

# Subtitling in Immersive Environments

Media for All 2019

ImAc Project

Partners



MOTION SPELL

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2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO  
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# Immersive content

Immersive content more and more present to inform, educate and entertain.

What type of immersive content are workshop participants familiar with?

# Immersive content

Virtual Reality (including 360° videos)

Augmented Reality

Mixed Reality



# Immersive content

Not fully developed, so the right moment to research how access services should be implemented

- SUBTITLING
- AUDIO DESCRIPTION AND AUDIO SUBTITLING
- SIGN LANGUAGE INTERPRETING

# In this workshop

1. **Short presentation (Anna Matamala)**
2. **First part: background**
  - **Learn about ImAc project (Mario Montagud)**
  - **Requirements for VR subtitling (Chris Hughes)**
  - **Architecture and workflow (Chris Hughes)**
3. **Second part: demos**
  - **The ImAc player (Mario Montagud), responsive subtitles (Chris Hughes) & planned actions (Mario Montagud)**
  - **Subtitling for VR: production, editing, distribution, and rendering & demo (Enric Torres)**



# **SDH: your views?**

**Challenges for both home/professional users?**

**Any suggested solutions?**

**Any experiences or ideas  
from workshop participants?**

# Challenges: home users

How to guide users to the speakers?

Where to position the subtitles?

What is the comfort viewing field?

How to deal with non-speech information?

What features to include in the user interface?



# Challenges: professionals

How to show the 360° scene on the editor?

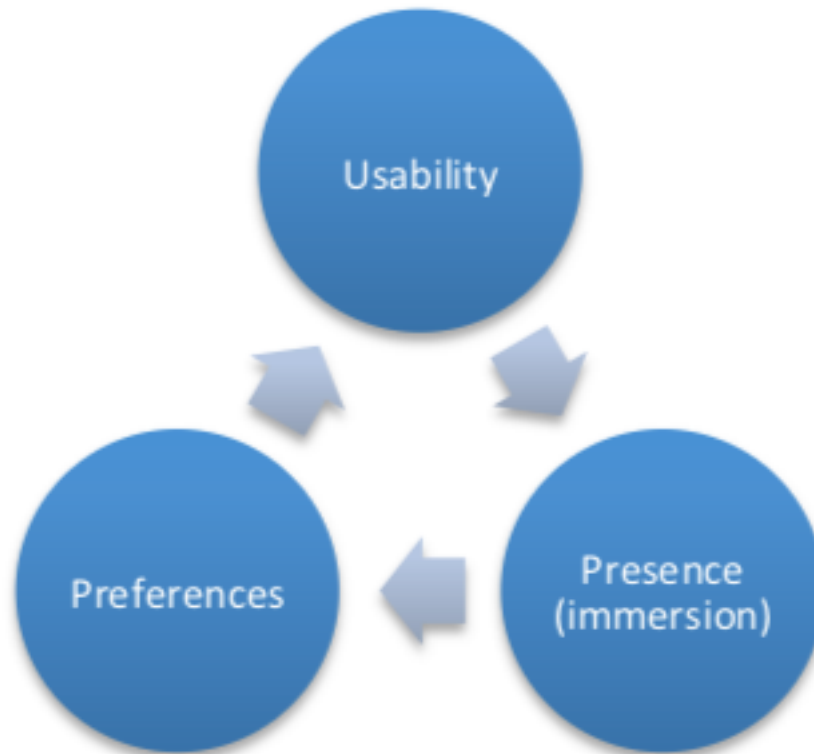
How to position subtitles?

How to visualise and test the result?

# User-centric approach

1. WHO? Define your users.
2. WHAT? Define what you want to develop: editing tools, player, access services. Different scenarios.
3. HOW? Define the methodology to gather data from users: qualitative versus quantitative methods.
4. Implement and test in different iterations.
5. Keep track of everything (requirement list).

# Methodological approach



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# ImAc Project

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Mario Montagud (i2CAT)

([mario.montagud@i2cat.net](mailto:mario.montagud@i2cat.net), @mario\_montagud)

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# ImAc Project

1. Introduction. Who we are
2. Objectives
3. Methodology
4. Overview of ImAc platform

# Introduction to ImAc

**ImAc** (Immersive Accessibility): EU H2020 project that is exploring how accessibility services can be efficiently integrated with immersive media

- **Access Services:** subtitles, audio description, sign language
- **Immersive Media:** omnidirectional video (i.e. 360°) and audio

## Premises:

- Accessibility is a must for **e-inclusion**
- Accessibility must **not** be considered as an **afterthought**, but as a key aspect in the specification and deployment of services
- Keep **compatibility** with current standard technologies / formats
- **User-Centric Methodology**



# Introduction to ImAc

## Communication

- Website: <http://www.imac-project.eu/>
- Twitter: @ImAcProject

## Who we are:

- Cross-disciplinary team

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# ImAc Objectives

**OBJ1.** Create accessible and fully personalized services for all citizens

**OBJ2.** Deliver novel resources for the broadcasting industry to provide adapted content ensuring accessibility in immersive environments

**OBJ3.** Demonstrate the tools and platforms in open pilots

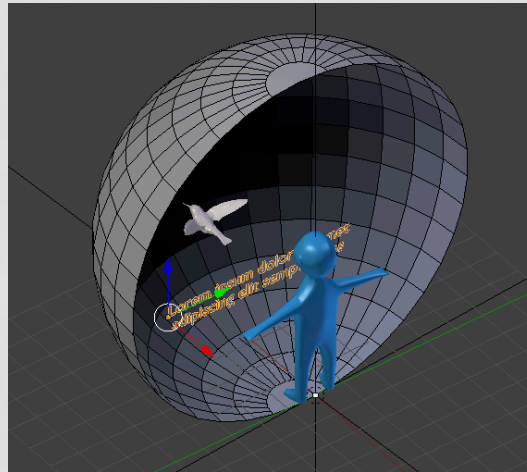
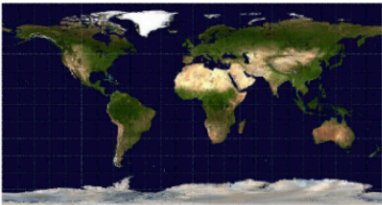
**OBJ4.** Work towards standardization of accessibility data in an immersive content environment

**OBJ5.** Maximize impact on society delivering real and useful solutions



# 360° Video

Time... and space!



100°



210°

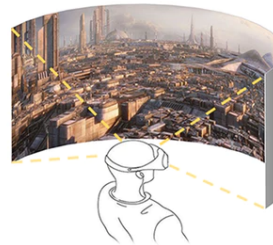
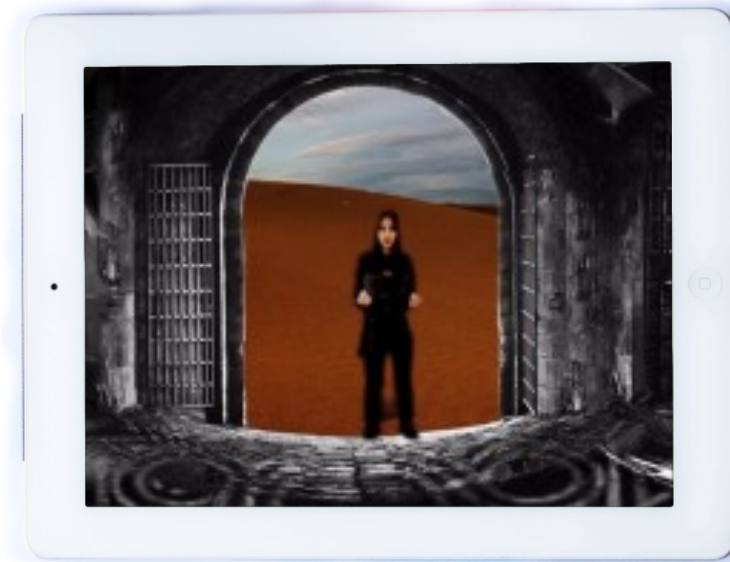


