Synchronization Management in DTV Applications

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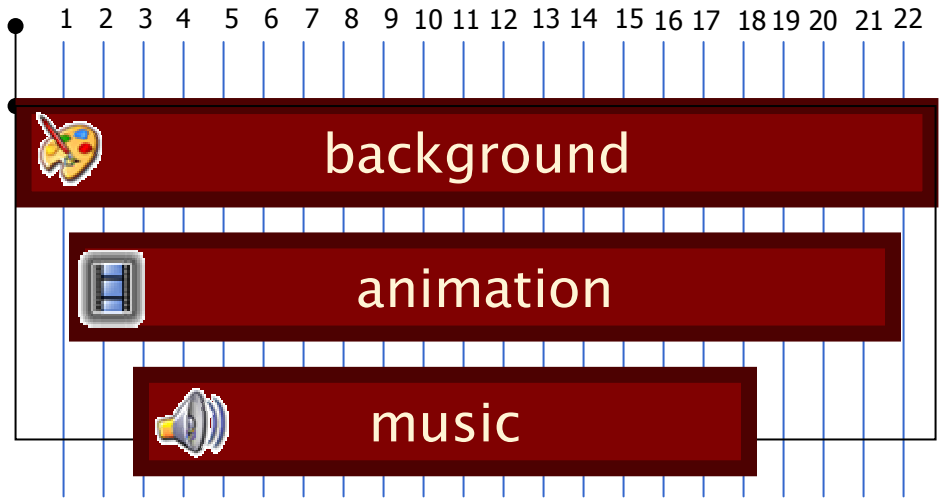
Contents

- **Introduction**
- Synchronization Plans
- Multiple Exhibition Devices
- Final Remarks

Motivation

- Intermedia Synchronization

  Timeline



- DTV Applications
  - Predictable events.
  - Unpredictable events.
  - Content and content-presentation adaptations.

Challenges

- In applications where unpredictable events and adaptations are common, it is desirable that the synchronization specification can be done in relation to the occurrence of events.
- The author does not to need to know the exact time moments when the events will occur.

Three Main Questions

- How to specify the synchronizations among events?
- How to calculate the moments in time of events, maintaining the presentation control of the application?
- How to manage transmissions from servers to receivers, maintaining the needed QoS to assure a synchronized presentation at clients?

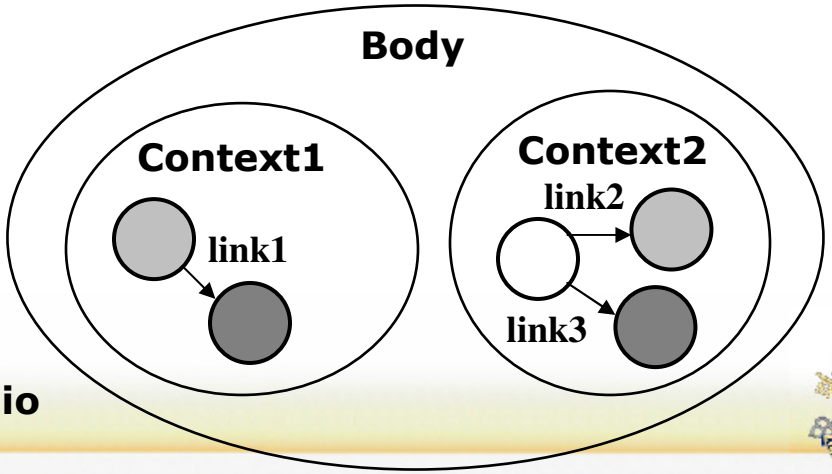
Application Specification

- The NCL is a declarative language used to specify spatio-temporal relationships among media objects.
  - NCL was adopted by the declarative middleware Ginga, proposed for the Brazilian Digital TV System (SBTVD).
  - NCL was also adopted by ITU-T for IPTV applications (H.761).

