CS 414 – Multimedia Systems Design

Lecture 28 – Synchronization Issues

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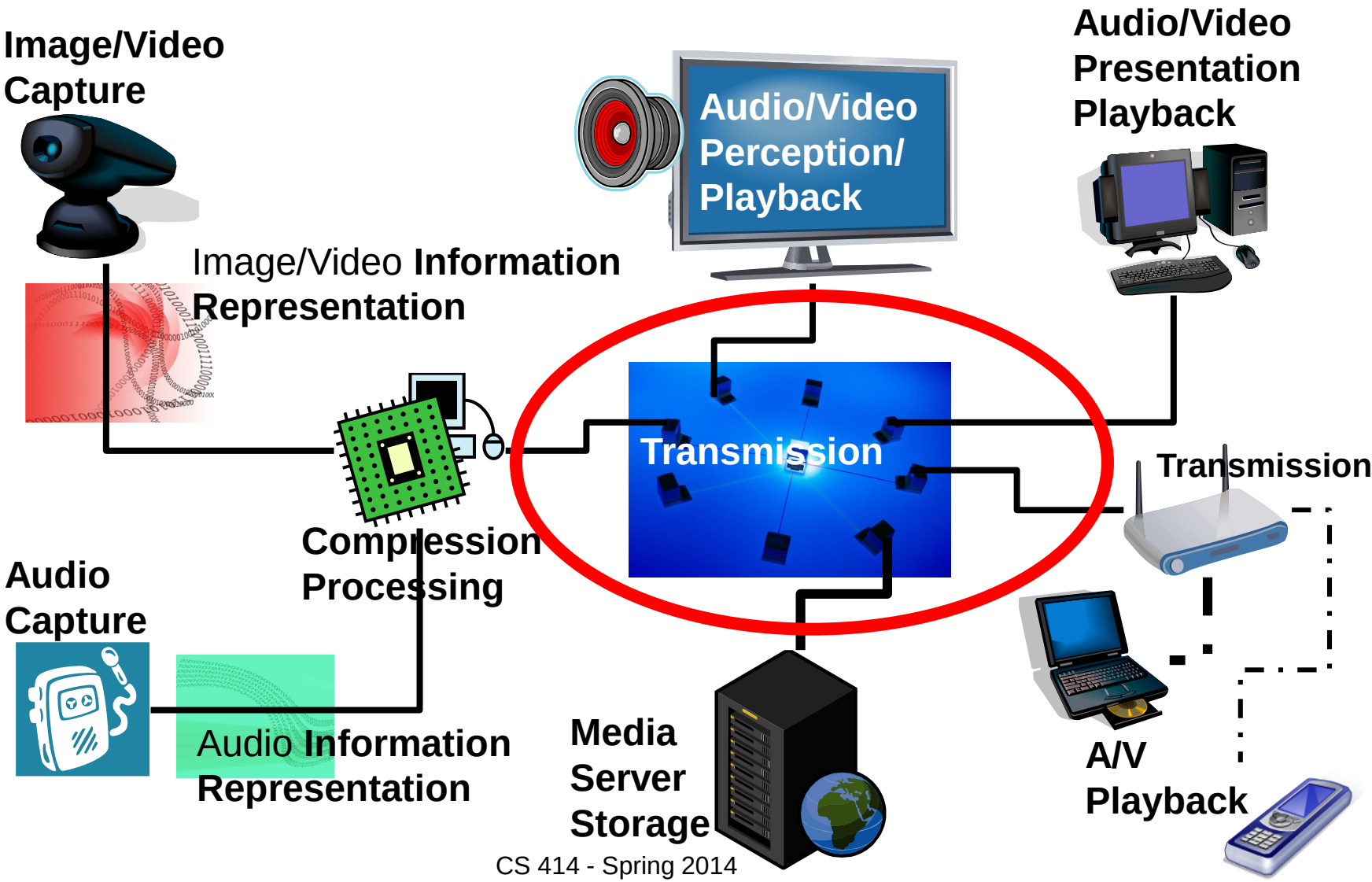
Spring 2014

