

# Research Challenges for Immersive Video Communication Ecosystems over Future Internet

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# Presentation

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- Networked Media in Future Internet
- 3D Video Characteristics
- 3D Media Representations, Coding & Transmission
- 3D Video QoE
- 3D Media Research Challenges
- Questions

# Future Internet Media



Prof. Tasos Dagiuklas

Μητρώο & Απαιτήσεις

August 2015

# Future Internet Characteristics

## Everything on Cloud



- Giga-bit Data Rate
- Ultra Low Latency

## Immersive Experience



- Giga-bit Data Rate
- Ultra Low Latency

## Ubiquitous Connectivity



- Massive Connectivity
- Ubiquitous Coverage

## Telepresence



- Giga-bit Data Rate
- Ultra Low Latency



# Presentation

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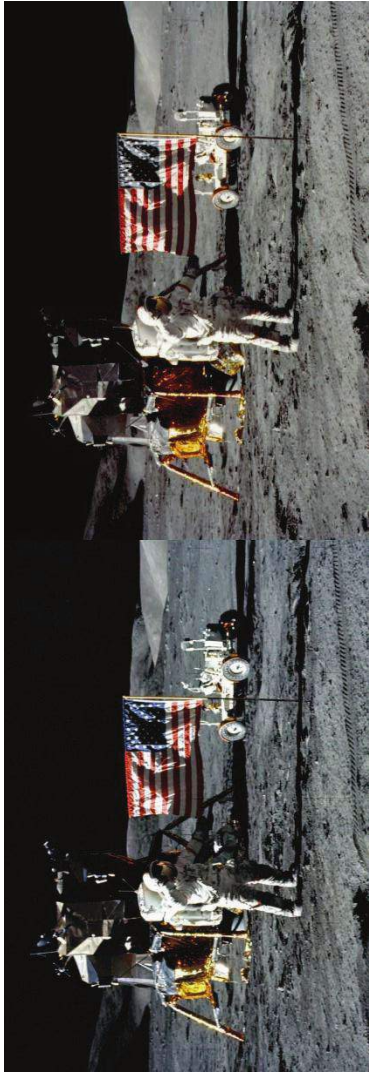
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# 3D Applications

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- 3D cinema
  - Technology: stereoscopic 3D, glasses based
  - Good stereo 3D viewing
  - Decent number of 3D productions
- 3D mobile
  - Technology: auto-stereoscopic 2 view display with fixed viewing position
  - Good 3D viewing despite of small display sizes
- 3D home entertainment (3DTV)
  - Technology: Different types of displays available: stereoscopic, auto-stereoscopic with 2 ... N views
  - Various technologies, input formats and display sizes
  - Glasses based systems may not be acceptable

# Stereo versus Multiview Video Data



- Stereo
  - One 3D Representation



- Multiview
  - Several Number of Views

# 3D Video Experience

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- Depth perception in stereoscopic displays
  - Effect provided through stereo video pairs, targeting the left and right eyes, allowing the perception of depth using stereo parallax
- Depth perception in auto-stereoscopic displays
  - Effect provided through N video views, targeting the left and right eyes in multiple positions, allowing the perception of depth using stereo and motion parallaxes
- Navigation
  - Effect provided through n video views, allowing navigating the 3D scene by changing the viewpoint and view direction within certain ranges; the viewer may experience a look around effect as well as depth perception