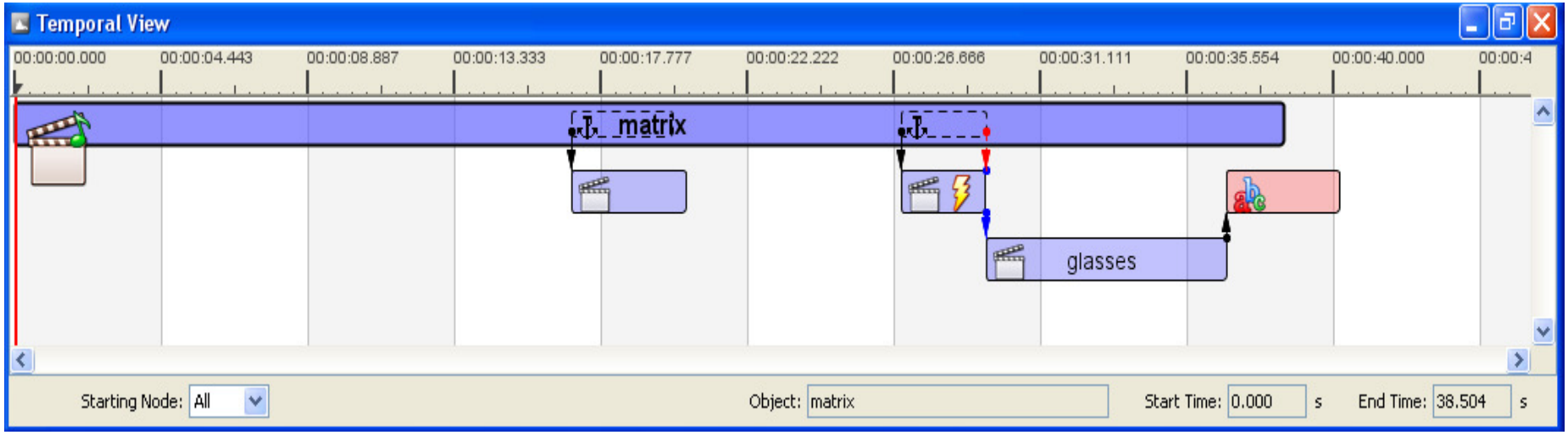
- NCL follows the terminology adopted by many W3C standards (XML elements – ncl, head, body).

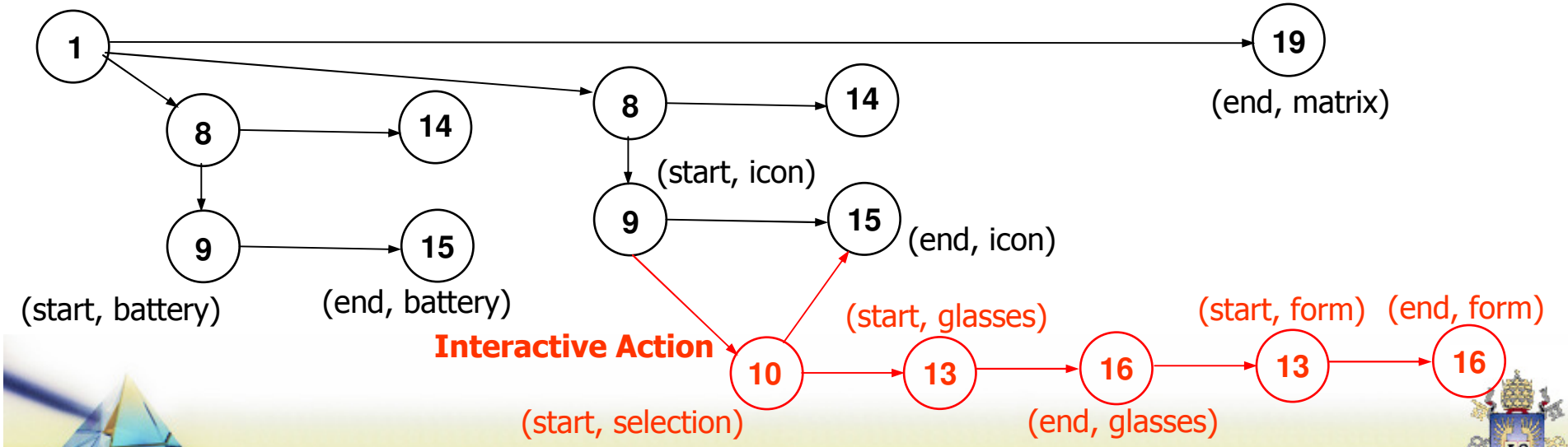
Spatio-Temporal Relationships

- The media objects are defined in NCL as media nodes.
- Media nodes are logically distributed inside context nodes, that can contain a set of nodes (context or media) and a set of links.
- NCL Contexts do not have embedded temporal semantics, they define only the logical structure of the application.
- The relationships among NCL nodes are defined using links and events.