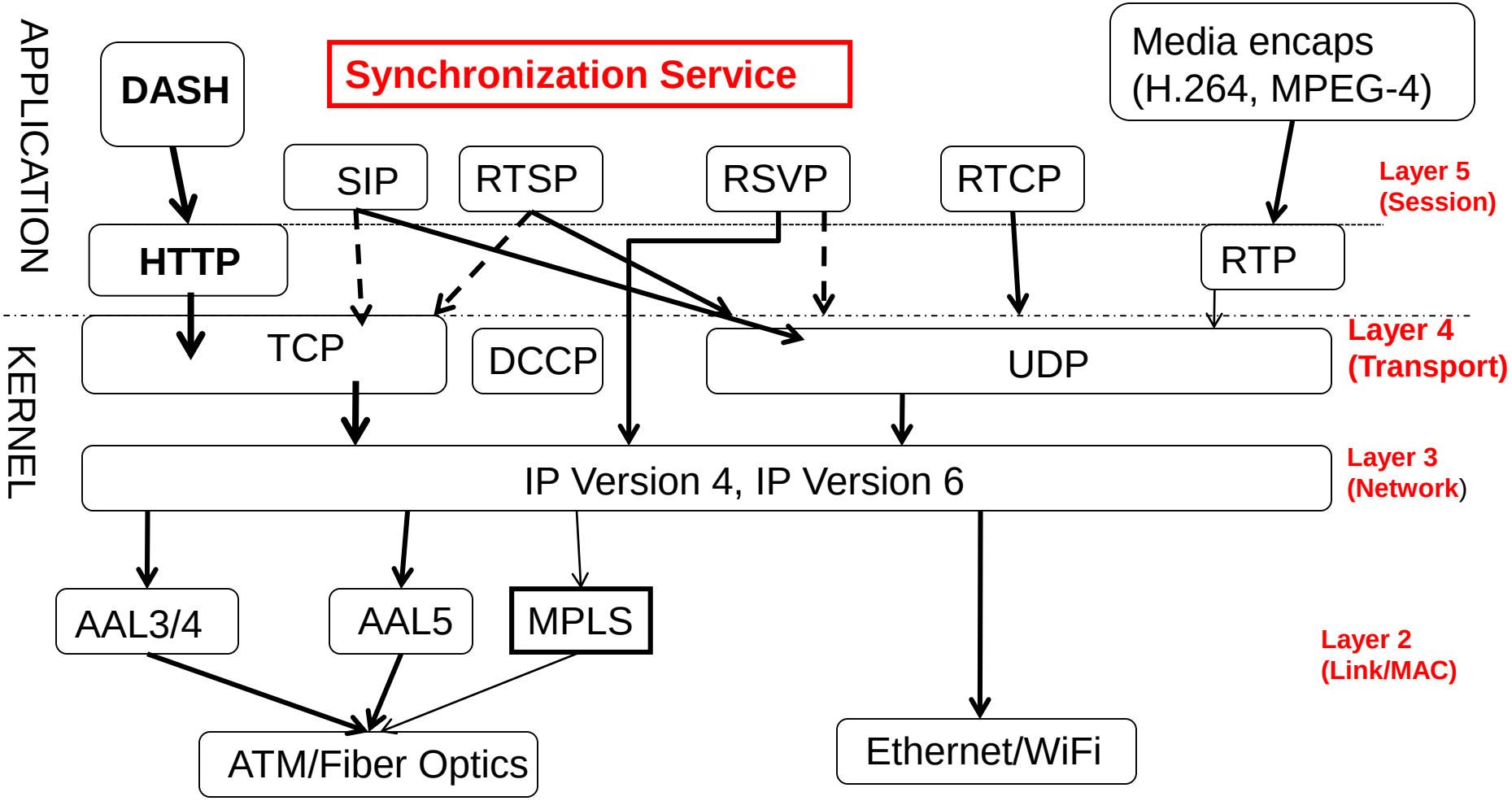
Administrative

- **MP2 ongoing**

Covered Aspects of Multimedia



Internet Multimedia Protocol Stack



Outline

- Synchronization Specification
  - Interval-based Specification
  - Timeline Specification
  - Control Flow based Specification
  - Event-based Specification

Requirements on Synchronization Specs

- Object consistency and maintenance of sync specifications
  - Media objects should be kept as one LDU in spec
- Temporal relations must be specify-able
- Easy Description of Sync Relations
- Definition of QoS requirements
- Integration of time-dependent and independent media
- Hierarchical levels of synchronization

Sync Spec Models

- Interval
- Timeline
- Flow-control
  - Hierarchical
  - Reference points
- Event-based

