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Multimedia Communications

Multimedia Technologies & Applications

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Content

1. Motivation
 - ❖ What is (Multimedia) Synchronization?
2. Synchronization and Multimedia
3. Reference Model for Multimedia Synchronization
4. Synchronization in a Distributed Environment
5. Synchronization Techniques
6. Case Studies

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Multimedia Synchronization

Refers mainly to the temporal relations between media objects in a multimedia document

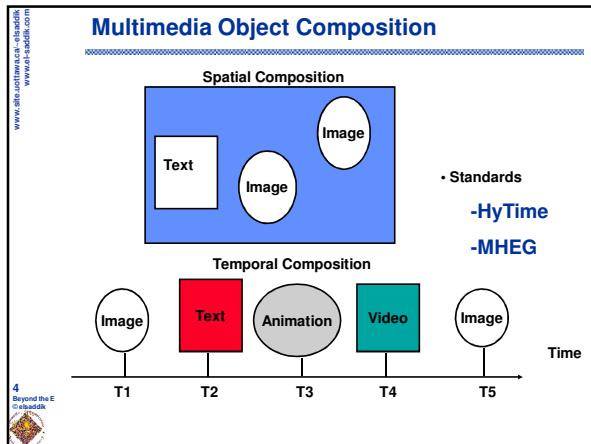
Media Objects

- > Time-dependent (media stream)
 - ❖ Continuous media: equal durations of all units (e.g., video)
- > Time-independent (discrete media): Text, Image

Synchronization is addressed at many levels:

- > operating system
- > communications system
- > databases
- > documents
- > applications

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Content Relations

Dependence of media objects on data

➤ **Examples:**

- ❖ A graphic that visualizes data from a spreadsheet
- ❖ Two graphics showing different views of the same data

➤ **Explicit definition of dependences for automated update**

- ❖ Only the data are edited
- ❖ All views of the data are
 - generated automatically
 - cannot be edited directly
- ❖ An update of the data triggers an update of the related views.

➤ **Implementation of content relations is based on the use of**

- ❖ common data structures or
- ❖ common object interfaces

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Spatial Relations

➤ **Usually known as layout relationships**

- ❖ Define the space which is used for the presentation of a media object
 - on an output device
 - at a certain point of time in a multimedia presentation

➤ **Typically expressed in layout frames:**

- ❖ A layout frame is placed and a content is assigned to this frame
- ❖ The positioning of a layout frame in a document may be
 - fixed to a position in a document
 - fixed to a position on a page
 - relative to the positioning of other frames

➤ **Spatial relations for time-dependent media objects:**

- ❖ A frame or a group of frames may be presented in a window
- ❖ **Note:** an audio presentation can be positioned on a stereo output device (imagine, e.g., a virtual meeting room where avatars are positioned in a VRML space: audio should be positioned with talking avatar!)

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Temporal Relations

- > Importance for time-dependent media objects
 - ❖ new in context of Multimedia (content, spatial existed before)
 - ❖ essential for communications, scheduling
 - ❖ non-trivial yet "general" issue
 - subject of standardization
 - to be emphasized in this course
- > Example for temporal relation between:
 - ❖ video object
 - ❖ audio object
- > recorded during a concert
- > At presentation time:
 - ❖ temporal relation of the two media objects must correspond to the temporal relation at the recording moment
- > Relations:
 - ❖ at the same time
 - ❖ independently
 - ❖ in sequel


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Intra-Media Synchronization

Intra-Media Synchronization:

- > refers to the temporal relations between media units within a time-dependent media object
- > Example:
 - ❖ Time relation between the single frames of a video sequence.
 - ❖ For a video with a rate of 25 frames per second each of the frames has to be displayed for 40 ms



Frames of a video sequence that shows a jumping ball

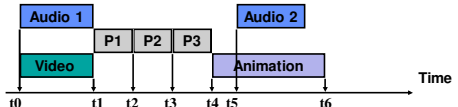
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Inter-Media Synchronization

Inter-Media Synchronization:

- > refers to the temporal relations linking the various media objects within a multimedia presentation
- > Example:
 - ❖ 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



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Live and Synthetic Synchronization

- > **Live Synchronization**
 - ❖ Conversational multimedia services
 - e.g., lip sync
 - ❖ Reproduces temporal relations of media exactly as they were produced during capturing process
- > **Synthetic Synchronization**
 - ❖ Presentational multimedia services
 - e.g., talking head
 - ❖ Temporal relations of media artificially specified

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Synchronization Anomalies

- > **Inter-media Skew:**
 - ❖ is the average difference in presentation times between two synchronized objects over n synchronization points
- > **Intra-media Jitter:**
 - ❖ is the difference between the actual presentation time of a media unit and its nominal presentation time

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Causes of Synchronization Errors

- > **Delay and Delay Variation**
 - ❖ Sample, Encode, Query, Seek, Packetize, Transmit, Buffer, De-packetize, Decode, Display delays
 - ❖ Random delay components induce delay variability at **packet** (network jitter) and **stream** (media jitter) levels
- > **Processing Loads**
 - ❖ Both at client and server nodes
 - ❖ Transport Layer Processing, Context Switching, Media Decoding, Media Rendering etc....
- > **Clock Synchronization**
 - ❖ **Clock Offsets** between client and server nodes
 - ❖ **Clock Drifts** in frequency may result in overflow or underflow conditions