Temporal View





Presentation and Transport Control

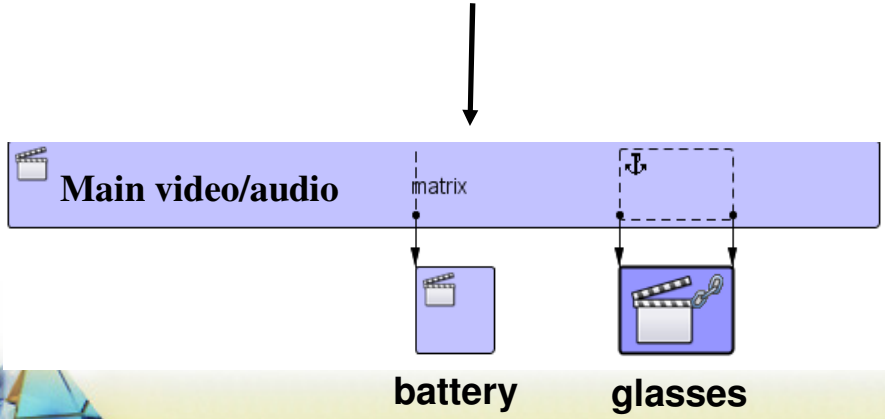
- Presentation engine must guarantee the author's specifications regarding applications.
  - Predictable and unpredictable events.
  - Content and content-presentation adaptations.

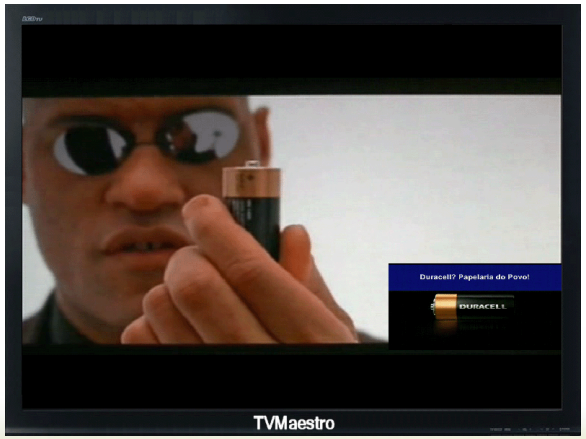
- Presentation engine must also support the specific DTV applications features.
  - Applications can be started at different moments in receivers.
  - Applications can be paused and resumed at some later time.

Live Editing

Main audio and video are playing

startDocument (matrixFilm,matrixExample)





Approach

- For the specification, some extensions to NCL elements and attributes are proposed to include facilities.
  - Multiple devices specification
  - NCL has a modular approach, new modules are proposed, defining new language profiles.
  - Live editing commands.

- For the synchronization support, a set of plans are proposed in order to configure services related to the presentation and transport of applications.
  - To calculate these plans a temporal graph is also proposed.

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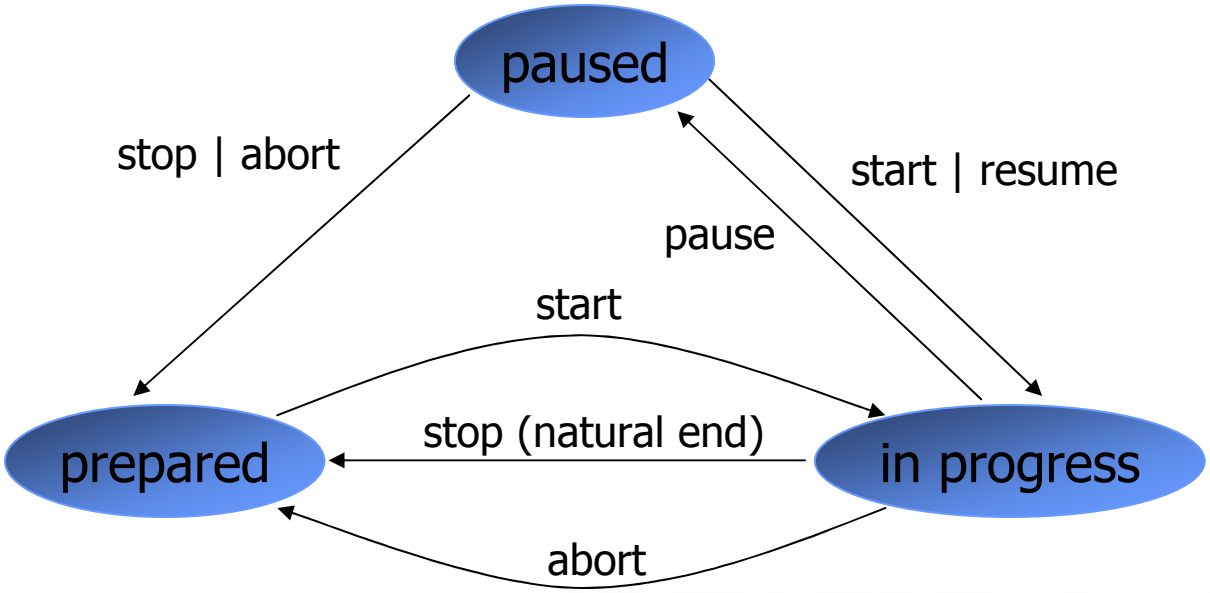
Data Structures

- Several data structures are proposed in order to support the DTV features.
- They can be built from the application specification.