# Presentation

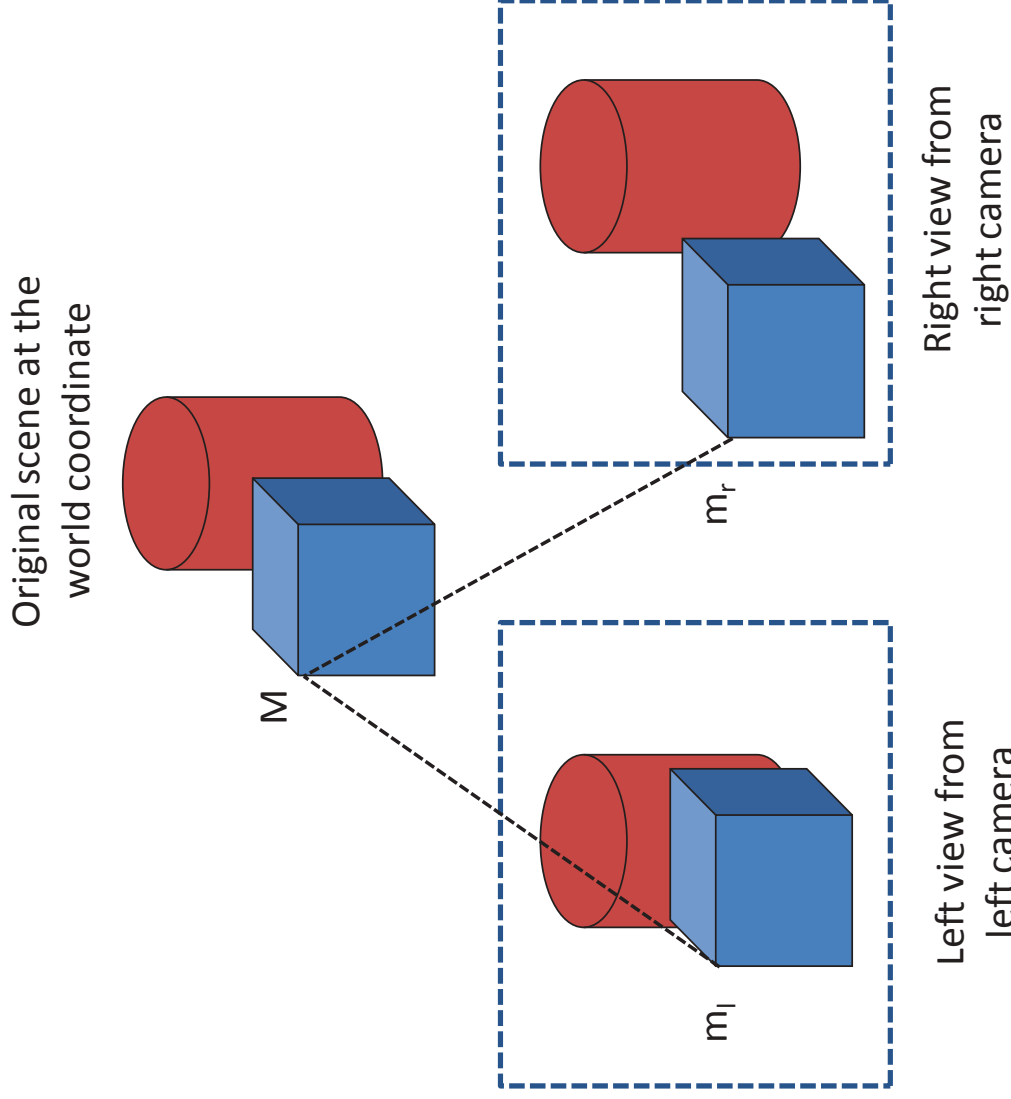
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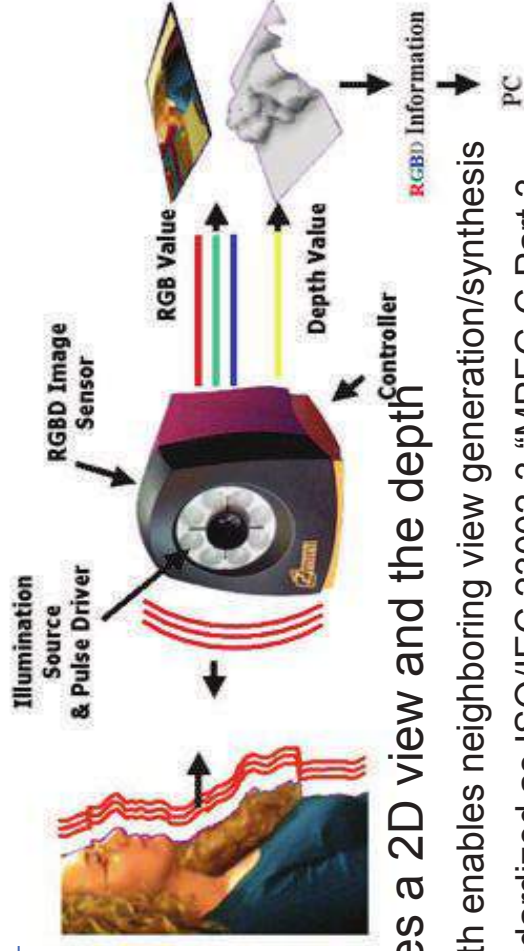
# Left-Right 3D Representation



## — Left and Right Cameras



# Colour Plus Depth Representation

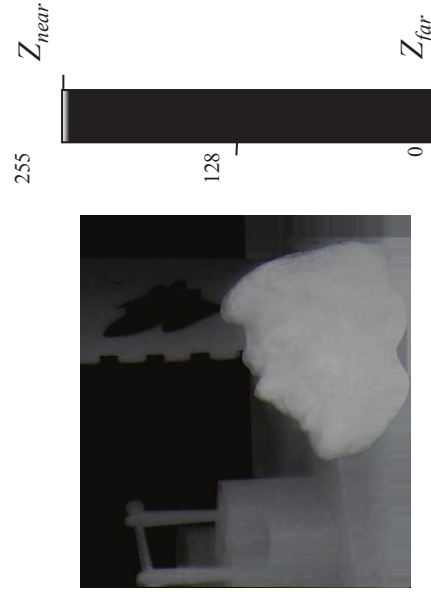


- Includes a 2D view and the depth
  - Depth enables neighboring view generation/synthesis
  - Standardized as ISO/IEC 23002-3 “MPEG-C Part 3
- Advantages
  - 2D video is backward compatible with legacy devices
  - Agnostic of coding format; can utilize MPEG-2, H.264/AVC
  - Additional bandwidth to code depth could be minimal
  - Support both stereo and multiview displays

## ■ Drawbacks

- Stereo signal not easily accessible and error-prone
- No provisions to handle occlusions
- Limited depth range rendering capability