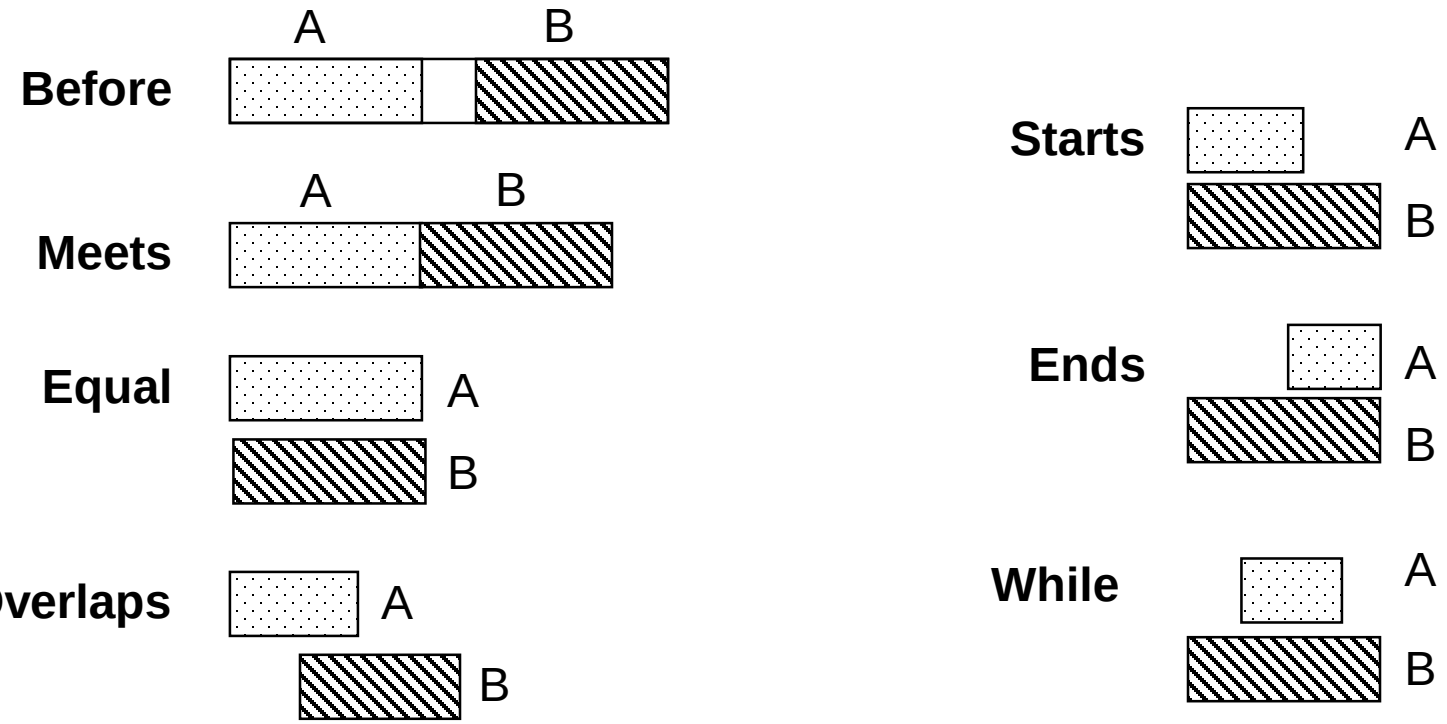
- Common threads
  - provide language to express relationships
  - runtime system to monitor relationships
  - policies to enforce relationships

Interval-based Specification (1)

- Presentation duration of an object is specified as interval
- Types of temporal relations:
  - A before B, A overlaps B, A starts B, A equals B, A meets B, A finishes B, A while B
- Enhanced interval-based model includes 29 interval relations, 10 operators handle temporal relations (e.g., before(δ1),…)

Interval Model (2)

- 13 relationships between two intervals



Example (3)