Client Side	Server Side
Presentation Plan Player-load Plan Pre-fetching Plan QoS Plan	Pushed-Data Plan

Ginga

- NCL has in its DTV profiles three types of events.
  - Presentation event.
  - Selection event.
  - Attribution event.



Presentation Data Structure

- Hypermedia Temporal Graph
  - A digraph structure that represents all relationships among transition states of events, predictable or unpredictable, of all media objects in a hypermedia application.

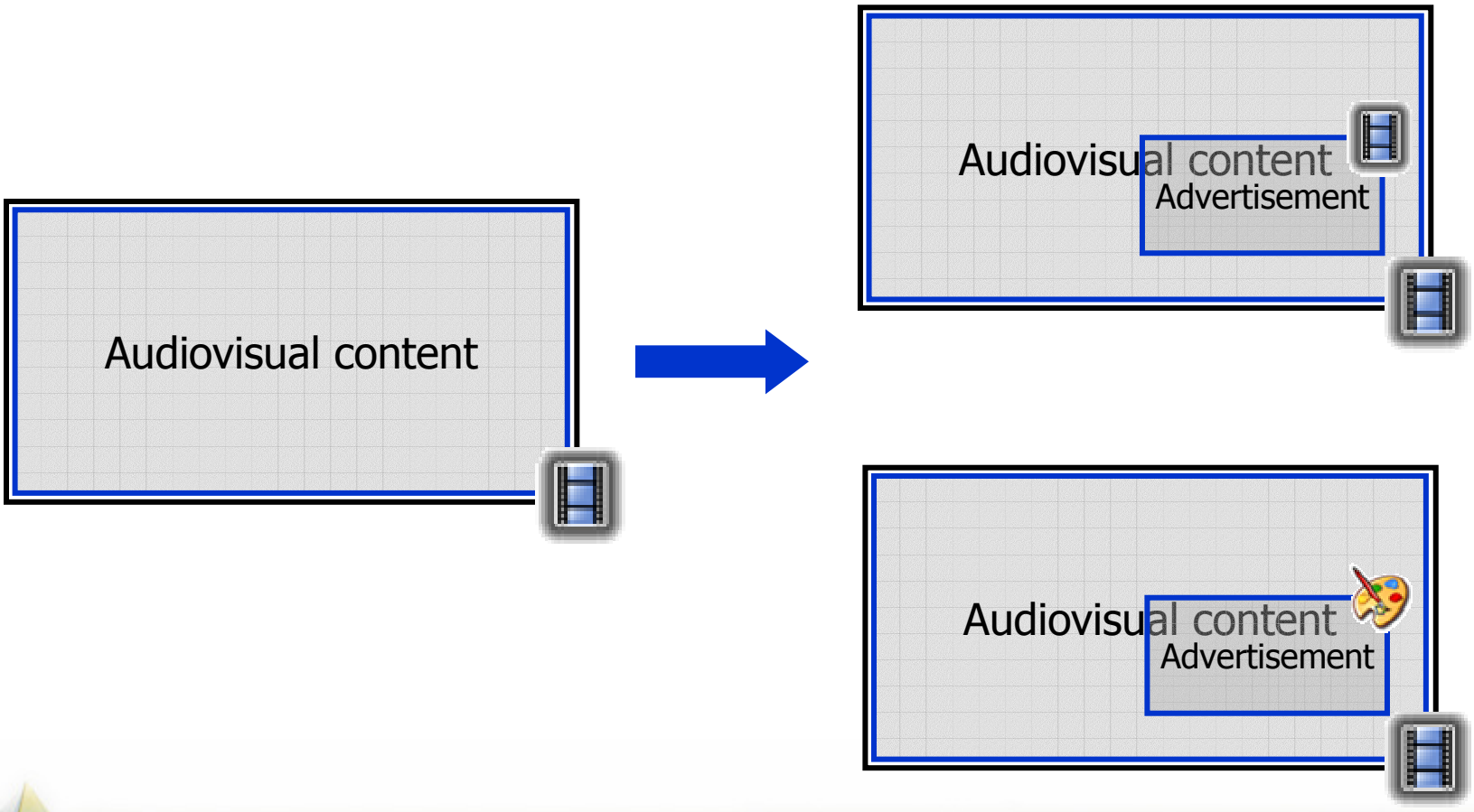
- HTG = (V, A, C) where:
  - V is a set of vertices where each one represents an state transition of an event.
  - A is a set of edges between vertices where each one represents relationships among state transitions.
  - C is a set of conditions associated with edges.

