Towards Scalable And Interactive Delivery of Immersive Media

NEM Summit – October 2012

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Watch on mobile
Zoom in
Watch in public
End-device categories

**Case 1:** Larger Displays for Public Viewing

**Case 2:** More Natural Images @ Home

**Case 3:** Mobile Terminals

*with Interactive Controllers*
End-device categories

Case 1: Larger Displays for Public Viewing

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Immersive Media – Research Area’s

Layered Panoramic & Omnidirectional A/V Capturing

Video Analysis and Automated Editing

Region-of-Interest Detection and Tracking

Automated shot framing

Scalable Delivery and in-network Adaptation of A/V flows

Immersive and Interactive Applications

Flexible and Interactive A/V Rendering

Gesture-based user interfaces
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Immersive Media Trends

- Increased realism through higher resolutions, 3D video, larger displays
- Increased personalization through diversity in end-devices, offering intuitive selection and control of content
Also at 2012 Olympics in London!

- Personalized video streaming service for mobile viewing
- People increasingly want their video to be sent to phones and tablets as part of a data-rich stream of content

- Series of public broadcasting in 8k video and 22.2 audio.
- No commentary and no info-rich graphical overlays
- Nothing except what a person at the event would see or hear
- Nothing to get in the way of their escapism
How do we support both trends?

- Produce format-agnostic audiovisual media and decide on format at delivery or rendering time.

- Allow end-users to interactively view and navigate around high resolution video panorama with the accompanying audio automatically changing to match the selected view.

- “Record everything, focus on one perspective”
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How do we support both trends in the network?

- Cope with huge bandwidth requirements
- Support interactivity and provide low latency for high QoE

- Content segmentation → tiled video streaming
- In-network rendering → adapt to end-user device
- Support pan/tilt/zoom navigation → virtual cameraman

- Coding…?
- High Efficiency Video Coding (HEVC)
  - Supporting Zoomable Video Streams with Dynamic Region-of-Interest Cropping, National University of Singapore
  - Evaluation of bandwidth performance for interactive spherical video, Alcatel-Lucent
The FascinatE Delivery Network – 1.0

A/V Data Compression & Encapsulation

In-network rendering

In-device rendering

Theater

Home

Mobile
The FascinatE Delivery Network – 2.0
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The FascinatE Delivery Network – 2.0

+ Short term deployment, reuse of current CDN/caching infrastructure
- Less control of service provider on end-to-end performances

+ High control of service provider on usage of delivery resource and performance (bandwidth, delay, ...)
- Longer-term deployment and higher impact on current infrastructure
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Functional components in the delivery network

A/V Ingest:
- interfaces with content source
- performs content segmentation

A/V Relay:
- segment transport
- scalability
- network deployment

A/V Proxy:
- interfaces with end-devices
- in-network rendering

A/V Ingest: Content Segmentation
- Multi Resolution Tiling

A/V Relay: Segment Server
- 1x1
- 2x2
- 4x4
- $2^n x 2^n$

A/V Proxy: Network Rendering

7K x 2K Video

Managed PUB/SUB Delivery

Unmanaged HAS-Based Delivery

Network Bandwidth

Managed Views

Unmanaged Views

Request

Mobile

Theater
**A/V Ingest: Content Segmentation**

- Parallel or distributed encoding → deal with processing bottlenecks
- Parallel or distributed delivery → combine multiple delivery networks

- Determine characteristics of content with higher level of granularity
- Adapt delivery: send content regions based on the viewing behaviour

- Content segmentation or *tiling* is defined as a spatial segmentation of each frame of the video content into a set of rectangular sub-images, typically following an MxN regular grid
A/V Ingest: Content Segmentation

Layered Scene
  └── Layer BCam
  │     └── Scale HD
  │         └── Grid 4x4
  │             ▼
  │             Tile T1
  │             ▼
  │             Representation Bitrate 1
  │     └── Layer Omnicam
  │         └── Scale 7kx2k
  │             └── Grid 2x2
  │                 ▼
  │                 Tile T3
  │                 ▼
  │                 Representation Bitrate 2
  │             └── Layer...
  │                 └── Scale...
  │                     └── Grid...
  │             ▼
  │             Tile T4
  │             ▼
  │             Generic Segment
  │             ▼
  │             Time_Segment
  │             ▼
  │             Time_Segment
  │             ▼
  │             Time_Segment

Tile T1
Tile T2
Tile T3
Tile T4
A/V Relay: HTTP Adaptive Streaming

Source: Dynamic Adaptive Streaming over HTTP – Design Principles and Standards, Thomas Stockhammer, Qualcomm
A/V Relay: Tiled HTTP Adaptive Streaming

Relation with HAS/DASH
- available
- extension
- optional
A/V Relay: Tiled HTTP Adaptive Streaming

- Extension of HAS/DASH with spatial segmentation for tiled streaming
- Control plane signaling for manifest and events
- AV relay implementation in live CDN

**Diagram:**
- A/V Ingest
- Multi Resolution Tiling
- Multi Rate Encoding
- 1x1
- 2x2
- 4x4
- $2^n 	imes 2^n$

**A/V Relay:**
- HTTP server
- CDN servers
- HAS delivery of spatial segments
- Spatial Manifest
- Event Signalling

**A/V Proxy:**
- Segment Client
- Frame Combiner
- 2nd Screen for control/display
A/V Relay: Publisher/Subscriber

- Rationale: seamlessly combine efficiency of
  - Multicast: push content useful for many devices
  - Unicast: pull content on-demand for single device
- Fit with next-gen managed video delivery

![Diagram of A/V Relay and A/V Home Client]

- Segmented Content
  - Lowres full panorama
  - Hires Tile 1
  - Hires Tile 2

- A/V Home Client
  - Segment Client
  - 2D Reconstructed Panorama

- Unicast
- Multicast

[Image of graph showing data rate over time]
A/V Proxy: In-network Rendering

- Challenge: Limited rendering on end-devices
- All reframing and rescaling commands are processed at the network-side
- Requested views are sent back in real-time
- Support of 2D panorama and 3D spherical content

DEMO @booth!

Alcatel • Lucent
Future Work

- Live delivery @final demonstration
- Evaluate scalability of each tier → intermediate A/V Relays
- Real network testing → CDN, xDSL

- HAS prototype: support of hybrid broadband/broadcast mode
- PUB/SUB: evaluation of bandwidth performance
- Control and event signalling
- Script-based navigation

- Consider standardization of transport → MPEG, IETF, DVB
- Discuss with other parties → let us know your thoughts!
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Questions? More info?

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- Come see our demo’s at the FascinatE booth!