Image quality falls off towards the edges



# Field of View (FoV)

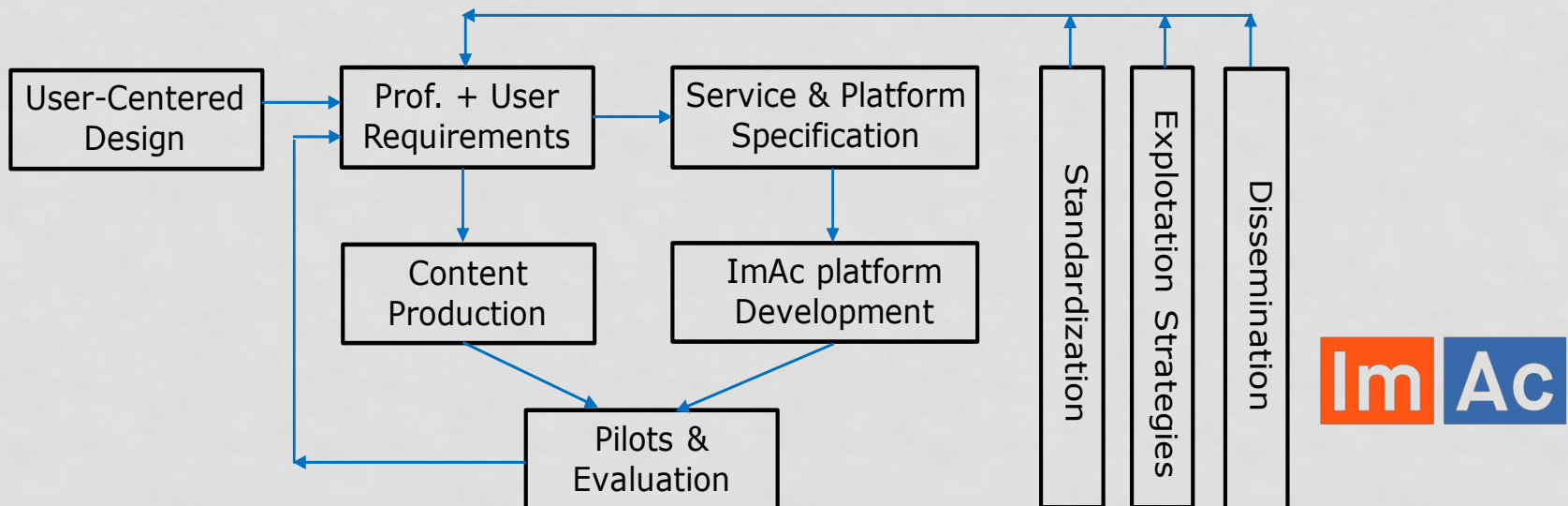


# ImAc Methodology

## Three Key Pillars:

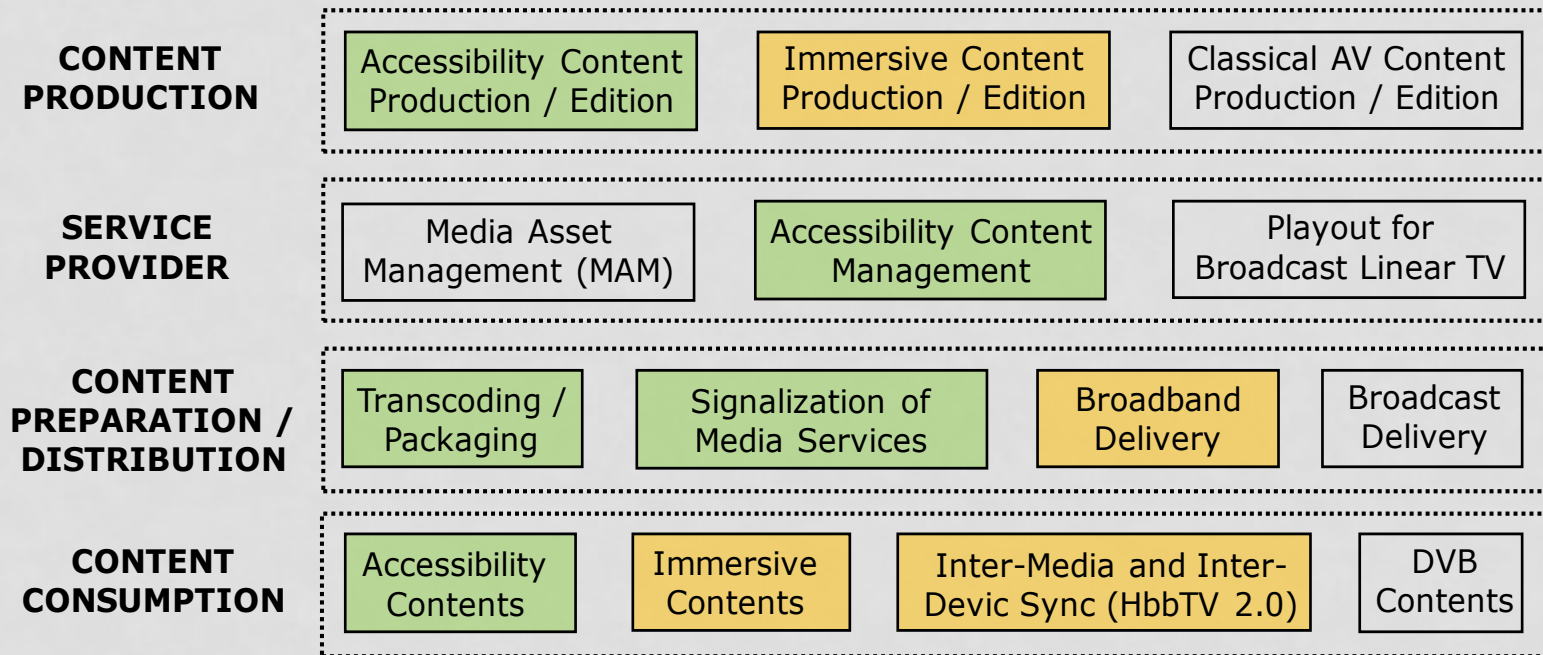
- 1) Requirement Gathering
- 2) Development and Integration
- 3) Validation and dissemination

*“Design for users, with users”*

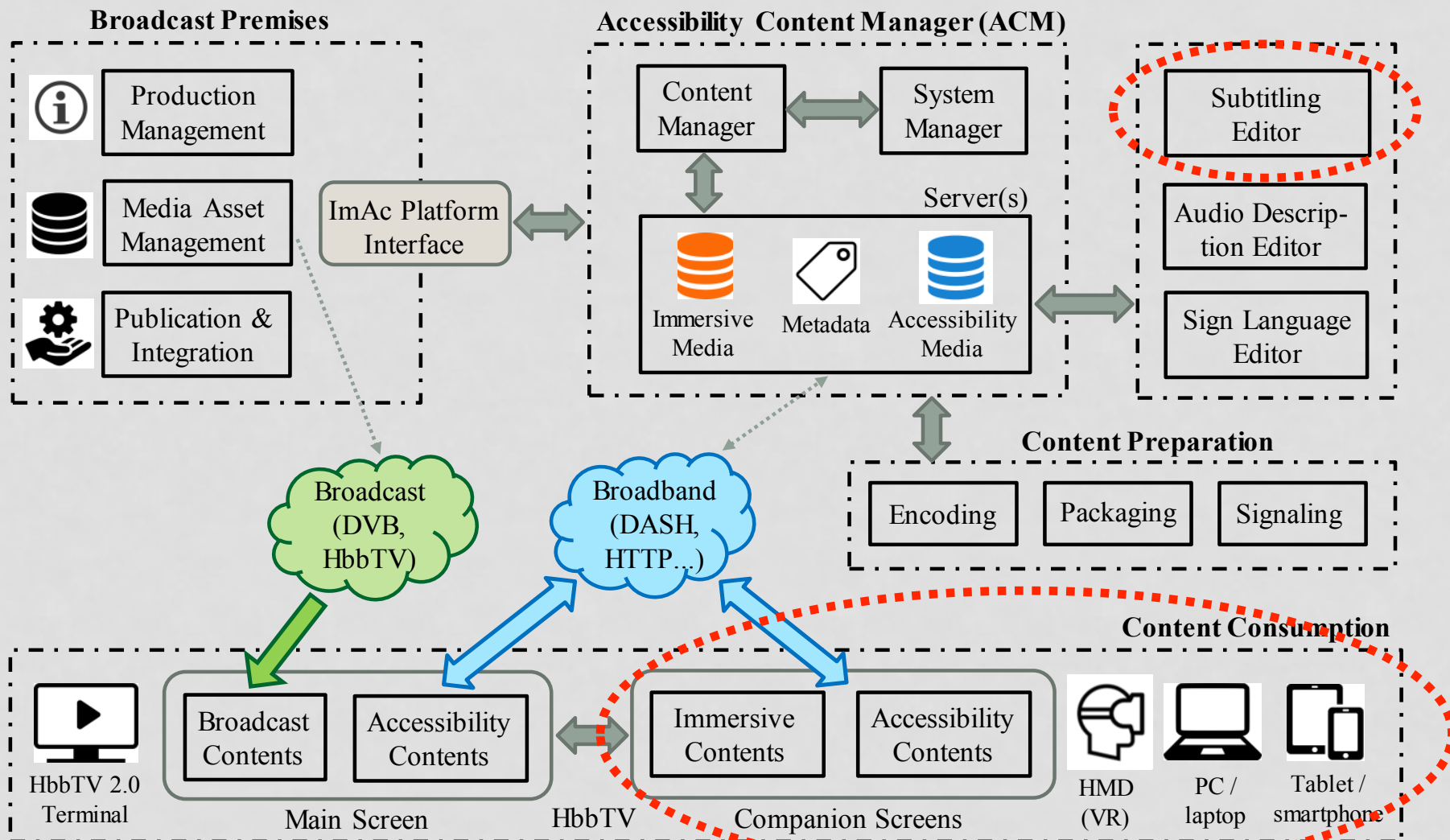


# ImAc Platform

## Main Parts:



# ImAc Platform



# ImAc Outputs

## Key components of the ImAc platform

- Accessibility Content Manager
- Edition tools (SaaS)
- Open-Source VR360 player

## Dissemination:

- High-Impact Publications
- Events / Fairs / Workshops

## Standardization:

- Contributions to MPEG, W3C, ITU, ISO...

## Benefits:

- Contributions and insights very welcome by interested agents (research community, end-users, professionals, stakeholders...)



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Immersive  
Accessibility



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Framework Programme of the  
European Union