Hypermedia Temporal Graph

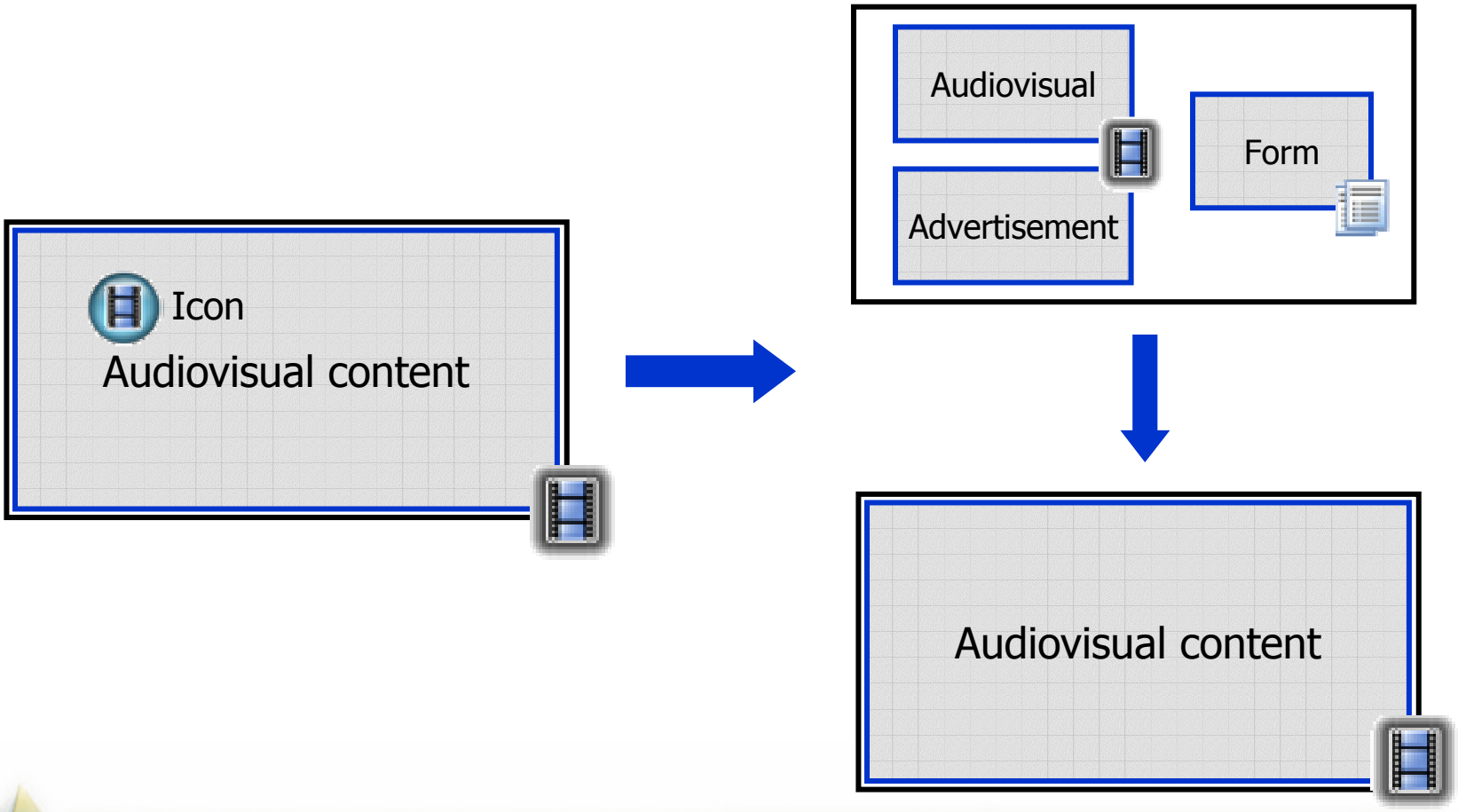
- When a edge condition is satisfied, the state transition defined in the output vertex of the edge is triggered.
  - Temporal interval that must be satisfied.
  - Variable that must be evaluated in relation to a value.
  - External actions, such as viewer interactions.
- After defining a starting point in the graph, the actions in HTG can have their moment in time computed, taking into account the time intervals required to satisfy the edge conditions.

