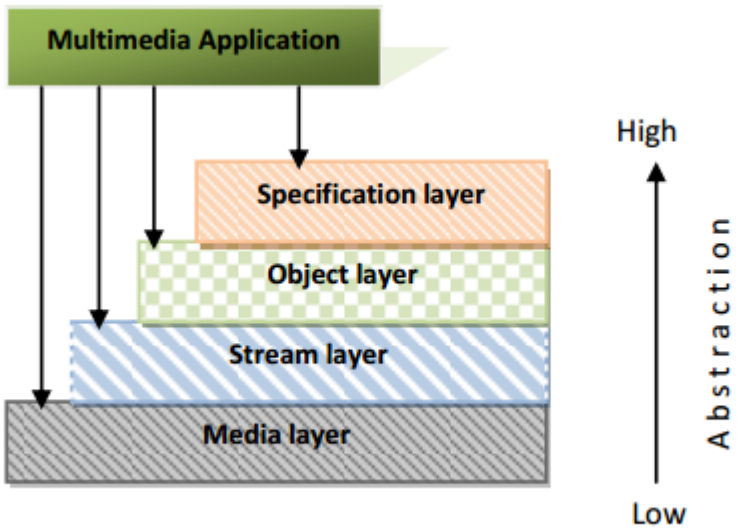


Figure: Four-layer reference model

Each layer provides synchronization mechanism, which is provided by an appropriate interface. These interfaces can be used to specify or enforce the temporal relationships each interface defines services, i.e. offering the user a mean to define his/her requirements. Each layer can be used by an application directly, or by the next high or layer to implement an interface.

Media layer
At the media layer, an application operates on a single continuous media stream, which is treated as a sequence of LDU. The abstraction offered at this layer is a device independent interface with operation like read and write. Media layer implementation can be classified into simple implementation and implementation that provide across two interleaved media stream.

Stream layer
Stream layer operates on continuous media stream as well as on groups of media streams. In a group, all streams are presented in parallel by using mechanisms for interstream synchronization. Continuous media is seen in the stream layers as a data flow with implicit time constraint. Individual LDUs are not visible. The streams are executed in real time environment, where all processing is constrained by well-defined time specification. An application using the stream layer is responsible for starting, stooping and grouping the stream for the definition of the required QoS in terms of timing parameters supported by the stream layer. It is also responsible for the synchronization with time independent media object.

Object layer

Object layer operates on all types of media and hides the differences between discrete and continuous media. The abstraction offered to the application is that of a complete, synchronized presentation. This layer takes a synchronization specification as input and is responsible for the correct schedule of the overall presentation. The task of this layer is to close the gap between the needs for the execution of a synchronized presentation and the stream-oriented services. The functions located at the object layer are to compute and execute complete presentation schedule that include the presentation of the non-continuous media object and the calls to the stream layer.

Specification layer

The specification layer is an open layer. It doesn't offer an explicit interface. This layer contains application and tools are located that allow to create synchronization specification. Such tools are synchronization editors, multimedia document editors, and authoring systems. It also contains tools for converting specification to an object layer format. It is also responsible for mapping QoS requirements of the user level to the qualities offered at the object layer interface.

Synchronization in Distributed Environment

Synchronization in Distributed environment is more complex than in a local environment. Elements of synchronization in distributed environment are:

1. **Transport of the synchronization specification**
   Three main approaches for the delivery of the synchronization information:
   i. Delivery of the complete synchronized information before the start of the presentation
   ii. Use of an additional synchronization channel
   iii. Use of multiplexed data stream
2. **Location of synchronization**
   To synchronize the media objects by combining the objects into a new media object.
3. **Clock Synchronization:**
   In distributed system the synchronization accuracy between the clocks of the source and sink nodes must be considered.
4. **Multiple communication synchronization/Relation:**
   Possible communication pattern with multiple sinks demand at run time.

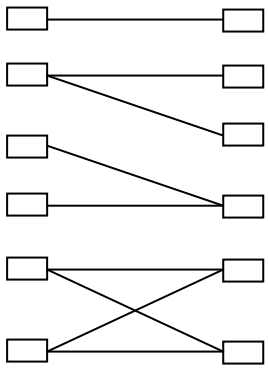


Figure: Communication Pattern

5. **Multi step synchronization:**

The synchronization must be maintained in a way that enabled the sink to perform the final synchronization. The steps are:

- **i.** synchronization during object acquisition (i.e. Digitizing video frame)
- **ii.** synchronization of retrieval (i.e. synchronized access to frames of stored video)
- **iii.** synchronization during the delivery of the logical data units(LDUs) to network
- **iv.** synchronization during transport
- **v.** synchronization at the sink
- **vi.** Synchronization within the output device.

Synchronization Specifications

The synchronization specifications of a multimedia objects describe all temporal dependencies of the included objects in the multimedia object. It is produced using the tools of the specification layer and used at the interface to the object layer.

A synchronization specification should be comprised of:

- ✓ Intra-object synchronization specification for the media object
- ✓ QoS description for intra-object synchronization
- ✓ Inter-object synchronization specifications for the media object
- ✓ QoS description for inter-object synchronization

Multimedia synchronization specification methods can be classified into the following main categories:

Interval based specification:

It allows the specification of temporal relations between the time intervals of the presentation of media object. This model allows the definition of duration for time dependent and time independent media objects.

Axes-based specification:

It relates presentation events to axes that are shared by the objects of the presentation. Synchronization is based on global timer and virtual axes.

Control-flow based specification:

In control flow based specification, the flow of the current presentation that is synchronized in predefined points of the presentation.

I. Basic hierarchical specification
II. Reference points.
III. Time Petri Nets

Event-based specification:

In the case of Event Based synchronization, presentation actions are initiated by synchronization events. Typical presentation actions are:

I. Start presentation
II. Stop Presentation
III. Prepare Presentation

Quality of Service (QOS)

I. QOS for media object
II. QOS for two related media objects
III. QOS of multiple related media objects.

Multimedia Synchronization specification method:

The following requirements should be fulfilled by specification method:

i. The method shall support object consistency and maintenance of synchronization specification.
ii. The method should supply an abstraction of the content of a media object that allows the specification of temporal relationship.
iii. All types of synchronization relations should be easily described
iv. The integration of time dependent and time independent media objects must be supported.
v. The quality of service requirements must be supported by the specification method.
vi. Hierarchical levels of synchronization must be supported.

Scripts:

It is a textual description of a synchronization scenario. Scripts are very powerful because they represent full programming environment.

References:

- ✓ Multimedia: Computing, Communications and Applications", Ralf Steinmetz and Klara Nahrstedt, Pearson Education Asia
- ✓ "Multimedia Communications, Applications, Networks, protocols ad Standards", Fred Halsall, Pearson Education Asia
- ✓ "Multimedia Systems", John F. Koegel Buford, Pearson Education Asia

Assignments:

(1) Why is the reference model for synchronization required and how is it defined? Explain.
(2) What is the importance of synchronization in Multimedia? Discuss the four-layer synchronization reference model.
(3) Why is the reference model for synchronization required? Briefly describe the synchronization specification?