Audio1 while(0,0) Video

Audio1 before(0)
RecordedInteraction

RecordedInteraction before(0) P1

P1 before(0) P2

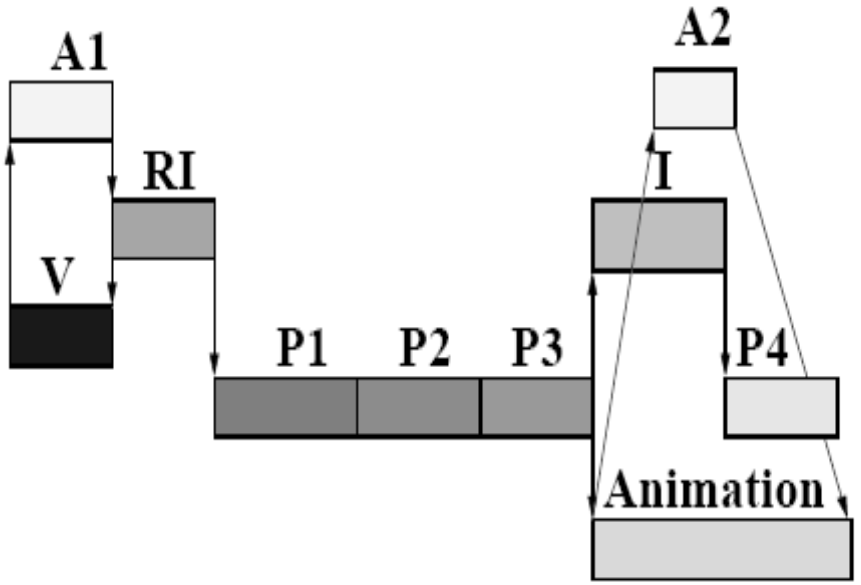
P2 before(0) P3

P3 before(0) Interaction

P3 before(0) Animation

Animation while(2,5) Audio2

Interaction before(0) P4



Interval-based Specification (4)

- Advantages:
  - Easy to handle open LDUs (i.e., user interactions)
  - Possible to specify additional non-deterministic temporal relations by defining intervals for durations and delays
  - Flexible model that allows specification of presentations with many run-time presentation variations

Interval-based Specification (5)

- Disadvantages:
  - Does not include skew spec
  - Does not allow specification of temporal relations directly between sub-units of objects
  - Flexible spec leads to inconsistencies
    - Example:

      A NOT in parallel with B

      A while(2,3) I

      I before(0) B

Timeline Axis-based Specification

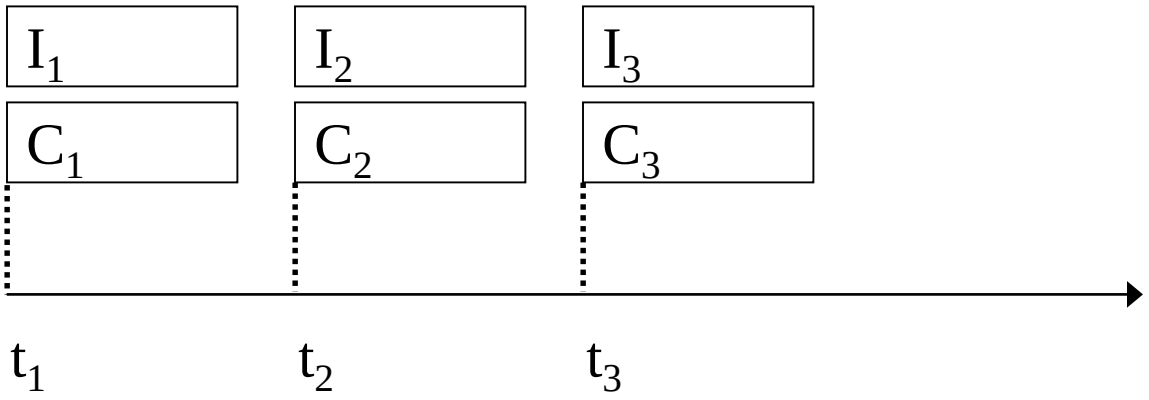
- Presentation events like start and end of presentation are mapped to axes that are shared by presentation objects
- All single medium objects are attached to time axis that represents abstraction of real-time
- This sync specification is very good for closed LDUs

Timeline Model (2)

- Uses a single global timeline
- Actions triggered when the time marker reaches a specific point along timeline