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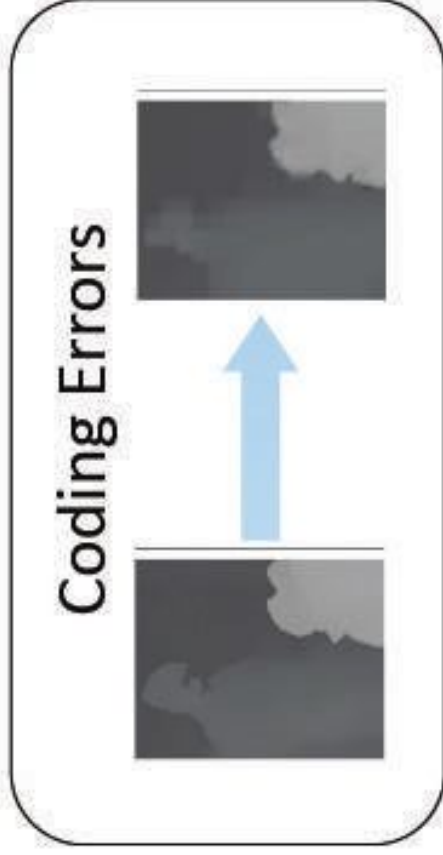
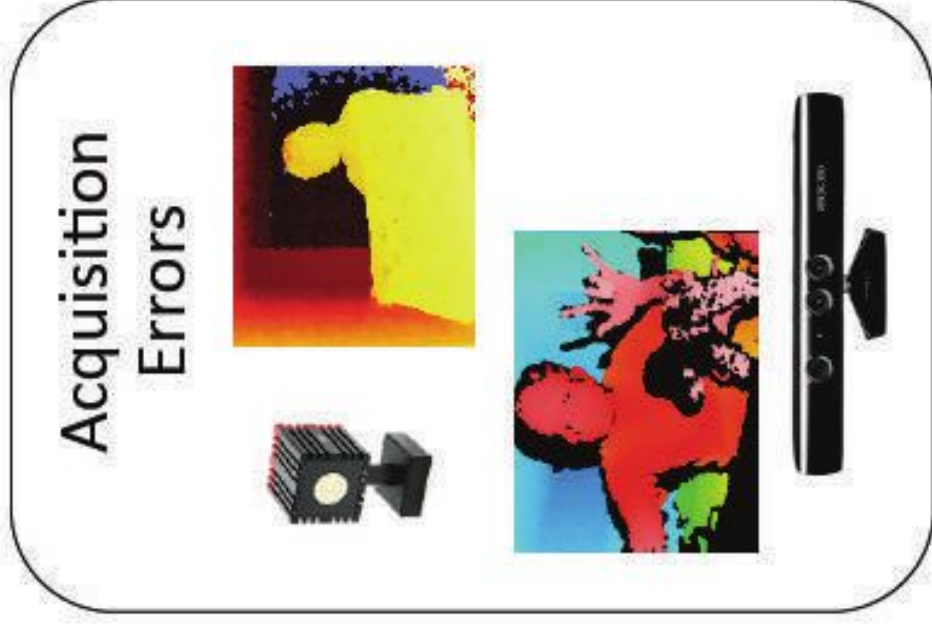
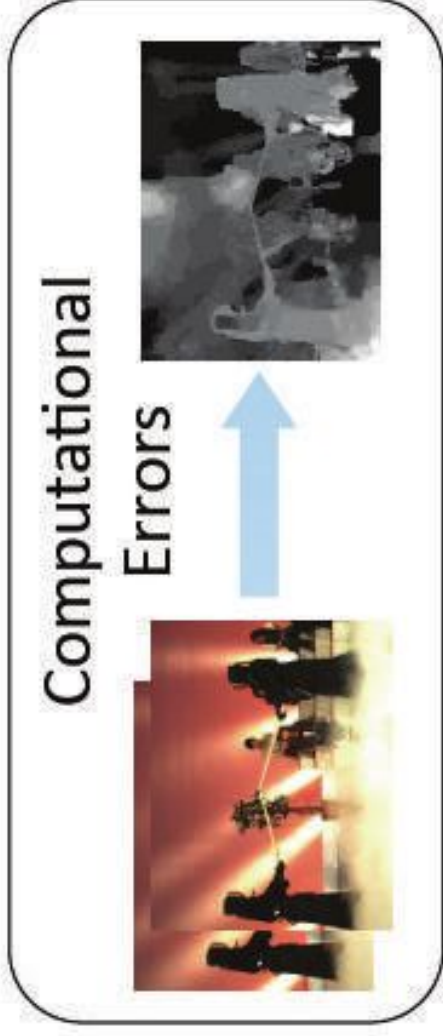
# Multiview Video plus Depth (MVD)

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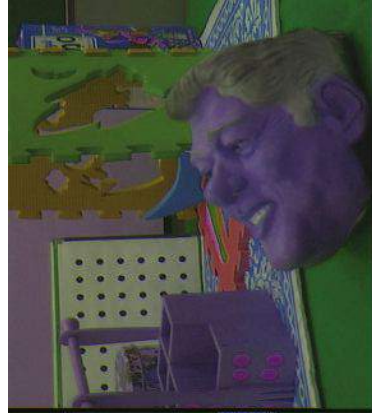
- The MVD format encodes both the texture and the depth data for the same number of views.
- Coding texture and depth simultaneously is a direction currently explored in MPEG as part of the 3D Video coding activity.
- MVD is the reference format for MPEG 3D Video



# Depth Errors



# Depth-Image Based Rendering



Colour

+



Depth



Left View



Right View



# 3D Display Technologies

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- Anaglyphic (passive red-cyan glasses)
- Wavelength multiplexing (passive glasses)
- Polarization (passive polarized glasses)
  - Two images are projected superimposed onto the same screen through different polarizing filters
  - Polarized 3D glasses restrict the light that reaches each eye, exploiting the polarization of light
- Alternate-frame sequencing (active shutter glasses)
- Autostereoscopic multiview (no glasses)
  - They provide a different viewpoint to each eye at different viewing positions, producing both stereo & motion parallax with a fixed number of views



# Conventional 3D to 2D Conversion (1)

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- The stereo signal is a multiplex of the two views into a single frame or sequence of frames to be coded with 2D video coding solutions.
  - Spatial Multiplexing
    - Top-Bottom
    - Side-by-Side
    - Row Interleaved
    - Column Interleaved
  - Temporal Multiplexing
- Embraced by broadcasters for initial phase of 3D video services



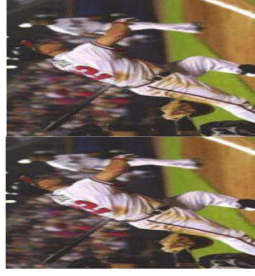
# Conventional 3D to 2D Conversion (2)