# *Immersive Subtitles:* Defining requirements Architecture and workflow

Media4All 2019, Stockholm

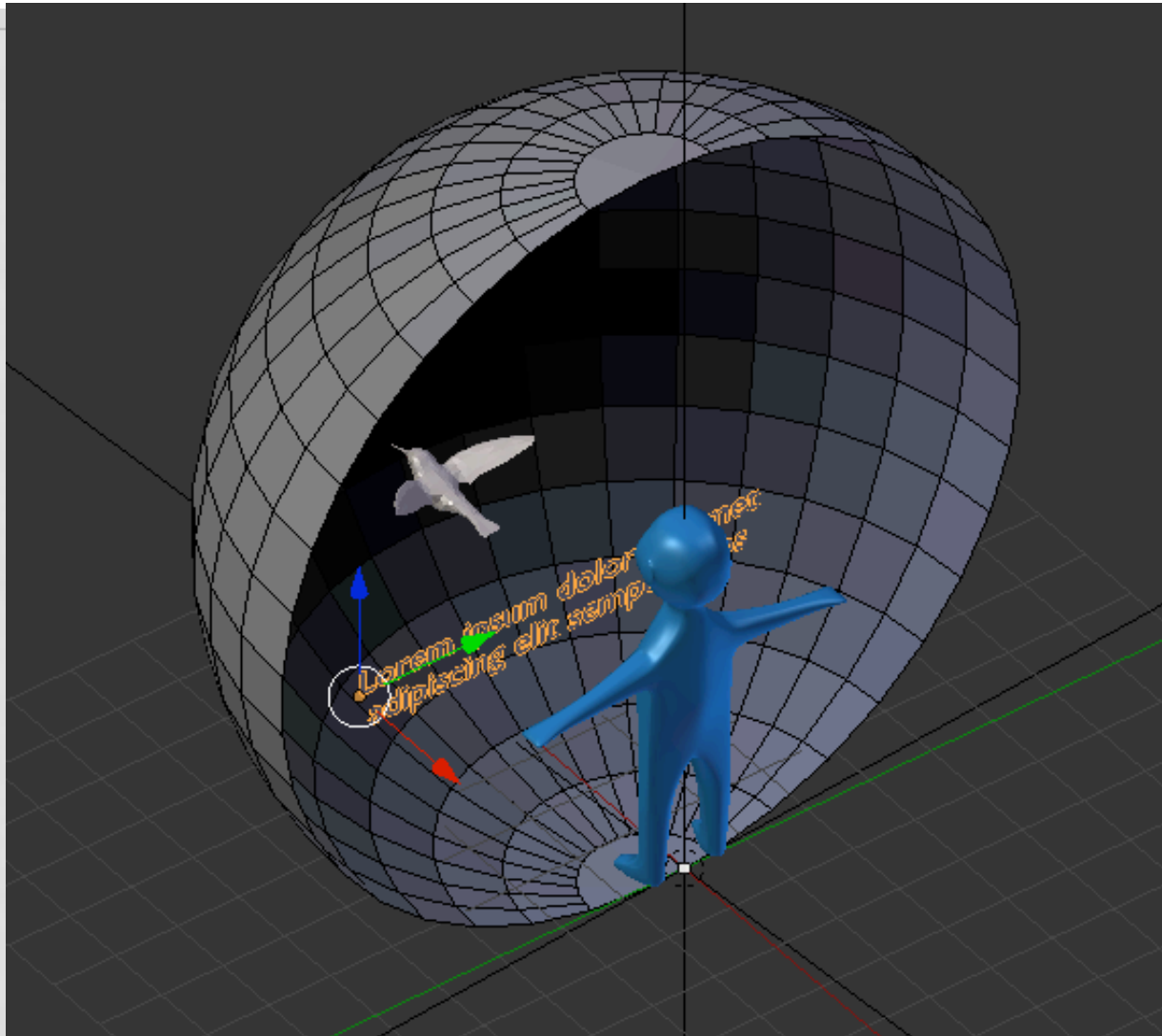
Chris Hughes, Salford University UK



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# Introduction

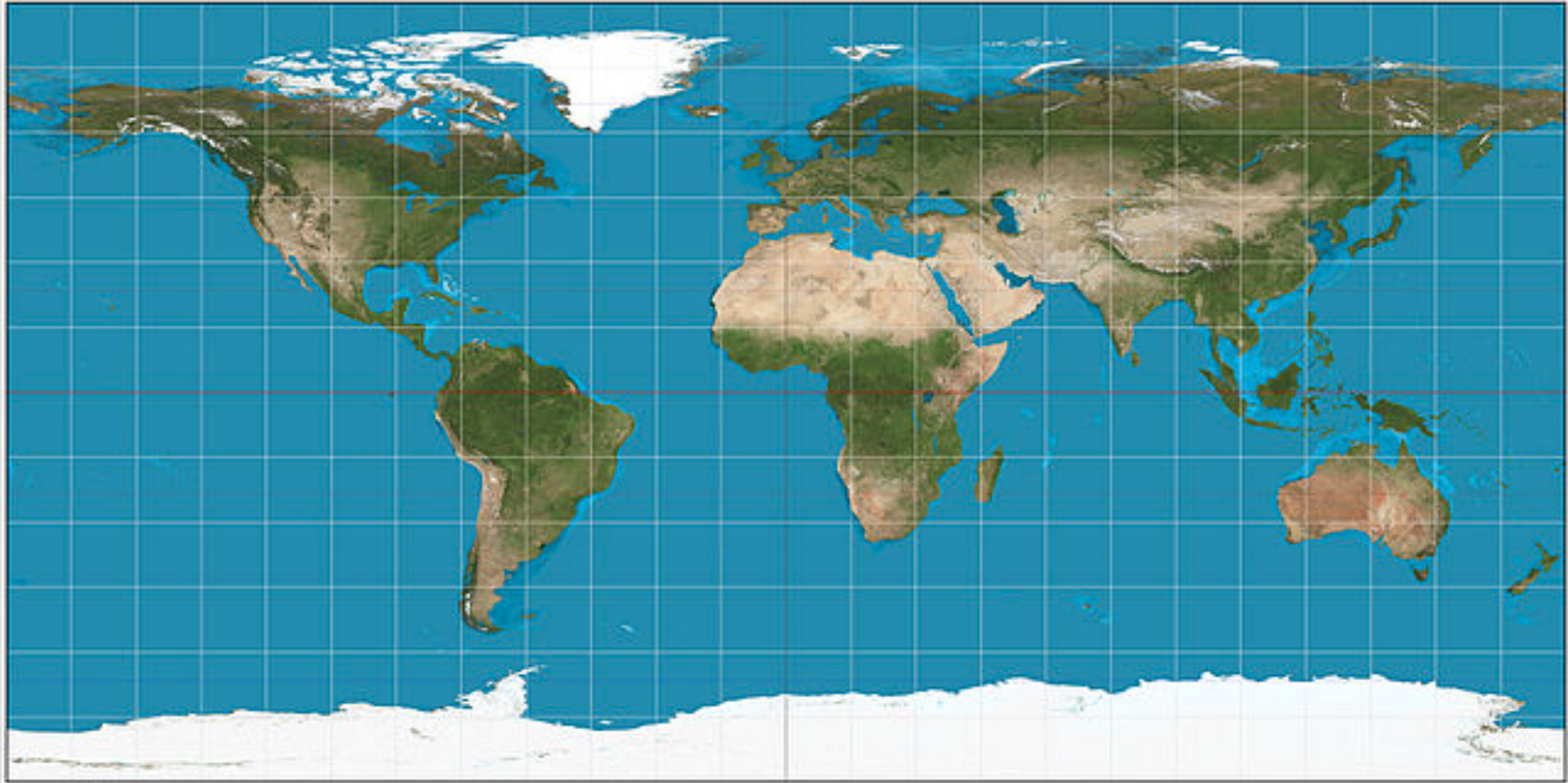


# Overview

- **Defining Requirements for Immersive Subtitling**
  - Challenges
  - Subtitling Workflow
  - Requirements for Editor, ACM, Distribution, Player
  - Presentation
- **Architecture and workflow**
  - Architecture
  - Delivery
  - Editor
  - Player
- **Conclusions**



# 360° SCENERY



Source: Wikipedia, [https://en.wikipedia.org/wiki/Equiarectangular\\_projection](https://en.wikipedia.org/wiki/Equiarectangular_projection)



# SUBTITLING

## Main challenges

- Comfort & Readability
  - Especially for VR glasses
  - Where can subtitles be rendered on the screen (safe area)?
  - What fonts and text sizes are reasonable?
- Speaker identification
  - How does the viewer know who is speaking?
  - How can the user keep orientation in the scene?

# COMFORT & READABILITY



Image quality falls off  
towards the edges

(Only exemplary, does not  
represent real image quality)

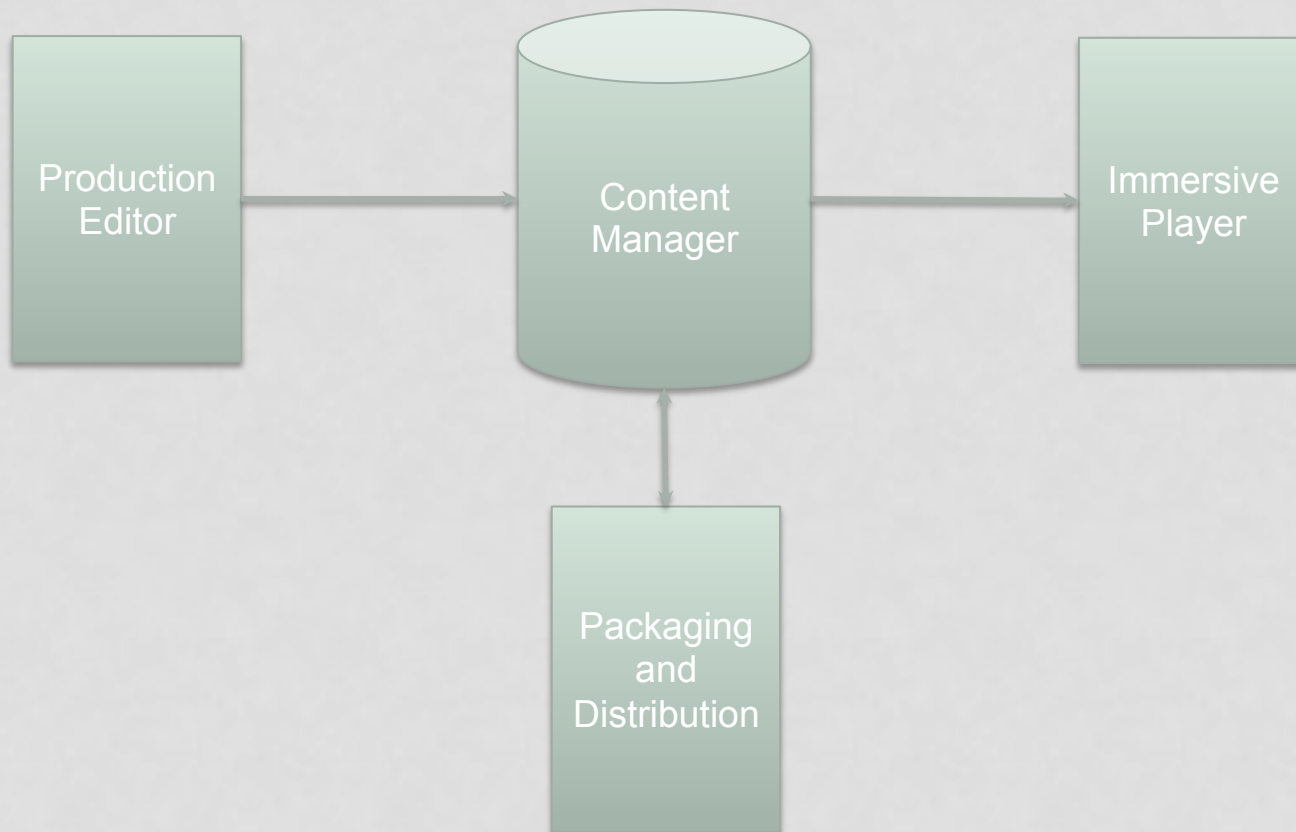
Foto through lens of the  
Oculus Go

# SPEAKER IDENTIFICATION



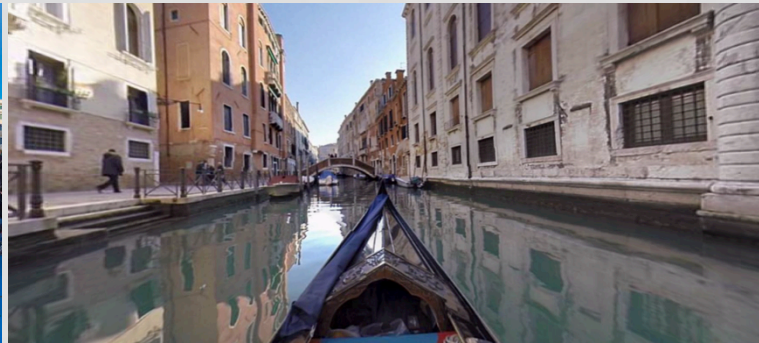


# Subtitling Workflow



# Requirements - Editor

- Allow the professional user to edit subtitles in both 'vr-mode' and 'normal mode'.
- Video should be managed via the ACM.
- Subtitling files should also be handled by the ACM, but it is foreseen to allow directly loading and saving subtitling content files from the computer hard drive on the second iteration.
- A 360 preview player for the low-resolution video playback and monitoring will be embedded in the editor with the following The video will be able to be viewed either as Equirectangular or VR view.



# Requirements - ACM

- Assign metadata to the asset with the accessibility contents, such as the ID needed to match the asset with external asset management systems.
- Prepare the final files for the packager using the asset's contents, such as a new mixed audio file created from the audio description file and the video file.
- Trigger the packaging by validating all the files required.
- The accessibility content manager web service will be used by the content packaging and distribution module to initiate and notify its processes.



# Requirements - Distribution

- Encode the content (compress the audio and video).
- Package the content inside a suitable container for delivery, and it will ensure that the content is segmented appropriately.
- This module will ensure a proper delivery that includes the signalling of the metadata according the editors' wishes.
- Push the content to the appropriate network (whether using streaming protocols or file-based caching infrastructures).

# Requirements - Player

- The UI needs to take into account the sensorial capacities of the target users.
- According to the focus group tests, different presentation modes and personalization options were identified.
- Colours to distinguish between different speakers:
  - The same colours will be used as per broadcaster's guidelines (3-4 colours).
  - The use of specific colour palettes for colour-blind people will also be considered.
- Maximum amount of text for one subtitle:
  - The TV broadcast subtitle services are still based on the teletext limitations as well as on viewer behaviour, including their reading speed. That implies that the number of characters is limited to about 37 characters per line and it is suggested to use not more than 2 lines for a subtitle.