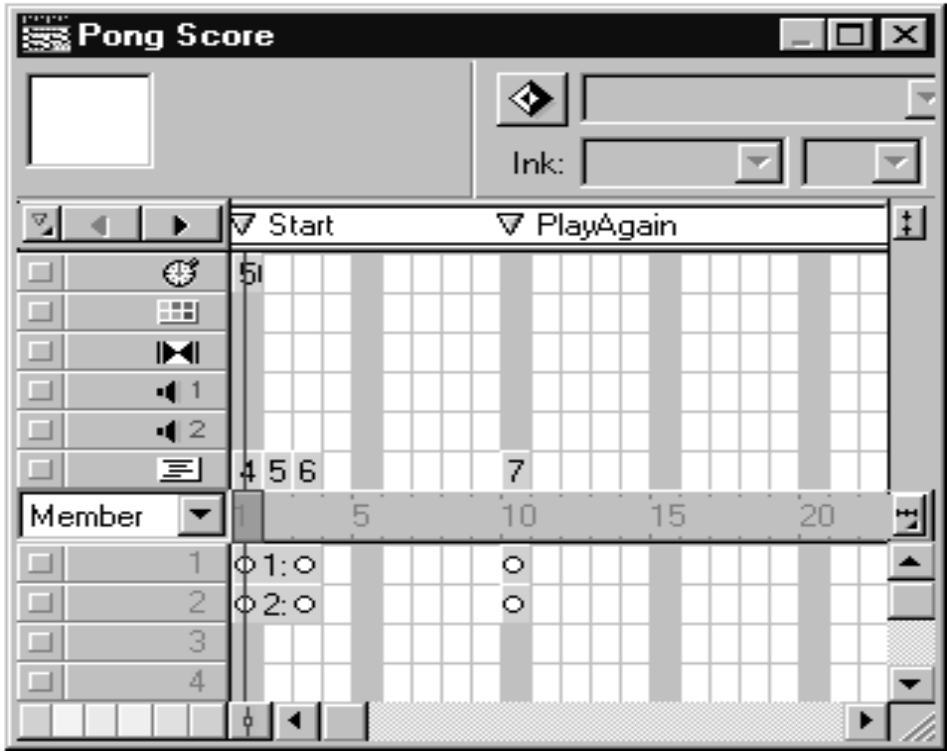
Example (3)

- Define a timed sequence of images, each image has a caption that goes with it



Example (4)

- Rule language
  - At (t1), show (I1, C1)
  - At (t2), show (I2, C2)
  - At (t3), show (I3, C3)
- Visual environment



Control Flow-based Spec - **Hierarchical Model** (1)

- Possibility to specify concurrent presentation threads at predefined points of presentation
- **Basic hierarchical spec types:**
  - Serial synchronization
  - Parallel synchronization of actions
- **Actions: atomic or compound**
  - Atomic action handles presentation of single media object, user input, delay
  - Compound actions are combinations of sync operators and atomic actions
  - Delay is atomic action – allows modeling of delays in serial presentations

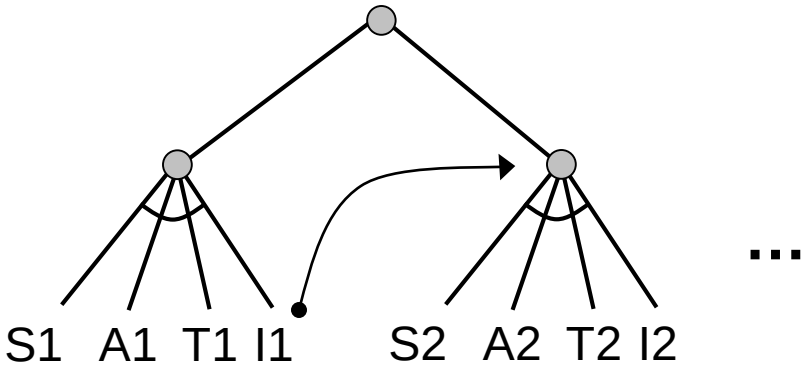
Hierarchical Model (SMIL)

- Based on sequential and parallel

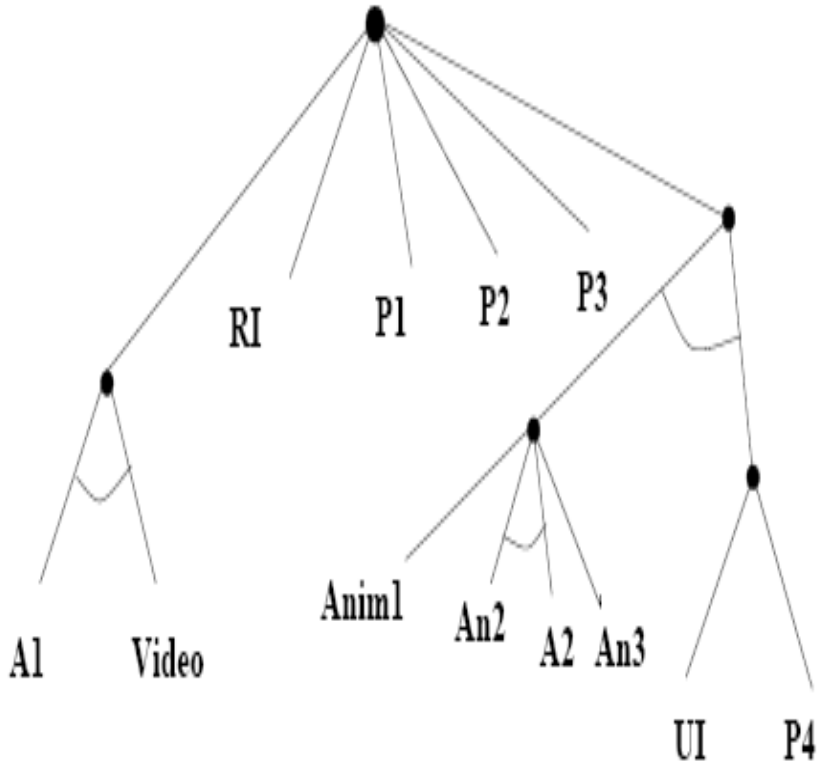
- Apply operators to only the start/end points of each media object