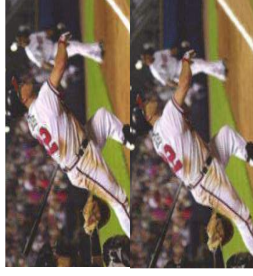
Left Eye



Right Eye



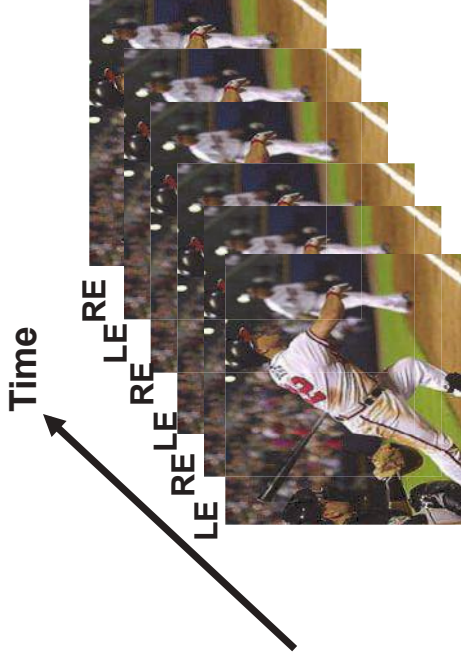
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**Spatial  
Multiplexing**

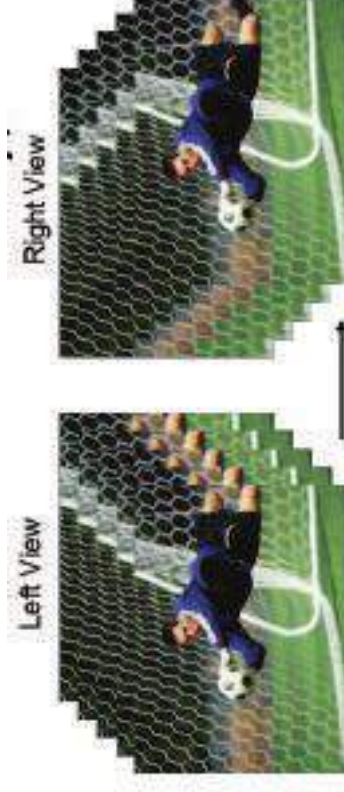
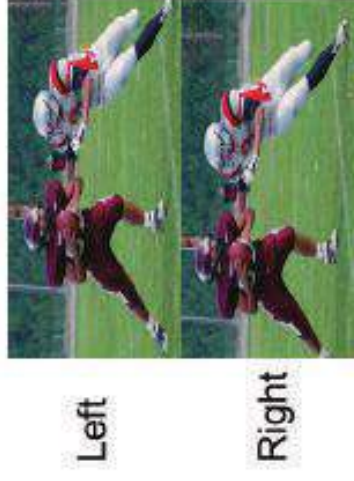


Time

**Temporal  
Multiplexing**

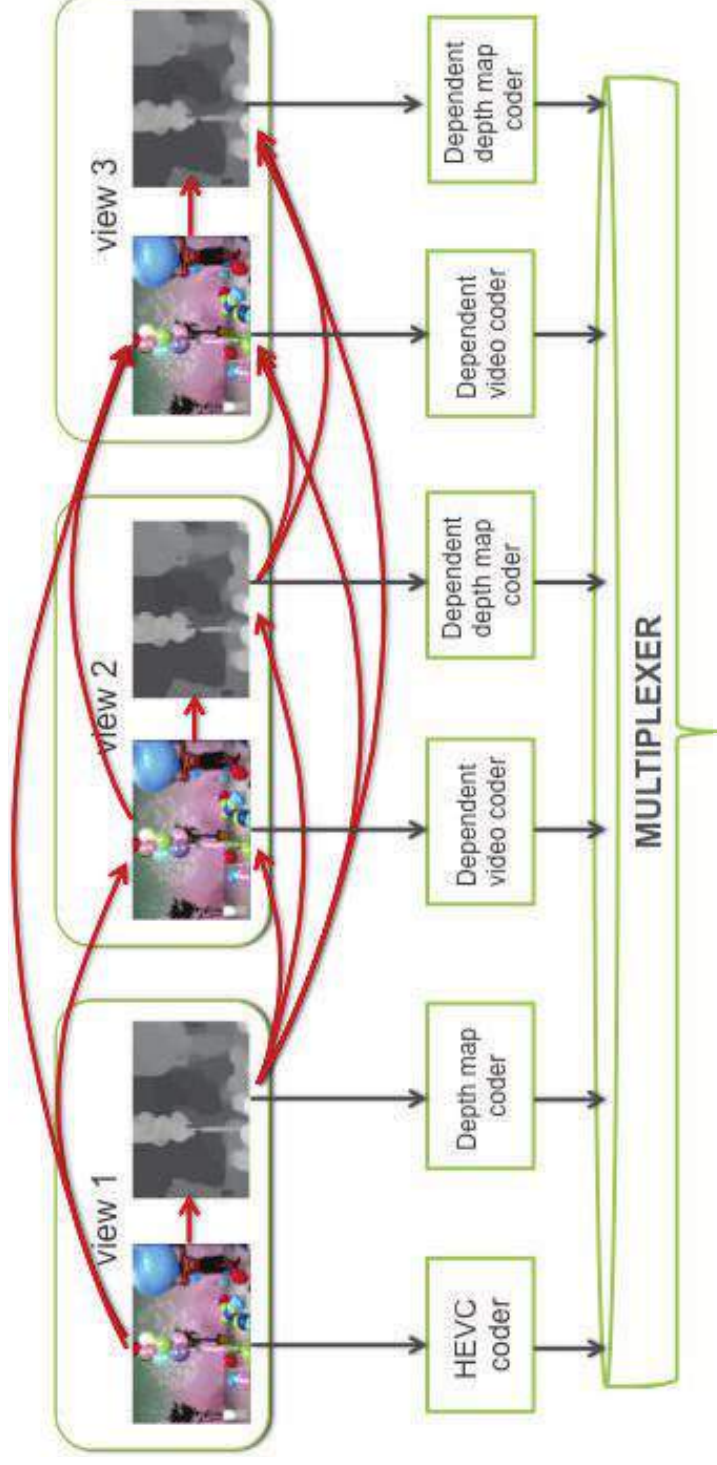
# Compression Schemes (1)