# Requirements - Player

- Without VR glasses, we assume the same ratio (16:9) and the safe area for interactive elements defined by the EBU guideline EBU R95 (<https://tech.ebu.ch/docs/r/r095.pdf>) in a HD format.
- The head mounted displays have different maximum visual fields defined as FoV (Field of View). The comfortable area for viewing is still being tested.



# Presentation Modes

- Adding arrows
- Using sided
- Adding a compass or wind



# Presentation Modes

- Notifications for Sound



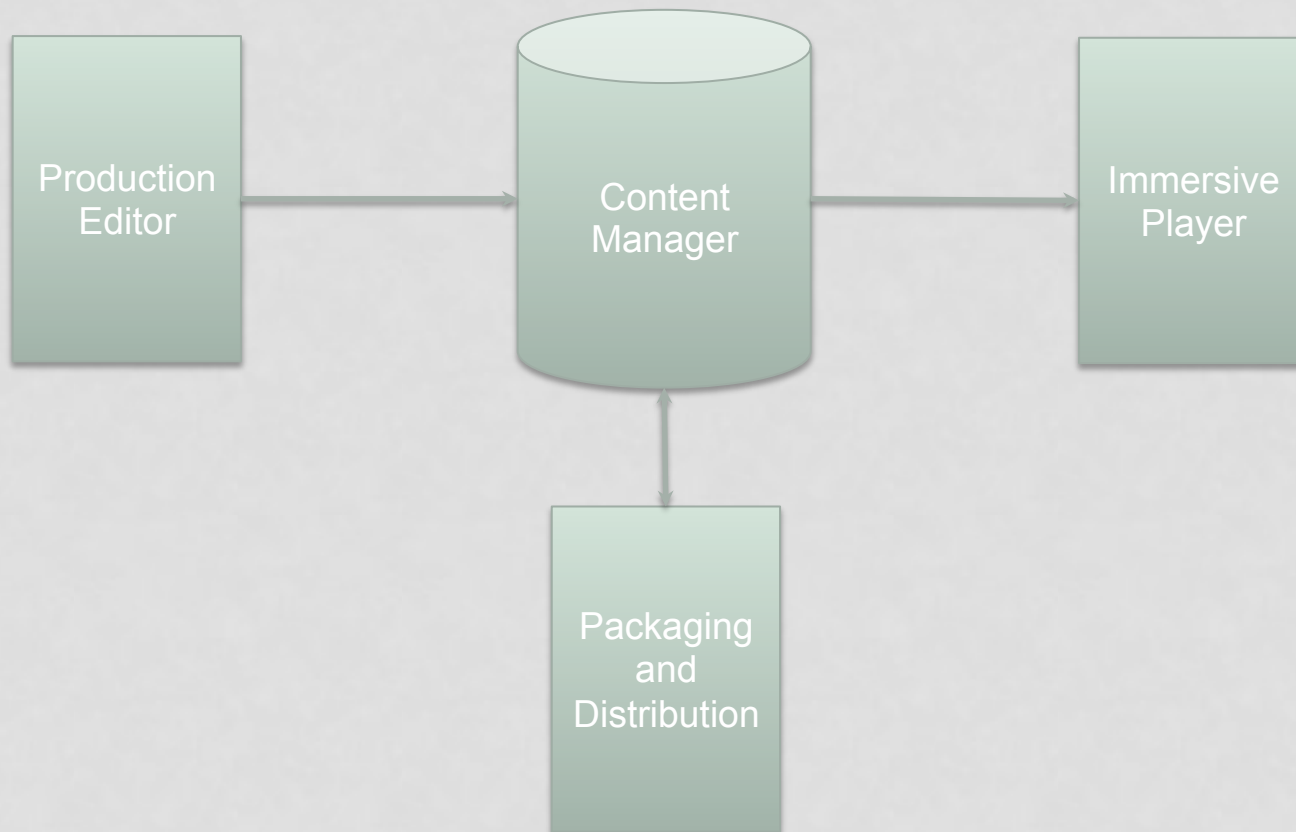


# Personalisation

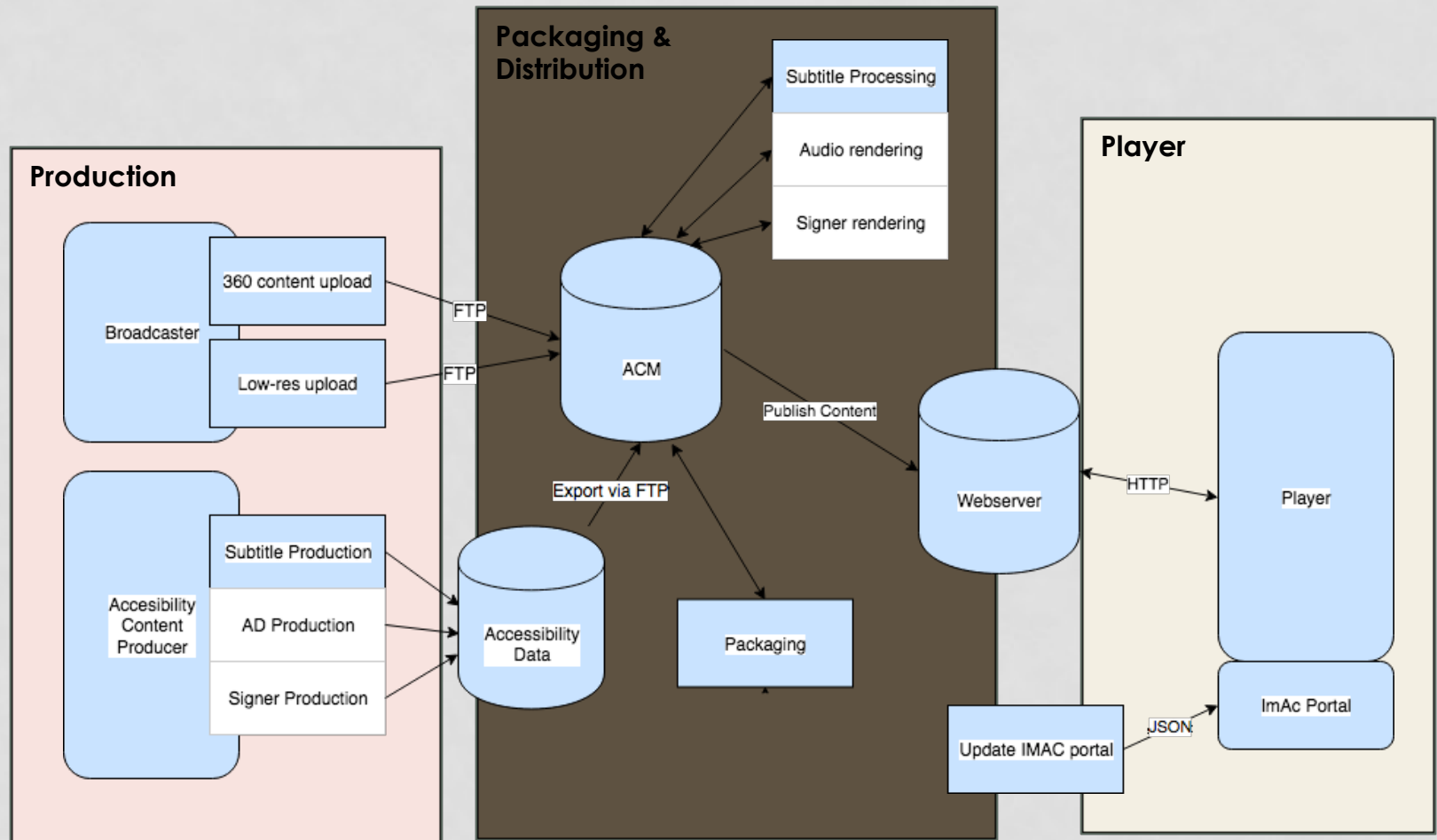
- Different font sizes (e.g. small, medium and large)
- Select between different backgrounds:
  - 1) semi-transparent box (80% opacity)
  - 2) outline (2px for each font size)
- Adding the subtitles below a scaled down video area.