Example (3)

- Narrated slide show
  - image, text, audio on each slide
  - select link to move to the next slide



Example (4) (and Comparison with Interval-based Spec)



Audio1 while(0,0) Video

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RecordedInteraction before(0) P1

P1 before(0) P2

P2 before(0) P3

P3 before(0) Interaction

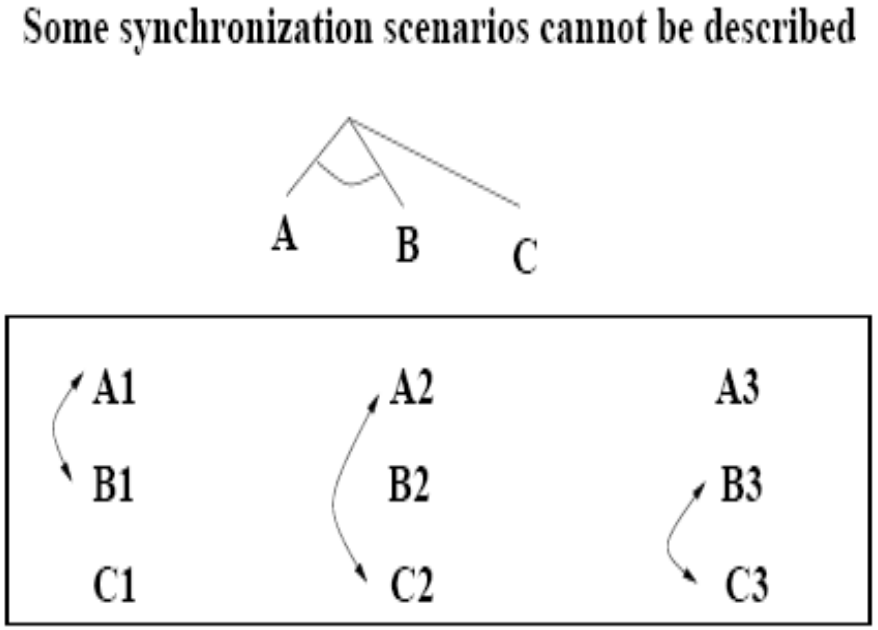
P3 before(0) Animation

Animation while(2,5) Audio2

Interaction before(0) P4

Control Flow-based Spec – Hierarchy (5)