- Frame Compatible Stereo
  - Reduced resolution Leverages existing infrastructure
  - Used for first phase of 3D broadcast
- Multiview Video Coding (MVC)
  - Full-resolution, exploits correlation among views
  - Adopted as 3D format for Blu-ray, ATSC & Phase 2 DVB

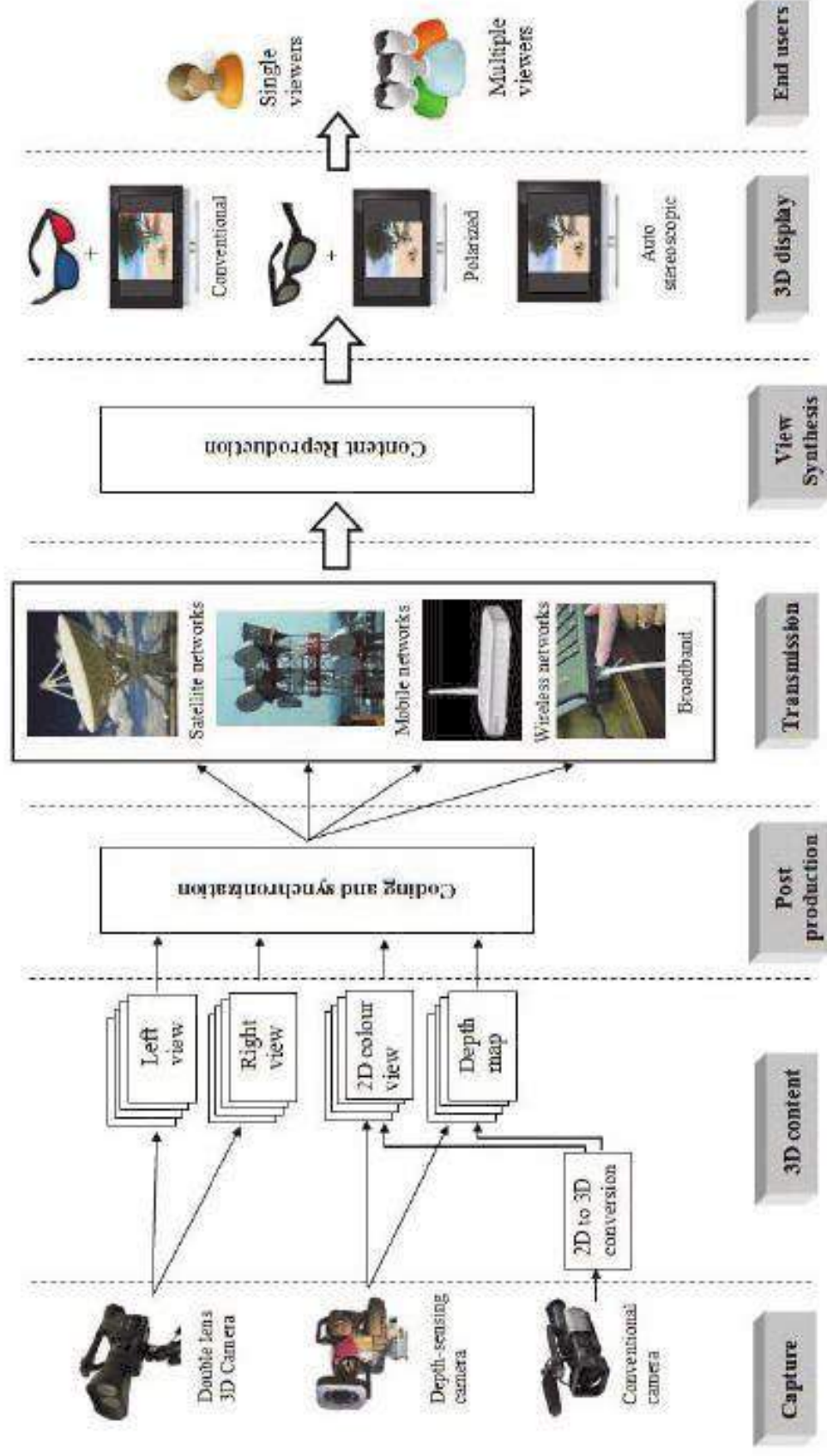


# Compression Schemes (2)

- 3D-HEVC
  - It introduces hierarchical layers and new depth coding tools
  - 3D-HEVC uses inter, intra, and inter-view predictions
  - View: combination of a texture video and its associated depth map
  - Layer: texture videos and depth maps are each called a layer.



# End-to-End 3D Video Chain





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# 3D Video Quality Artifacts

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- “3D video quality of experience” is more than just visual quality in the 2D sense
- New types of artifacts compared to 2D:
  - Issues in capture of stereoscopic signals
  - Geometric distortions, camera miscalibration, ...
- Differences in color, contrast, asymmetric coding, ...
- View reconstruction
- Interpolation of occluded areas, ...
- 3D Rendering issues
  - Crosstalk, color and brightness deficiencies, ...