# ARCHITECTURE AND WORKFLOW

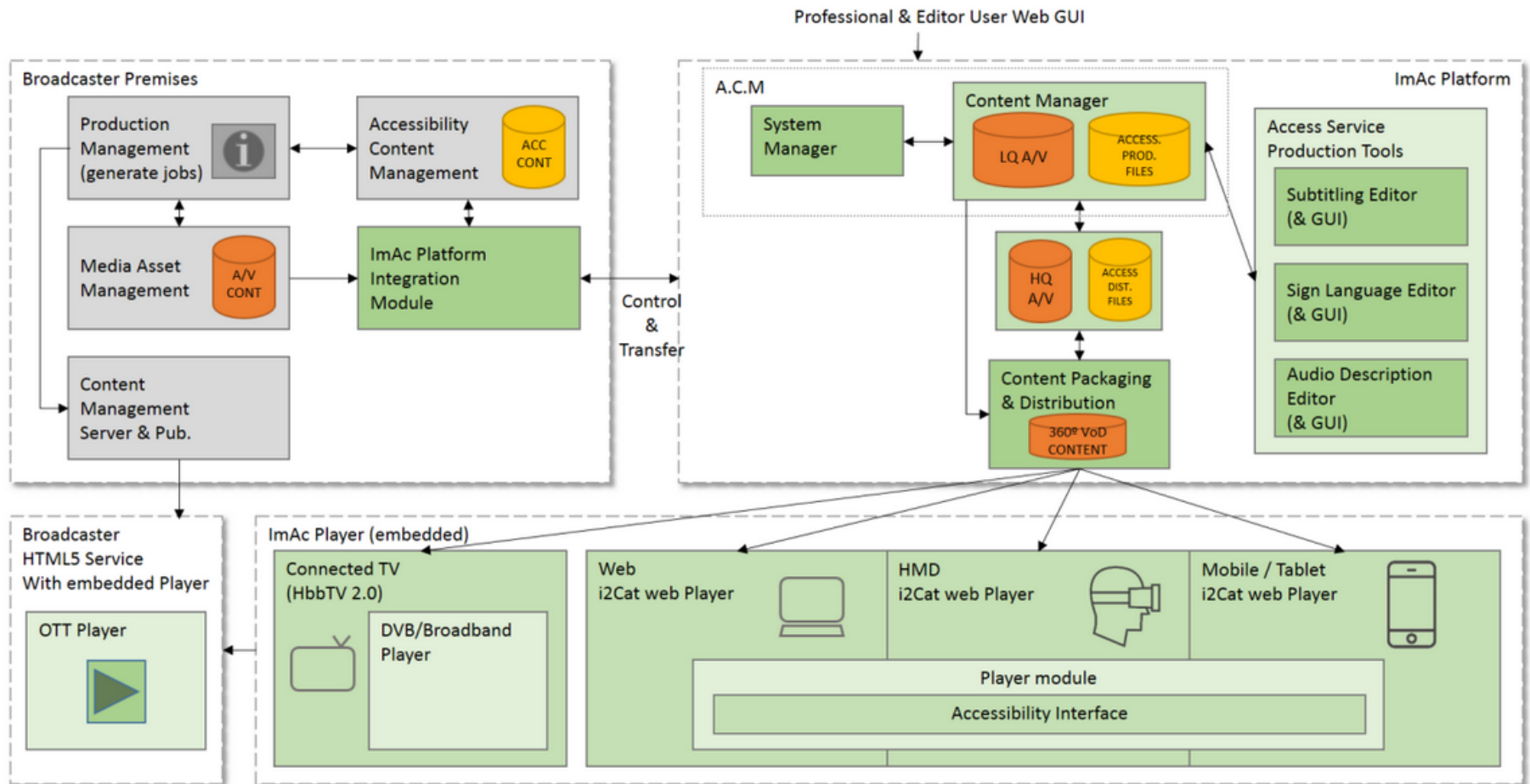
# Implementation



# Architecture



# ARCHITECTURE



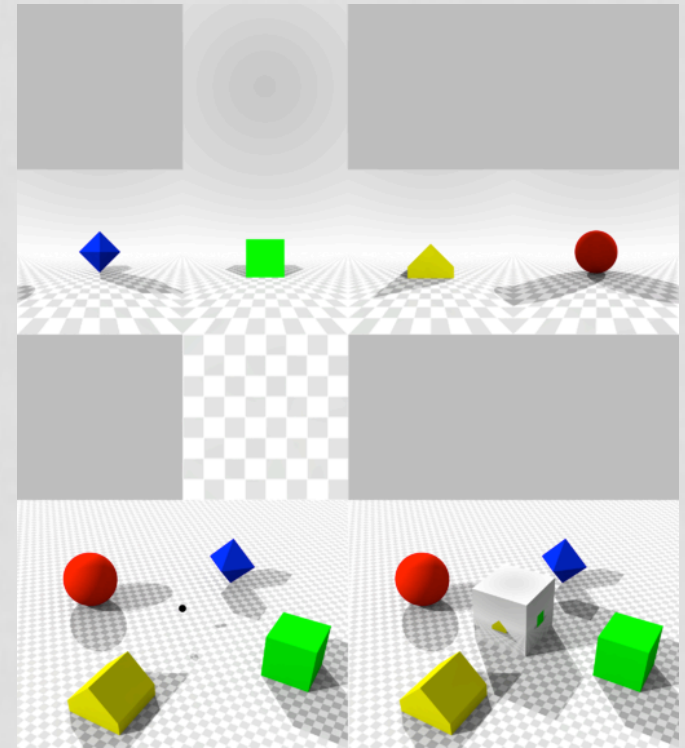
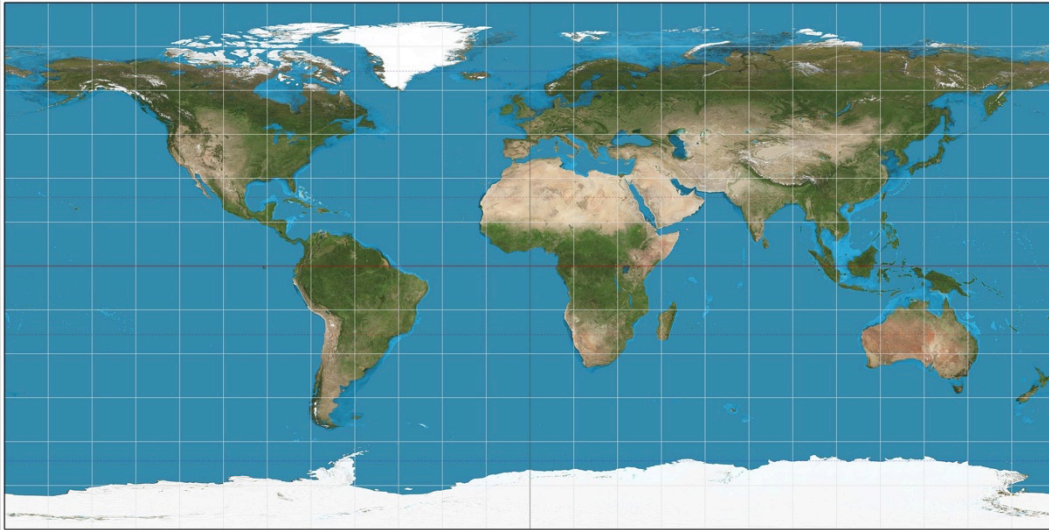
# MPEG-DASH (MP4; H.264)

- Dynamic Adaptive Streaming over HTTP (DASH)
- Designed for delivery over IP using existing HTTP protocol
- Adaptive bitrate - content split into many parts and stored at different bitrates
- Automatically selects from the alternatives the next segment to download and play based on current network conditions.
- Codec-agnostic, which means it can use content encoded with any coding format, such as H.265, H.264, VP9, etc
- CMAF - will allow over IOS



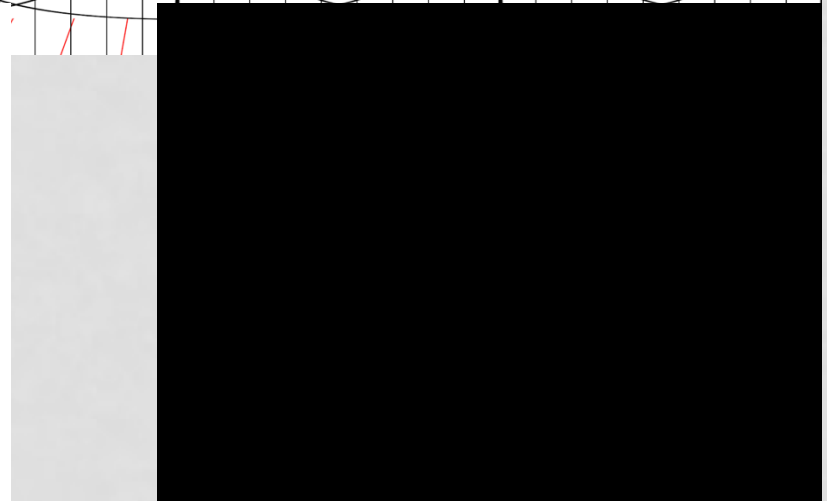
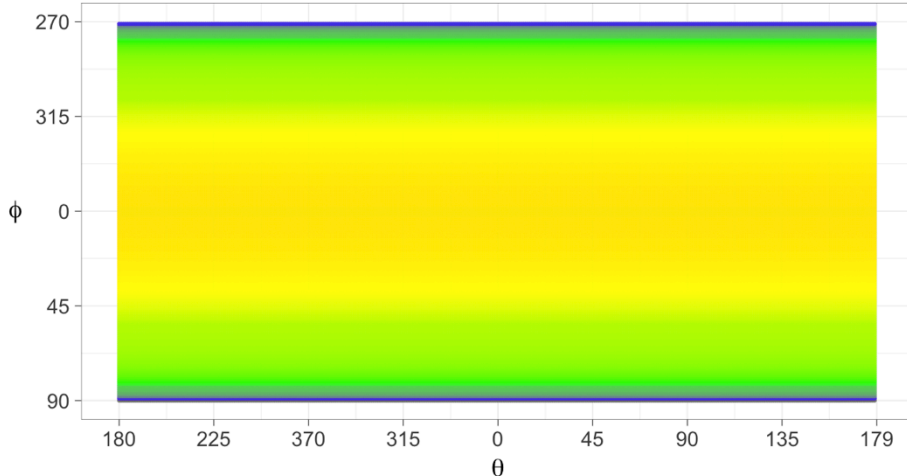
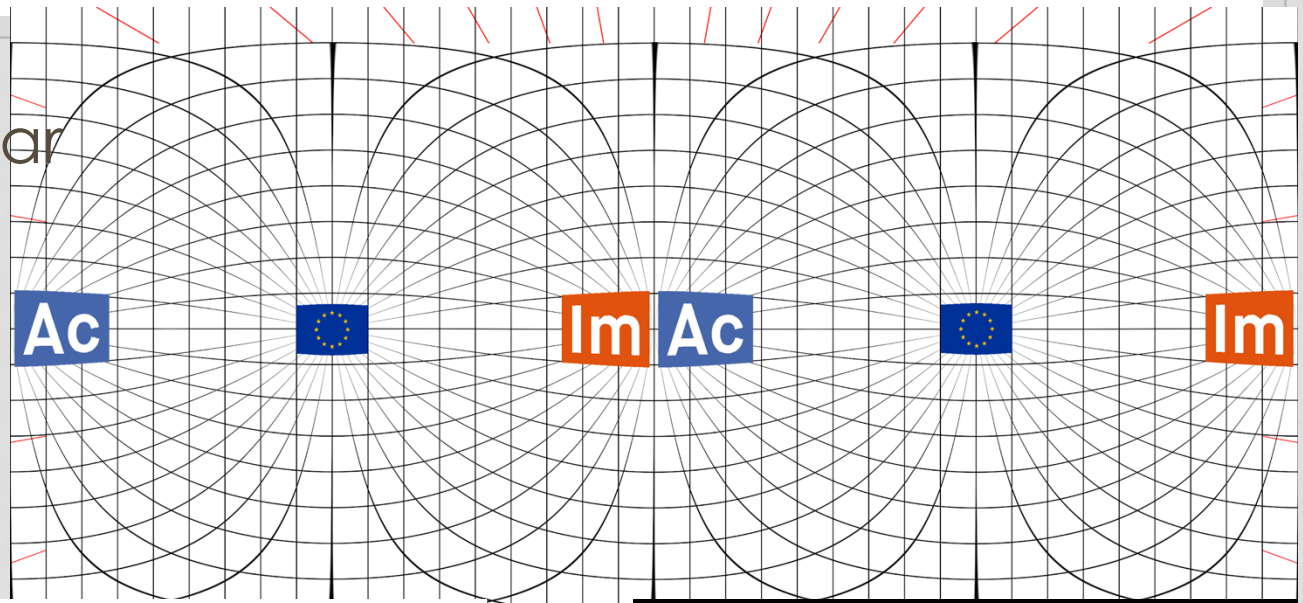
# 360 VIDEO FORMAT