Presentation Plan

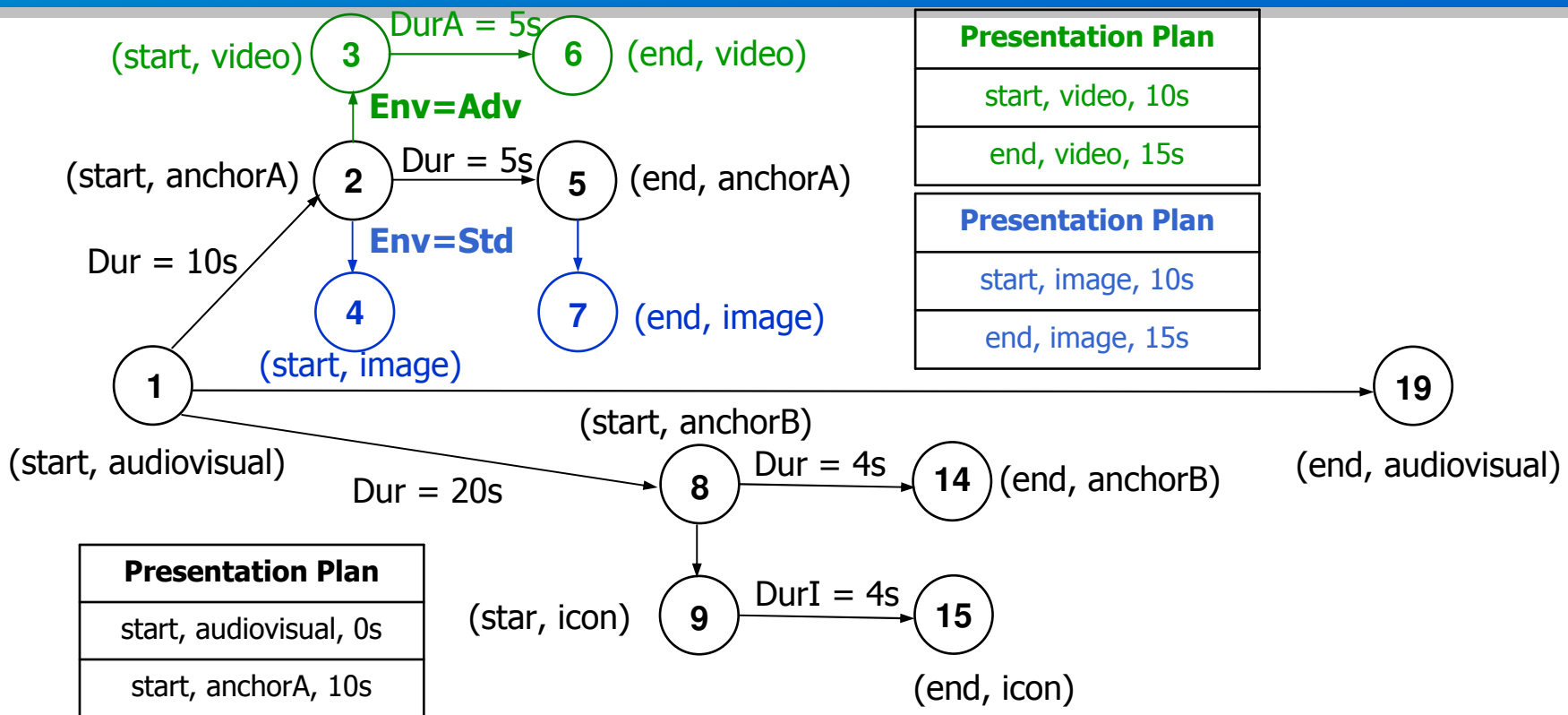
Application



Application



Hypermedia Temporal Graph

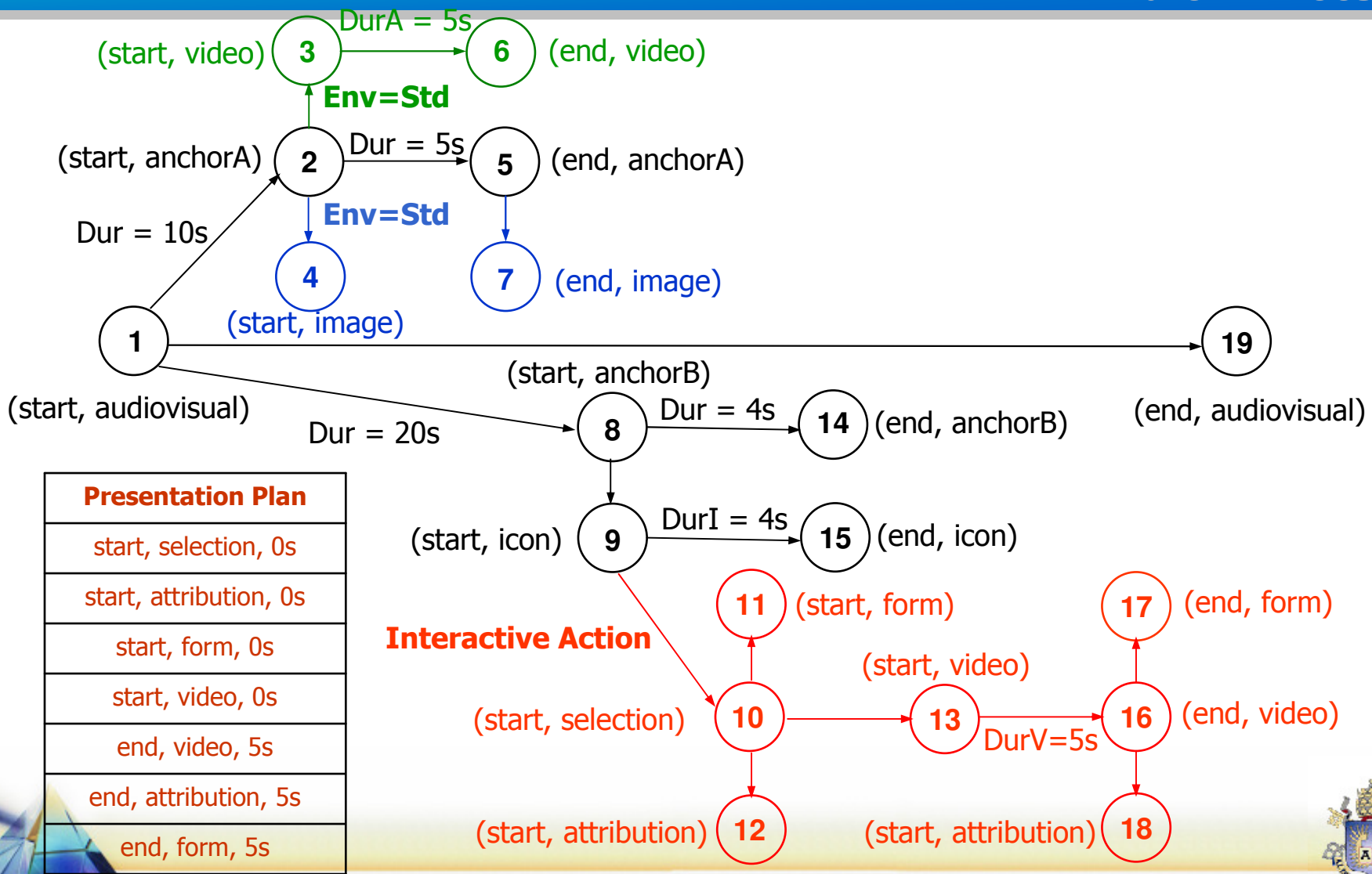


Presentation Plan
start, video, 10s
end, video, 15s

Presentation Plan
start, image, 10s
end, image, 15s

Presentation Plan
start, audiovisual, 0s
start, anchorA, 10s
end, anchorA, 15s
start, anchorB, 20s
start,icon, 20s
end, anchorB, 24s
end, icon, 24s