# 3DTV QoE

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- 2D image quality
- Depth Quantity
  - Amount of perceived depth using the monocular and binocular depth cues
- Visual Comfort
  - Related to multisymptoms (e.g. eye strain, dry eyes, double vision) as well as the sensation of visual impairment or the sense of vision difficulties
- Depth Rendering
  - Quality of perceived depth, depending on the subject's preference, compression of the depth and the shape of objects
- Naturalness
  - Natural appearance of images, i.e. more or less representative of reality
- Visual Experience
  - Overall quality of experience in terms of immersion, perceived image quality as well as depth rendering (shape and dimension)



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# Video Evolution in 2020

- New video formats and codec
  - UHDTV (Ultra High Definition TV; 7680 x 4320 )
  - New coding standard HEVC
    - 1920 x 1080, 60 fps → 15 Mbit/s (half the bitrate of H.264/AVC)
    - 7680 x 4320, 120 fps → up to 800 Mbit/s
- Transition to 3D and interactive video services
  - Immersive service
    - High Resolution Panoramas
    - 3D video content with more than 2 views (e.g. lenticular displays with 8 views)
  - Interactive content
    - Select your viewpoint
  - Augmented/Mixed Reality
    - Gaming
    - Manufacturing/Design
    - Cultural Heritage

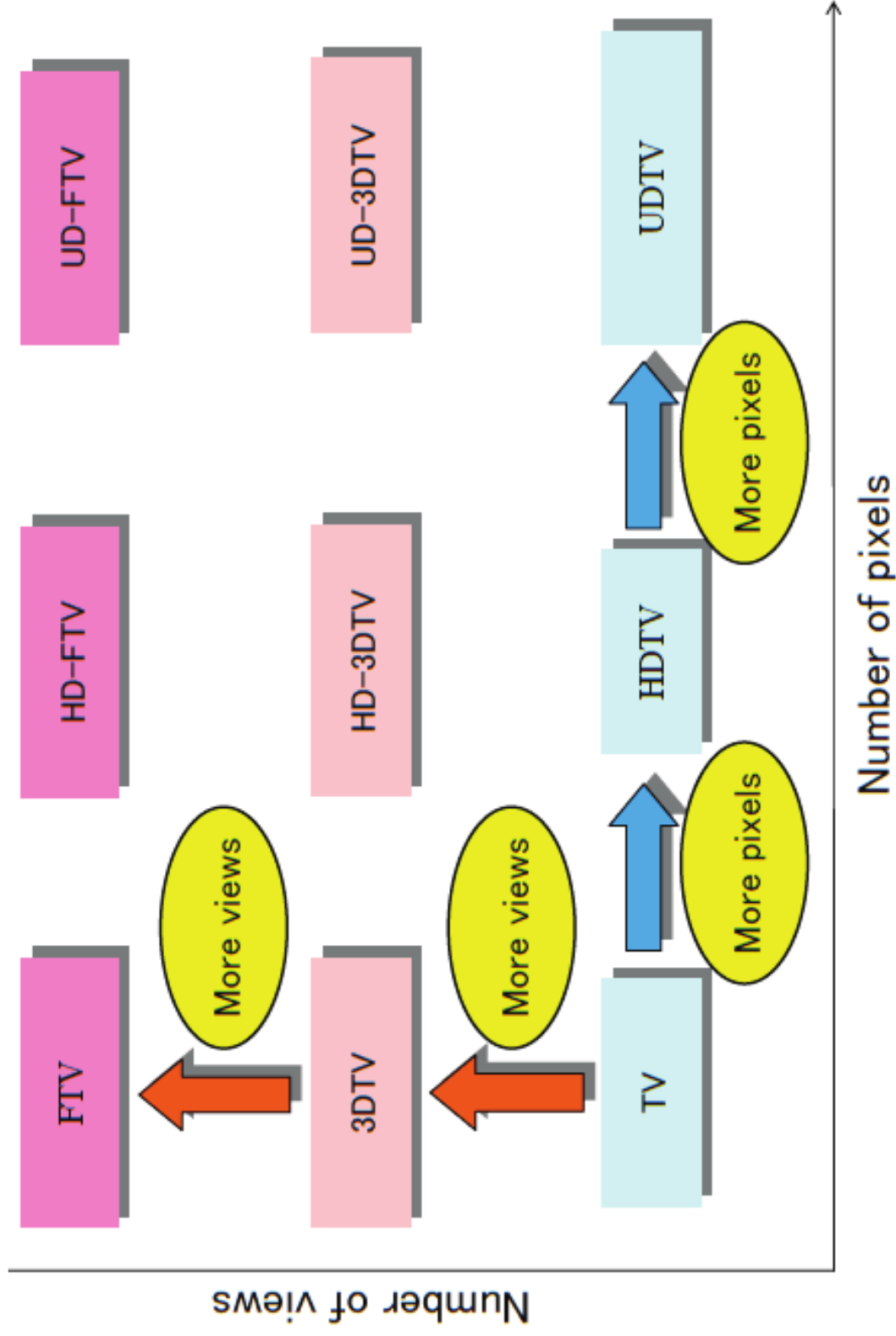


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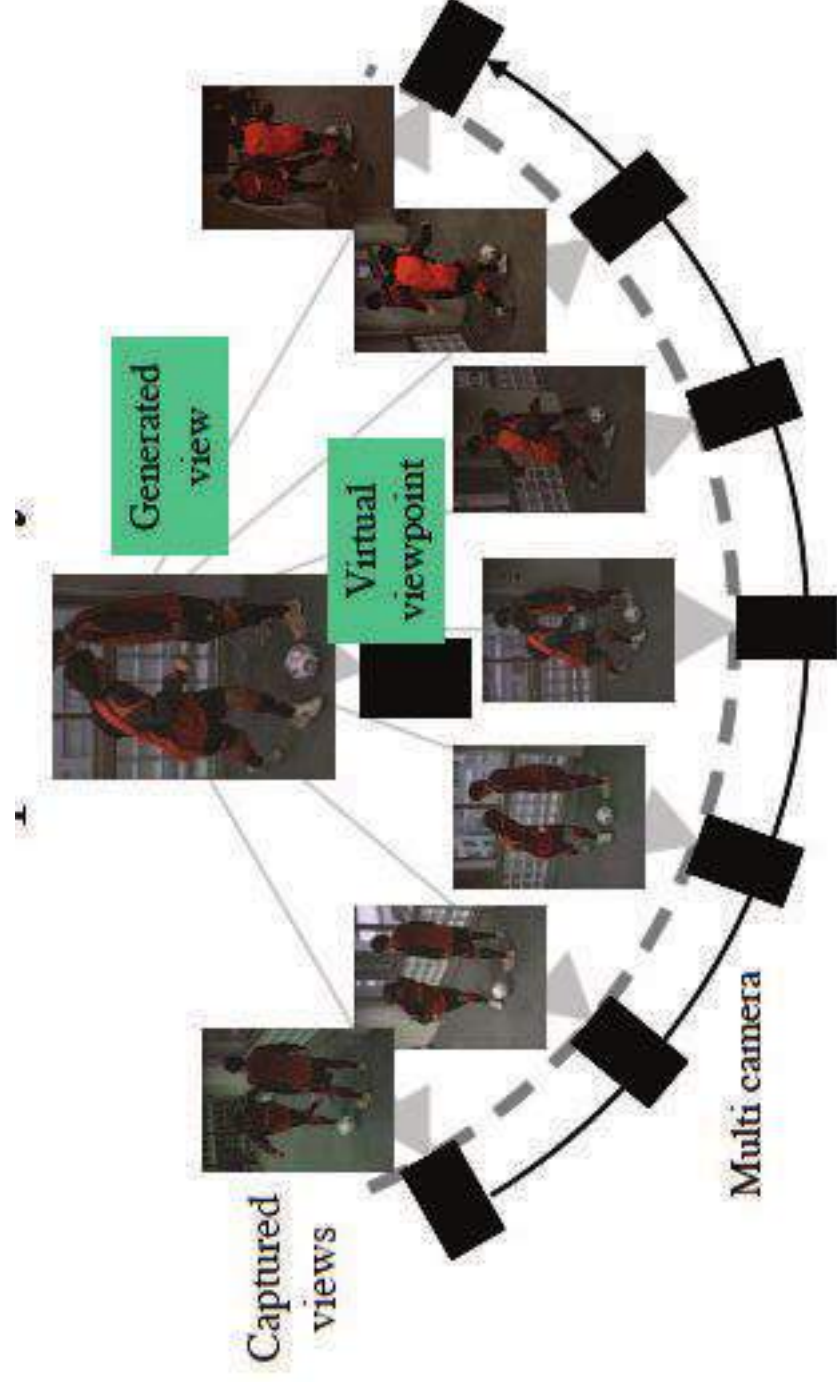
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# Visual Media Evolution

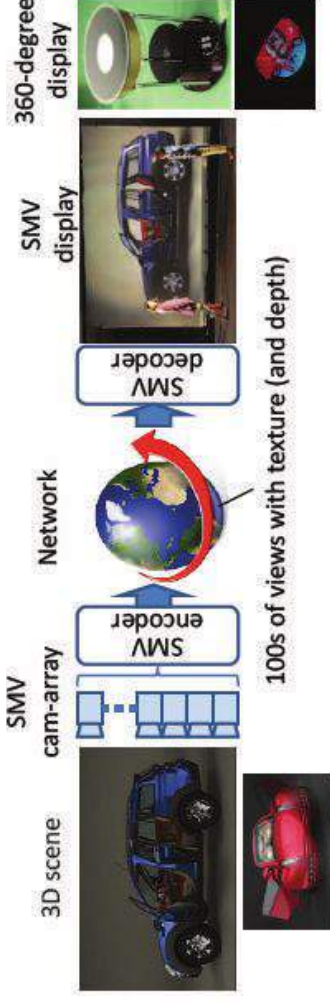


# FTV Technology



# FTV Exploration in MPEG

- **Super Multiview Displays:** hundreds of very densely rendered views provide horizontal motion parallax for realistic 3D visualization



- **Integral Photography:** 3D video with both horizontal & vertical motion parallax are captured for realistic display.