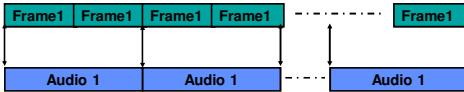
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Synchronization Examples

- At IBM ENC Heidelberg to quantify synchronization requirements for:
 - ❖ Audio/video synchronization
 - ❖ Audio/pointer synchronization
- Selection of material:
 - ❖ Duration
 - 30s in experiments
 - 5s would have been sufficient
 - ❖ Reuse of same material for all tests
- Introduction of artificial skew:
 - ❖ By media composition with professional video equipment
 - ❖ With frame based granularity
- Test conditions:
 - ❖ Huge set of test candidates
 - Professional: cutter at TV studios
 - Casual: every day "user"
 - ❖ Awareness of the synchronization issues
 - ❖ Set of tests with different skews lasted 45 min

Lip synchronization

- demands for a tight coupling of audio and video streams with a limited skew between the two media streams



- View mode (head view, shoulder view, body view)



Synchronization QoS Parameters (R.Steinmetz, IEEE JSAC, Jan.1996)

MEDIA	MODE, APPLICATION	SyncQoS	
Video	Animation	correlated	
	Audio	lip synchronization	+/-80 ms
	Image	overlay	+/-240 ms
		non overlay	+/-500 ms
	Text	overlay	+/-240 ms
		non overlay	+/-500 ms
Audio	Animation	event correlation (e.g., dancing)	+/-80 ms
	Audio	tightly coupled (stereo)	+/-0.011 ms
		loosely coupled (dialog mode with various participants)	+/-120 ms
		loosely coupled (e.g., background music)	+/-500 ms
	Image	tightly coupled (e.g., music with notes)	+/-5 ms
		loosely coupled (e.g., slide show)	+/-500 ms
	text	text annotation	+/-240 ms
	pointer	audio relates to showed item	+/-500 ms

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SMIL (Synchronized Multimedia Integration Language)

- **A markup language based on XML**
- **First markup language oriented to delivery of multimedia on the web**
- **Allows coordination of multiple elements on a common timeline**
 - ❖ **Much like what Quicktime does for a single file, SMIL coordinates elements from a page**

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Advantages of SMIL

Potential support for any data or file type

- **Compare this to quicktime and mpeg**

Creates greater flexibility

- **To change the presentation, one changes the SMIL file**
- **Addition, subtraction, or rearrangement of elements**

Greater customization for the user

- **Allows content deliverer to present the same content in different ways based on the users' browser preference (eg. different bit rates or languages)**

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Players

Driven by RealNetworks

- **G2 player supports SMIL 1.0**
- **RealOne player support SMIL 2.0**

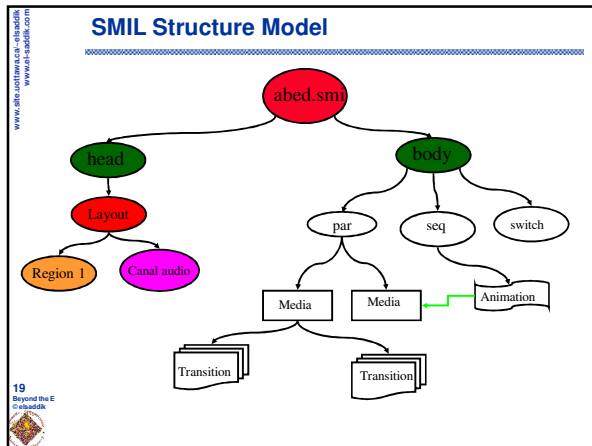
Microsoft

- **Initial support, but withdrew just before 1.0 released. Introduced HTML+TIME (Timed Interactive Multimedia Extensions for HTML)**
- **Came back to the fold as V2.0 started to jell**
- **Currently supports of subset of SMIL in IE 5 for Windows**
- **IE 6 supports XHTML + SMIL profile**

Apple

- **Includes SMIL 1.0 in Quicktime Extensions**

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Example

```

<par>
<video id="carvideo" src="car.rm" region="videoregion"
title="Car video" alt="Illustration of relativistic time
dilation and length contraction."
longdesc="carvideodesc.html" readIndex="3"/>
<audio id="caraudio" src="caraudio.rm" region="videoregion"
title="Car presentation voiceover" begin="bar.begin"/>
<animation id="cardiagram" src="car.svg" region="animregion"
title="Diagram of the car" readIndex="2"/>

</par>

```

- > <par>
 - ❖ parallel
- > <seq>
 - ❖ sequential
- > <switch>
 - ❖ Defines a list of choices from which the first acceptable is chosen

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Problems with SMIL

Only a few players at this point

- > Just like XML, until applications are pervasive, other approaches are better

Competition/Cooperation with MS products

- > Support for XHTML-SMIL Profile eases transition

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