- There are two popular formats.
  - Equirectangular
  - Cubemap



# 360 VIDEO FORMAT

- Equirectangular



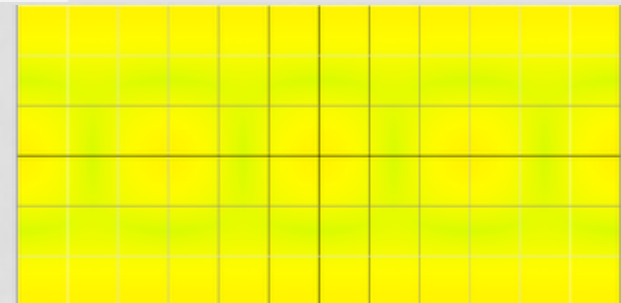
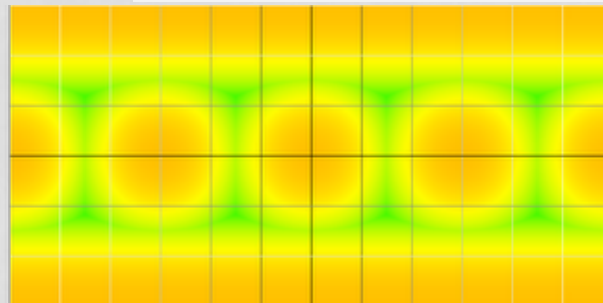
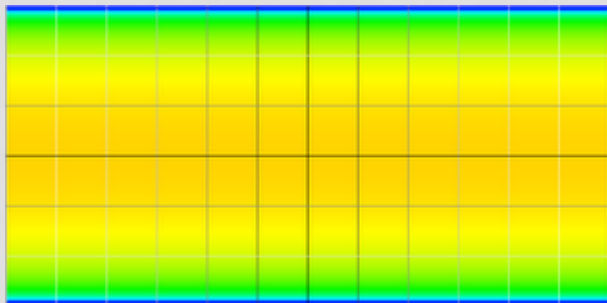
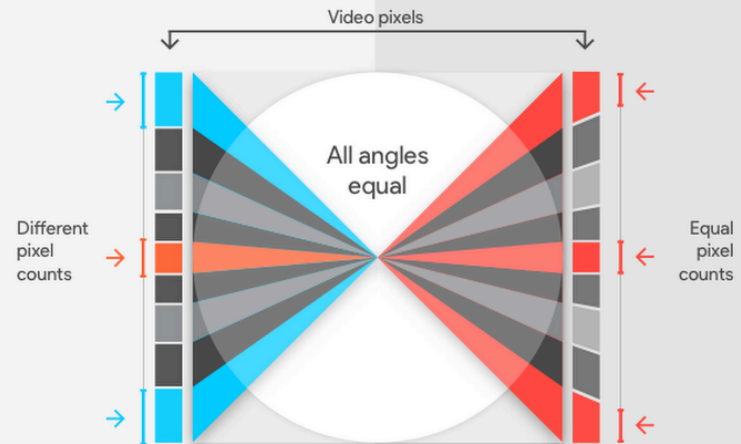


# 360 VIDEO FORMAT

- The Equi-Angular Cubemap (EAC)

Standard  
Cubemap

Equi-Angular  
Cubemap



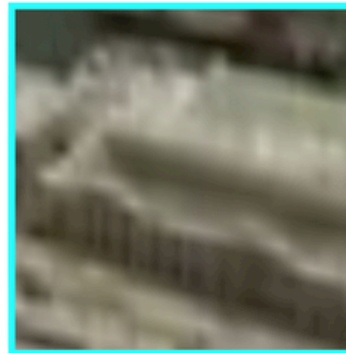
Equirectangular Projection (left), Standard Cubemap (middle), Equi-Angular Cubemap (right)



# 360 VIDEO FORMAT



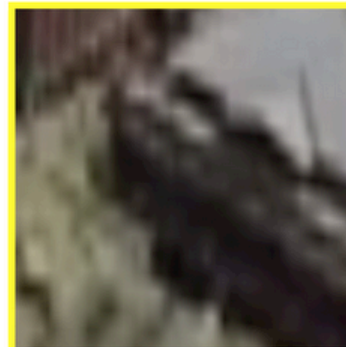
Video frame as viewed in VR headset



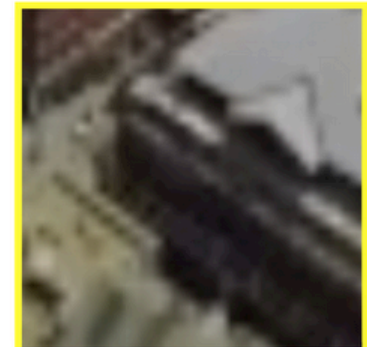
Equirectangular



EAC



Equirectangular



EAC

Source: [www.blog.google/products/google-ar-vr/bringing-pixels-front-and-center-vr-video/](http://www.blog.google/products/google-ar-vr/bringing-pixels-front-and-center-vr-video/)



# SUBTITLE DISTRIBUTION

- Options for subtitle distribution:
  - XML-based (TTML)
  - Plain-text (SRT, WebVTT)
  - Embedded in video (CEA-608, CEA-708)
  - Burned into video ('open captions')

# EBU TTML

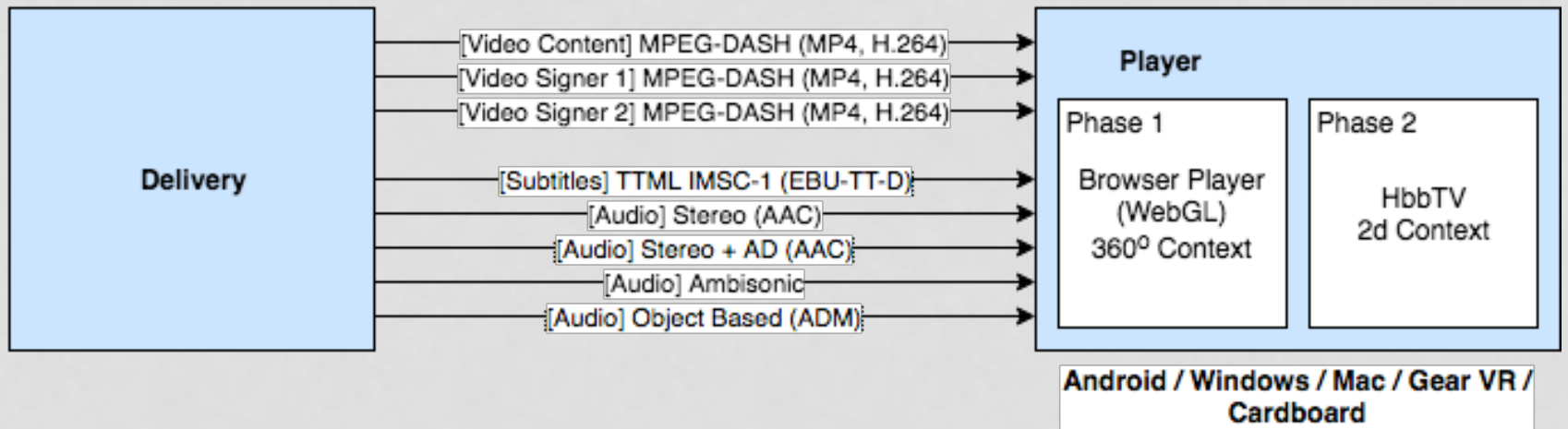
- W3C Timed Text working group
- Encompasses all functionalities from existing timed text formats
- Two TTML profiles:
  - EBU-TT, for archiving and as interchange format.
  - EBU-TT-D, which is specifically meant for distribution over IP-based networks.

```
<body>
  <div>
    <p begin="00:00:00.000" end="00:00:02.000">
      This is a subtitle<br/>
      on two lines
    </p>
  </div>
</body>
```



# Delivery

## Delivery



# Conclusions

- Defined Requirements for Immersive Subtitling
- Discussed Implementation for an Immersive Subtitling System
- Questions?

# ImAc Player

Media for All 2019

Mario Montagud (i2CAT)

([mario.montagud@i2cat.net](mailto:mario.montagud@i2cat.net), @mario\_montagud)

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# ImAc Player - Features

## Use of web technology

- Universal support (cross -device, -browser, -network support)
- No need for installations / updates at the client side

## Supported media formats:

- Traditional 2D and 360° video
- Traditional 2D and spatial audio (Ambisonics)
- Internet Media Subtitles and Captions (IMSC) subtitles (subset of TTML, W3C standard)

## Supported consumption devices (interaction modalities):

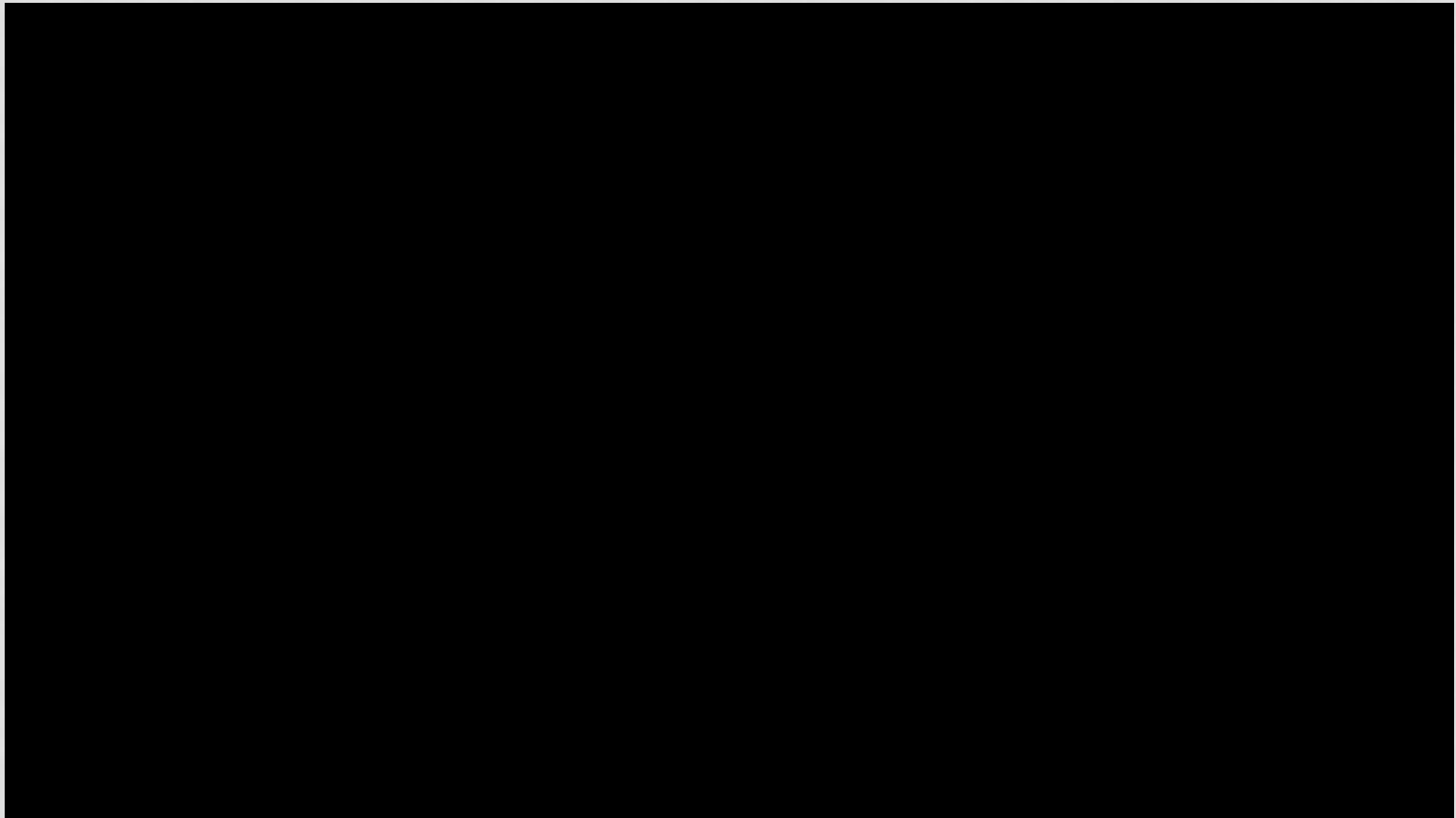
- PC and laptops
- Smart TVs
- Mobile devices (tablets, smartphones...)
- VR devices (Head Mounted Displays, HMDs)