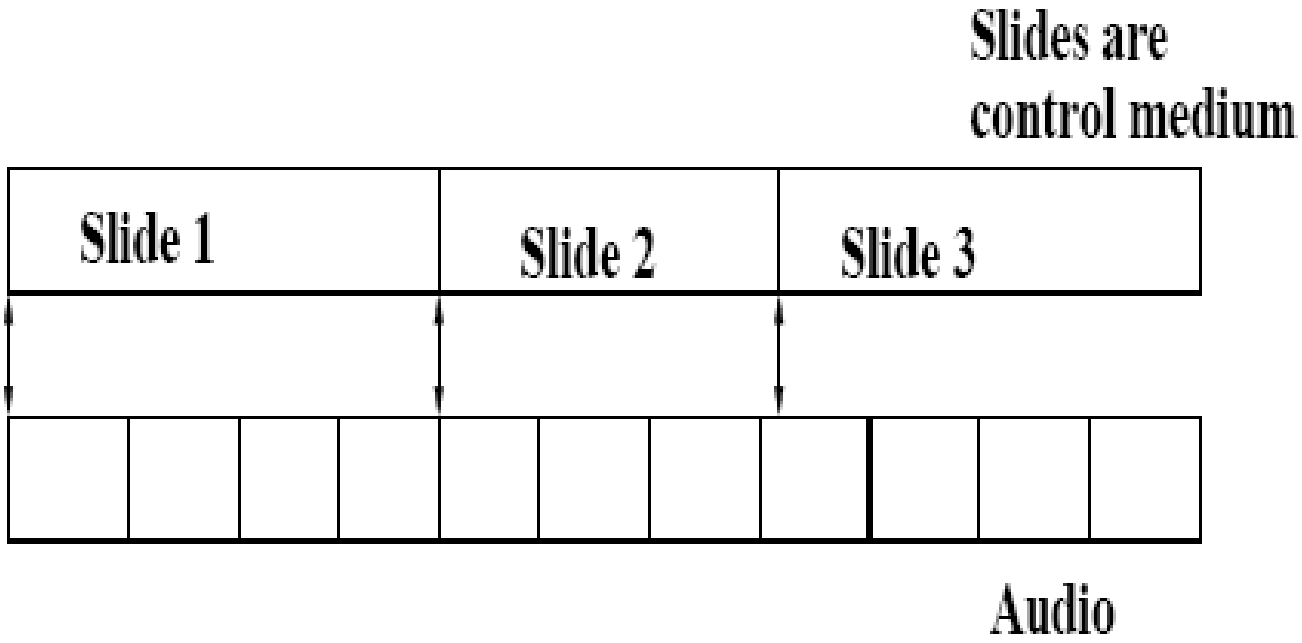
- Advantages
  - Easy to understand
  - Natural support for hierarchies
  - Integration of interactive object easy
- Disadvantage
  - Need additional descriptions of skews and QoS
  - No duration description



Control Flow-based Spec – **Reference Points** (1)

- Time-dependent single medium objects are regarded as sequences of closed LDUs
- Start/stop times of object presentation are reference points
- Connected reference point is synchronization point
- Temporal relations specified between objects without explicit reference to time

Example (2)



Control Flow-based Spec – Reference Points (3)

- Advantages:
  - Sync at any time during presentation of objects
  - Easily integrated object presentation with unpredictable duration
  - Intuitive type of synchronization spec
- Disadvantages:
  - Not easy way to detect inconsistencies
  - Cannot specify delays in presentation

Event-based Specification

- Presentation actions initiated by synchronization events
- Example:
  - Start presentation
  - Stop presentation
  - Prepare presentation
- Events initiating presentation
  - External or internal

Event-based Spec

- Advantage:
  - Easily extended to new sync types
  - Easy integration of interactive objects
- Disadvantage:
  - Difficult to handle in case of realistic scenarios
  - Too complex specification
  - Need separate description of skew/QoS
  - Difficult use of hierarchies

Event Model (Nsync)

- Associate *actions* with *expressions*
- Expressions may contain scalars, clocks, variables, relations, and connectives
- When the expression becomes TRUE, invoke associated action

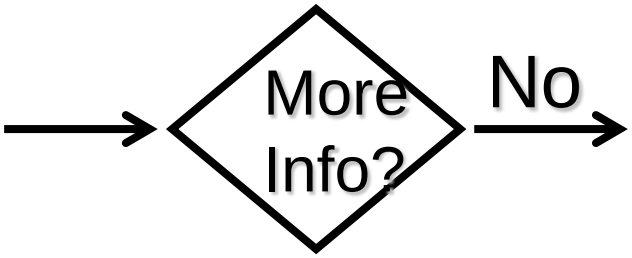
```
When “Time > Q.end + 5 &&
      !Response” Answer=WRONG
```

Source: B. Bailey et al. “Nsync- A Toolkit for Building Interactive Multimedia Presentations”, ACM Multimedia 1998

Example: Delayed Transition

Overview

More Info



Detailed Narration

More Info

Model Specification

```
When “Narration >= Overview &&
       !MoreInfo”          NextSlide
When “Narration >= Overview &&
        MoreInfo”          PlayDetails
When “Narration >= Overview + Details”
                           NextSlide
```

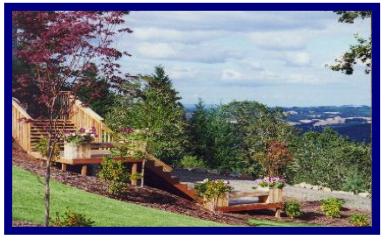
`Narration`: narration’s logical timeline