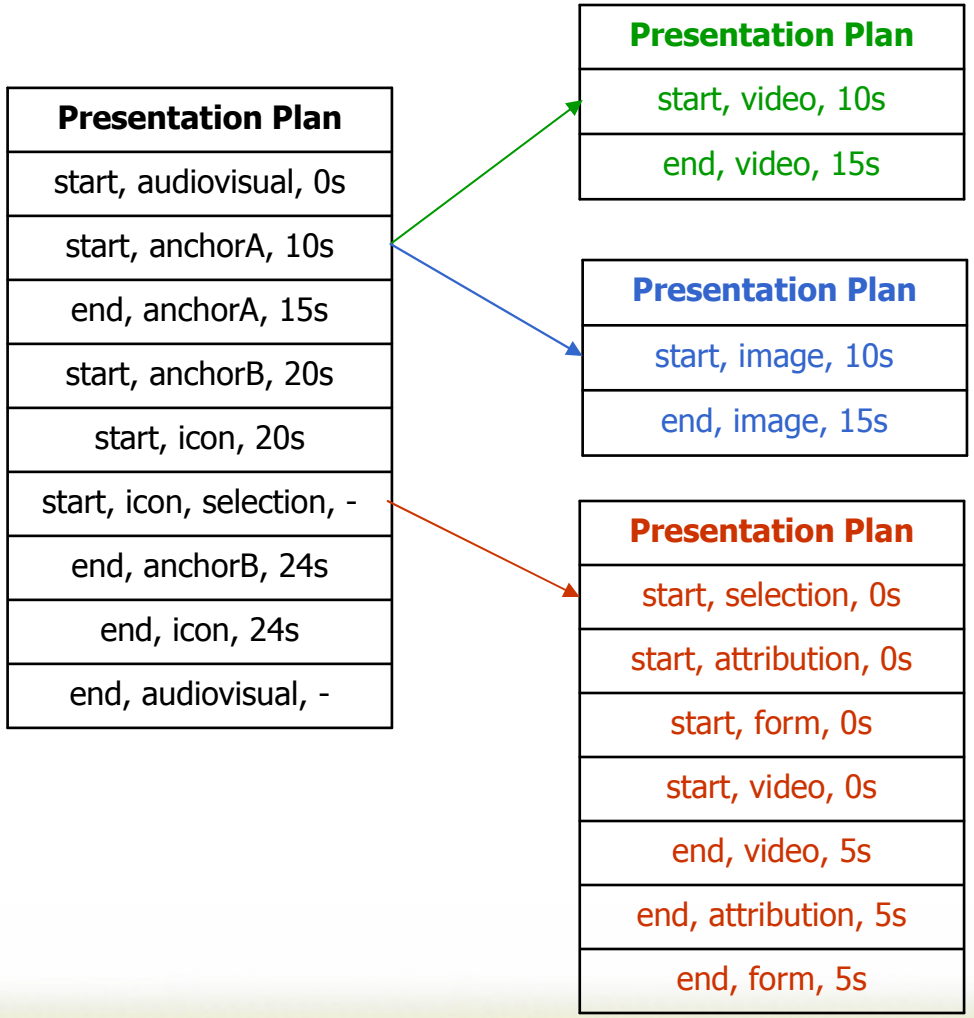
Hypermedia Temporal Graph



Presentation Plan
start, selection, 0s
start, attribution, 0s
start, form, 0s
start, video, 0s
end, video, 5s
end, attribution, 5s
end, form, 5s

Presentation Plan

- Presentation Plan can be entirely computed at compile time.
- When an adaptation point is reached, Presentation Plan is updated with transitions that satisfied an adaptation condition.
- For unpredictable events, the computed moments in time will be relative to the moment in time that the starting unpredictable event happens.



Player-Load Plan

- Media players should be instantiated only when necessary.
  - Resource limitations of DTV receivers.
- Limited resources can introduce undesirable delay when players are instantiated, losing the temporal synchronization.
- Player-load Plan must be computed from the Presentation Plan.
  - This plan must take into account the delay for each specific player and platform, including exhibition in multiple devices.

Transmission

- The bandwidth for cyclical transmission must be maintained as small as possible.
- Only the essential parts of an application must be in a carousel at a specific time moment.
  - Server must know which parts of an application a carousel should transport at a given moment.
  - The server must build a Pushed-Data Plan to guide object insertions to or removals from a carousel.
- Pushed-Data Plan is similar to the Presentation Plan, but it does not need to be updated. All unpredictable events must be treated as if they will happen at the moment they are enabled.

Content Loading

- Pre-fetching Plan is based on the Presentation Plan.
  - Pre-fetching Plan is calculated assuming that all unpredictable events will happen immediately after they are enabled.

- Pre-fetching Plan assumes the worst case transfer delay and jitter (both for the carousel and also for the interactive channel).

- The interactive channel is continuously probed, adjusting the worst case delay and jitter on the fly.

QoS Plan

- Pre-fetching Plan is built based on estimates.
  - In interactive channels the pre-fetching will only minimize the probability of having temporal mismatches.

- In interactive channels with QoS support, a better control can be achieved.
  - QoS Plan can be built from the Presentation Plan, negotiating the transfer delay and the transfer jitter for each media object.

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Multiple Devices

- Two types of device are proposed for exhibitions:
  - Those where the same content is shown in a set of devices under the same control.
  - Those where content is under control of each individual device, working completely independently.
- The first case favors the cooperative work, since a group of users with devices can work together.
- The second one allows individual control.
- When another NCL application is defined as a node of the NCL application being presented, this other application can be delivered to a device and this device can start to distribute the presentation to other devices.

Specification

- NCL defines two types of classes:
  - Passive: for devices where the same content is shown, under the same control;
  - Active: for devices with individual content and individual control.

- Many different classes may be defined for the types mentioned. Classes are associated with the regions where the media objects must be presented.

- Each device can request the base device, which controls the devices registered, entry to a specific class.

Synchronization

- During presentation, the presentation engine at the base device must distribute to devices:
  - Raw video frame buffer and the audio sample sequence, for those registered in passive classes.
  - Media content and other NCL applications, for those registered in active classes.

- All content distribution is centralized at the base device, where the player-load plan must consider the time delay to delivery content to devices, especially those in active classes.

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Work to be Done

- Some algorithms are very simple, based only on the worst case.
  - Pushed-Data Plan.
  - Pre-fetching Plan.
  - QoS Plan.
- The use of adaptations to compensate for delays greater than the predictable values, stretching and shrinking media object presentation.
- Implementation of techniques to distribute part of an presentation plan to be presented in another device.

Achievements

EuroITV 2009

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Contacts

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Thanks for your attention