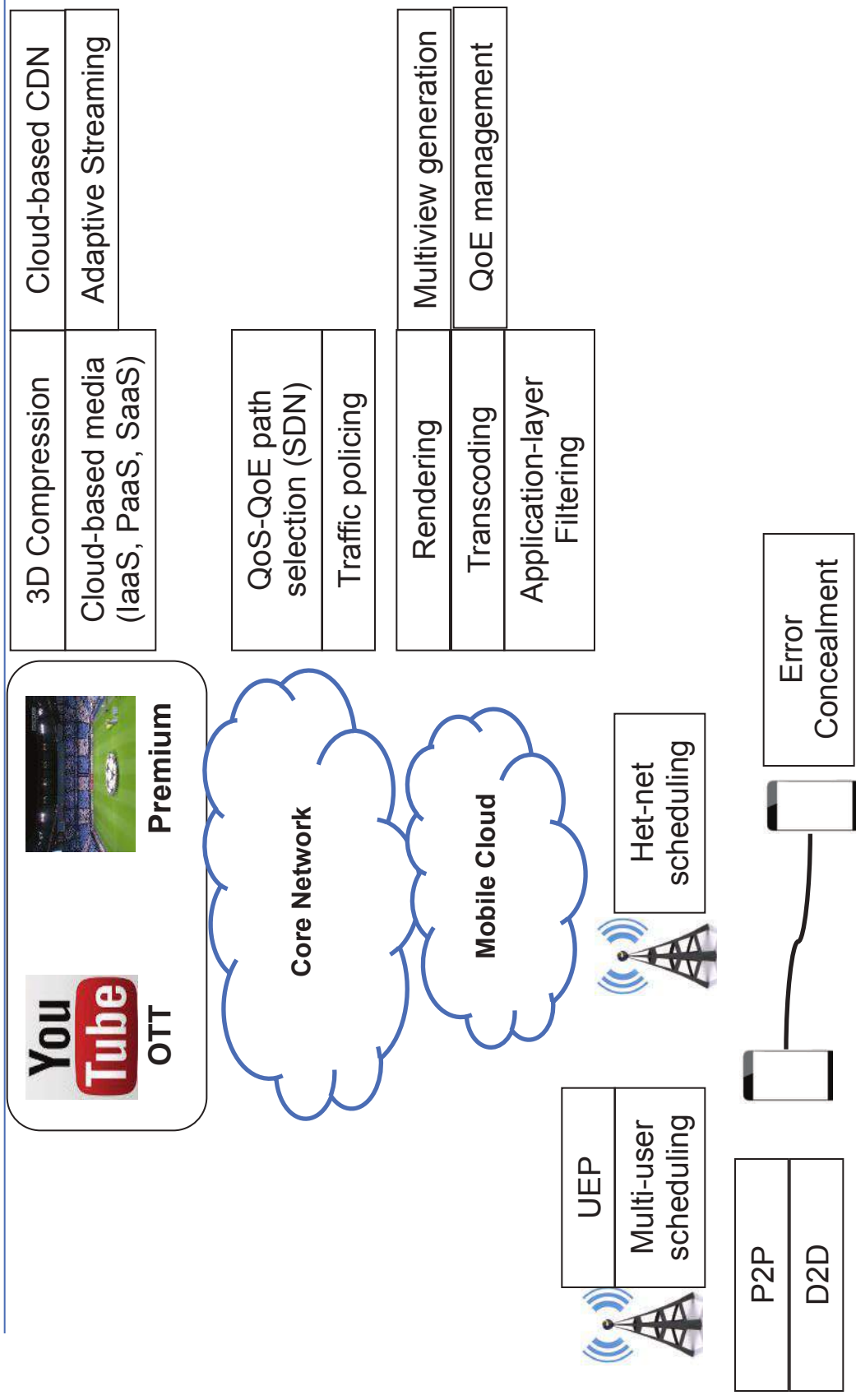


- **Free Navigation:** allow the user to freely navigate or fly through the Scene, not just along predefined pathways

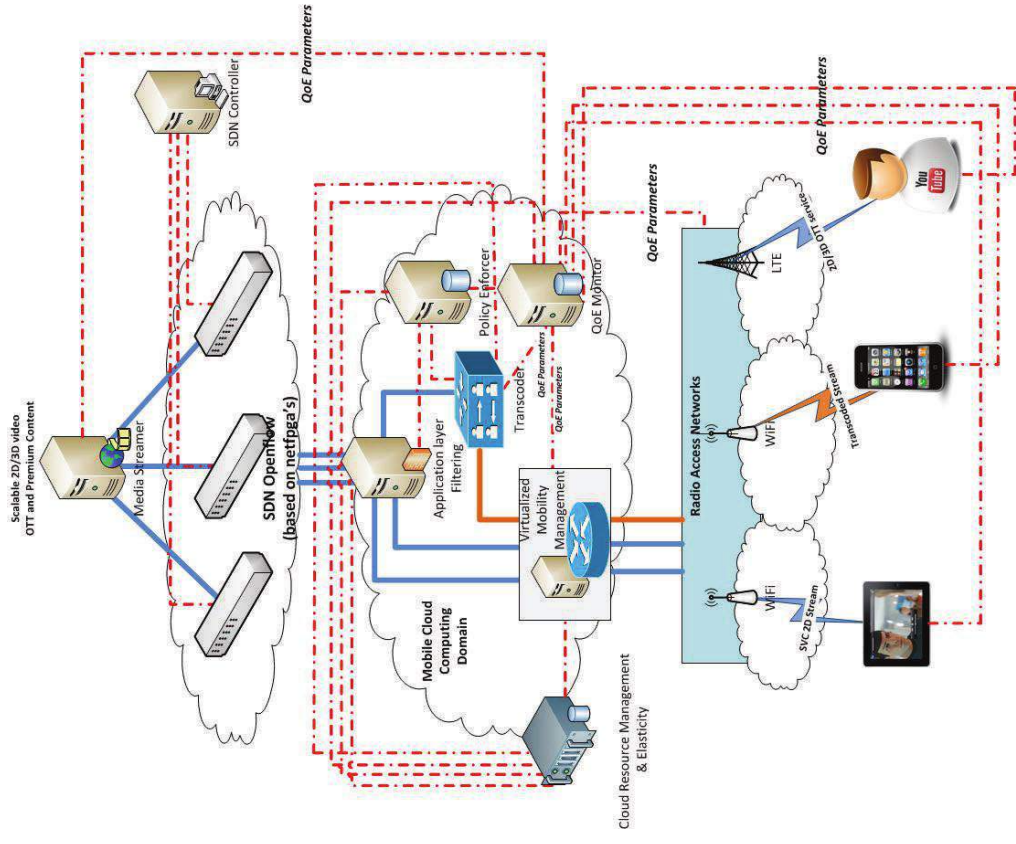


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# 3D Media Research Challenges



# Research Project “DIOGENES” Use Case



■ <http://diogenes.eap.gr>

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## Critical Success Factors for 3D

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- High quality experience not burdened with high transition costs or turned off by viewing discomfort or fatigue
- Usability and consumer acceptance of 3D viewing technology, e.g., glasses vs no glasses
- Availability of premium 3D content in the home
- Availability of an appropriate data format providing interoperability through the delivery chain and taking into consideration the constraints imposed by each delivery channel

# Questions

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<http://cones.eap.gr>