`Overview`: normal transition point

`Details`: additional narrative details

`MoreInfo`: records kitchen info status

Reactive Interface



Model Specification

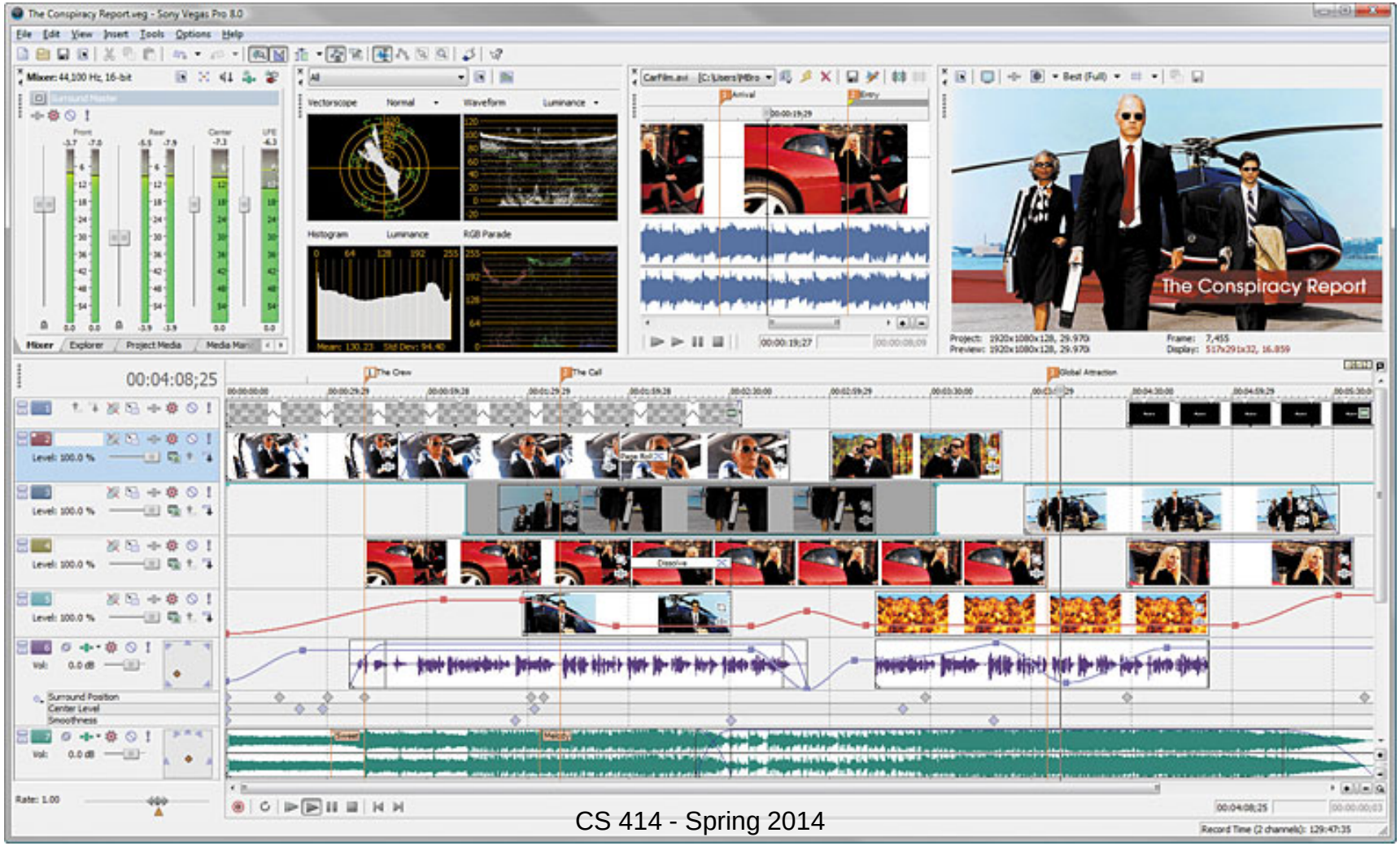
```
When “Video >= 0 && Video < T1”
                        Select Kitchen

When “Video >= T1 && Video < T2”
                        Select Deck

When “Video >= T2 && Video <= T3”
                        Select Yard
```

Synchronization/Editing Tool in CS/UIUC Vegas Video

http://www.sonycreativesoftware.com/vegaspro



Conclusion

- Synchronization Specifications
  - Important for different authoring tools for complex presentation
  - Be careful as you go from one spec to another
  - Carefully consider which spec closest allows you to specify sync requirements in your application