# ImAc Player

Demo video: <https://bit.ly/2Fw0d9P>



# ImAc Player – ST Features

## Styling effects for speakers' representation:

- Color, formats, voice-off

## Integration of Non-Speech Info:

- Examples: test descriptions, emojis
  - Demos: [[Contact mario.montaged@i2cat](mailto:mario.montaged@i2cat) if interest]

## Personalized presentation:

- Language, Size, Outline and Position
  - Demos: <https://imac.gpac-licensing.com/player/>

## Easy-to-Read Subtitles:

- Validated simpler text structures.
  - Demos: [[Contact mario.montaged@i2cat](mailto:mario.montaged@i2cat) if interest]

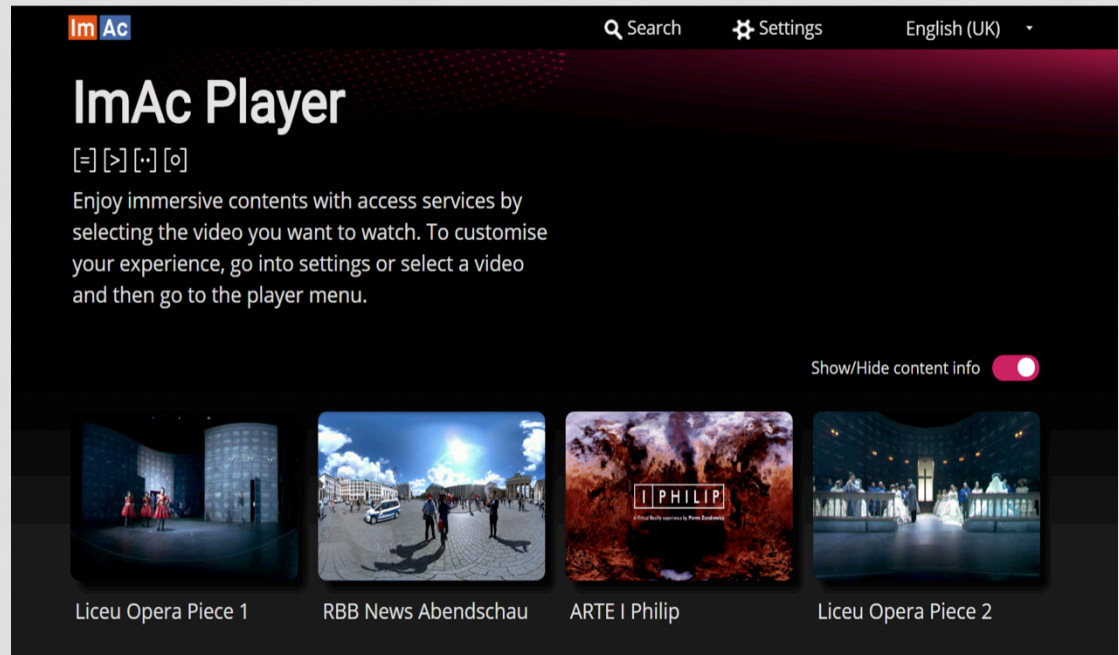
## Responsive Subtitles *[Explained later by Chris Hughes]*



# ImAc Player - UI

**ImAc portal.** Landpage for:

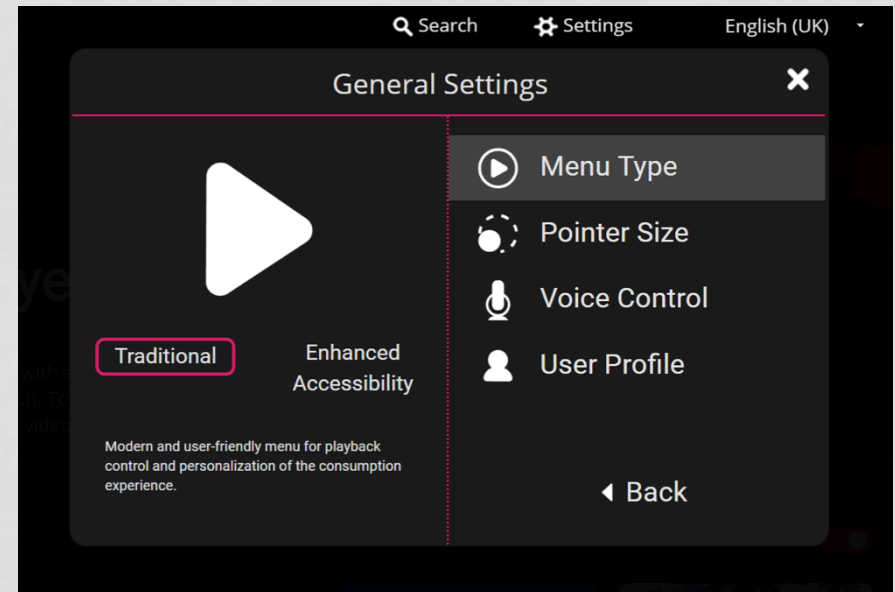
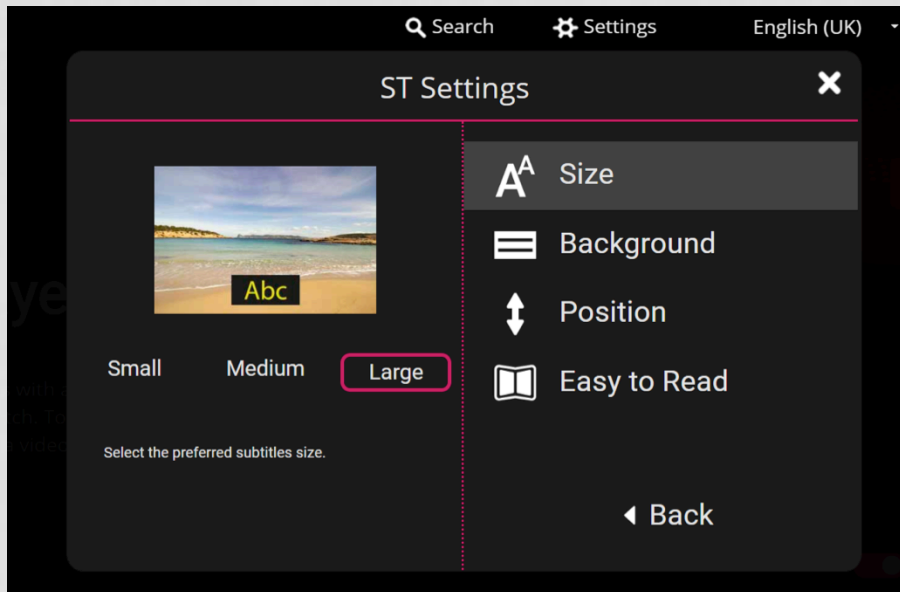
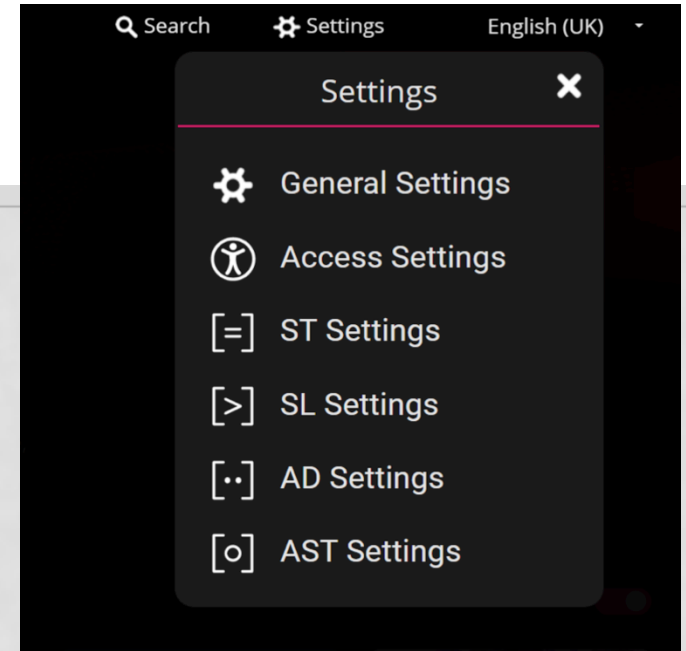
- Language selection
- Catalogue of videos, indicating their language, cover and available access services ( [=] [>] [⋯] [o] )
- Search and filtering
- Video Selection



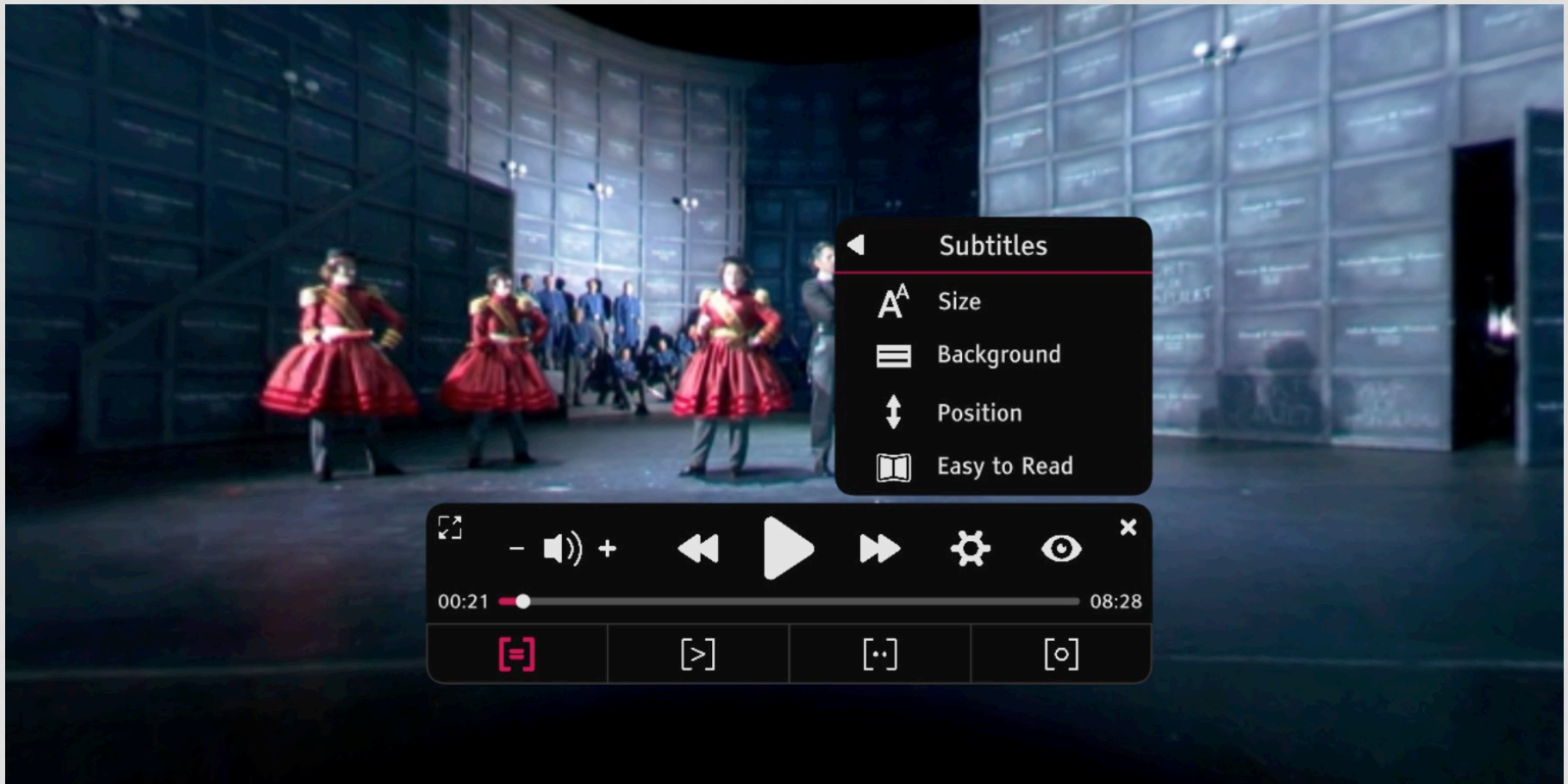
# ImAc Player - UI

ImAc portal. Landpage for:

- Initial Settings



# ImAc Player - UI



# ImAc Player – ST Indicators



# ImAc Player – ST Indicators



# ImAc Player – ST Indicators

## Auto-positioning mode

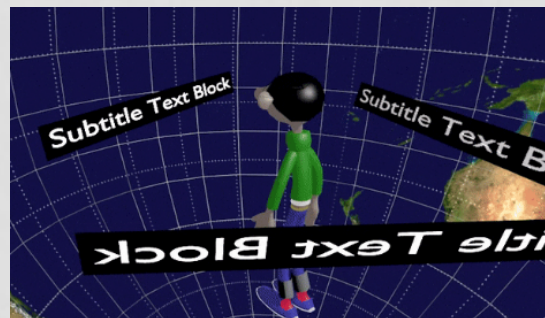
- Automatically and smoothly change the Field of View
- Previous research in the context of storytelling and Cinematic VR has shown that it can provide added value.
- Challenges:
  - In VR mode, it is difficult to implement
  - In VR mode, if always applied → dizziness, motion sickness
  - When? Determine moments / scenes to apply this strategy
  - How? Determine appropriate transition strategies
- Current Solution
  - Rescue Button / Bring me to action



# ImAc Player – ST Features

Three presentation / rendering modes being tested:

- Evenly spaced every 120° (proposal by BBC)
  - Demos: [Contact [mario.montaged@i2cat](mailto:mario.montaged@i2cat) if interest]
- User-referenced: always visible at bottom center of the FoV
  - Demos: <https://imac.gpac-licensing.com/player/>
- World-referenced: Attached to the speaker / action / position
- World-referenced (subtitles) + User-referenced (indicators)
  - Demos: [Contact [mario.montaged@i2cat](mailto:mario.montaged@i2cat) if interest]



# ImAc Player – Multi-Screen



# ImAc Player – ST Features

Help us by filling this questionnaire!

- URL: [http://bit.do/imac\\_subtitling\\_questionnaire](http://bit.do/imac_subtitling_questionnaire)



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# ImAc Pilots

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# ImAc Pilots

## Two iteration of pilots

- Pre-pilots to validate technology, contents and methodology
- ACM and Editors are tested by professionals
  - Closed: controlled scenarios with facilitator(s)
  - Open: Remote tests (with guides / tutorials)
  - Usability and Usefulness of Features
- Player features are tested by end-users
  - Closed: controlled scenarios with facilitator(s)
  - Semi-open: uncontrolled network infrastructure, but controlled scenario and equipment
  - Open: users access the services from remote locations, using their own devices
    - Websites
    - Broadcast programmes



# ImAc Pilots – End-Users

## Comfortable Field of View (CFoV) – Safe Area

- In traditional screens (16:9, 2D): European Broadcasting Union (EBU) Recommendation R95, “Safe areas for 16:9 television production”
- In VR screens (1:1, 3D): What and How is the safe area?

**1:1 (60%, 70% of FoV)**

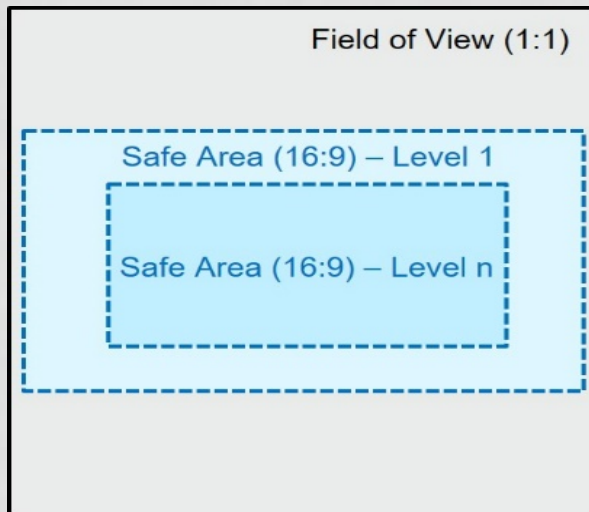


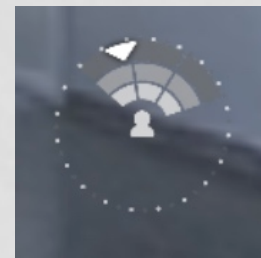
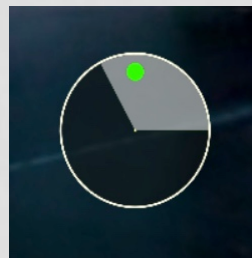
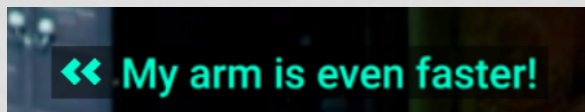
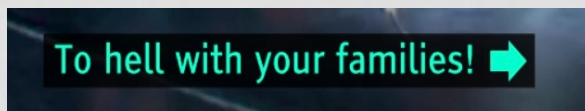
Image quality falls off towards the edges



# ImAc Pilots – End-Users

## Guiding Methods

- Arrows vs Radar
  - Arrows were preferred when using a first design of the visual elements
  - Improvements to arrows and radar (based on feedback), and second iteration of tests → Personalization!
- Auto-positioning
  - In VR, it can lead to dizziness & motion sickness, if always applied
  - If further research + development, it can have potential!





# ImAc Pilots – End-Users

## Rendering Modes

- User-Referenced vs State-of-the-Art World-Referenced
  - User-Referenced is preferred!
- User-Referenced vs Proposed Combined Strategy
  - World-Referenced Subtitles + User-Referenced Indicators



# ImAc Pilots – End-Users

## Subtitles Reading

- Easy-to-Read (E2R) vs Traditional
  - Tested by aged users → E2R preferred for ~2/3.
  - Explore further:
    - Impact of content genres
    - Different profiles of users (e.g. cognitive impairments...)
- Other Research Questions
  - Reading speed: Do the same recommendations as for traditional media apply?
  - Size: In a 3D environment, no accurate sizing in px, but in %. Other parameters influence: distance, viewing perspective, dynamism
  - Font: need to contribute to immersion and to accessibility!



# ImAc Pilots – End-Users

## Audio Subtitles (AST)

- Synthetic voice (TTS)
- Use of spatial audio modalities
  - Classic
  - Static
  - Dynamic
- Relative volume levels
- Co-existence with AD (mixing, space, volume levels...)
- E2R AST?

Results being processed!



# ImAc Pilots – End-Users

## Combined usage of Subtitles and Sign Language

- Requirement by German users
  - Personalization option
  - Use of Responsive Subtitles to fit within the CFoV (the size of the Sign Language video is a personalization feature as well)
  - One master service for indicators: subtitles
  - On-off periods for Sign Language Video: dynamically hide / show the Sign Language video, based on signers' activity
  - Demos: [Contact [mario.montaged@i2cat](mailto:mario.montaged@i2cat) if interest]
- Have you seen this before?

Results being processed!



# ImAc Pilots – End-Users

## Open Pilots

- Integration of player + contents in websites
  - RBB, CCMA, RTVE?
- Augmented TV programmes with ImAc content on companions screens
  - HbbTV standard
  - Web-based scenarios
- Registration of statistics on users' activity
- Short questionnaires

# ImAc Pilots

Media for All 2019

Mario Montagud (i2CAT)

([mario.montagud@i2cat.net](mailto:mario.montagud@i2cat.net), @mario\_montagud)

Partners



MOTION SPELL



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Supporting people  
with sight loss



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# Subtitling with ImAc (ImAc production tools)

Media for All 2019

Enric Torres i Feixas, Anglatècnic s.l.

Partners



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# Index

- ImAc access service production tools
- Aproach
- Web subtitle editor (Web ST Editor).
- Accessibility Content Manager (ACM).
- ST production workflow



# ImAc access service production tools

- **Web subtitle editor (Web ST Editor)** used by subtitlers
- Web audio description editor (Web AD Editor) used by audio describers
- Web sign language editor (Web SL Editor) used by signers
- **Accessibility Content Manager (ACM)** used by broadcasters for:
  - Assigning the production of 360° access services to producers such as **subtitlers**, audio describers or signers (usually external service providers).
  - Sending the LQ 360° video file to the producer so they can carry out the access service production with the editors.
  - Receiving the access service files from the producers and verifying that they are correct.
  - Cataloguing the verified files so they can be used anytime that the 360° programme is broadcasted or published.
  - Automatic background processes (transcodings, renderings, notifications, ...)

# Approach

- Web ST Editor and ACM embrace:
  - the 360° media
  - the user requirements
  - TTML-based formats (extension of IMSC profile)
  - interconnection with existing systems
  - not losing its backward compatibility (import and export from/to other formats: EBU-TT-D)

# Web ST Editor

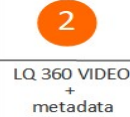
- Features that you find in professional subtitling editors. Correct **timing** is the main quality of the subtitle service. Additional information like **colours** and **positioning** on the screen help the viewer to perceive the content.
- Producing subtitles for the 360° media.
  - The dialogues from the speakers on the 360° videos come from different directions, not necessary from the viewer's FoV (Field of View), so it is necessary to add **graphical elements during the production to guide the viewer towards the dialogue source.**
  - During the verification:
    - Forced preview (mainly when using integrated 360° video player): During playback the FoV automatically turns to where the subtitle is presented.
    - Free preview (mainly when using HMD); During playback the user has to turn to the FoV where the subtitle is presented, which is more real.

# ACM user interfaces

- ACM is web based (universal access), with the following interfaces:
  - System Management interface (SM) for administrative, configuration and maintenance issues.
  - Content Management interface (CM) for managing the production of access service files (**subtitles**, audio description and sign language files) and their cataloguing. The file cataloguing is made via assets that correspond to a TV programme
  - Edition interface (ED) for producers such as **subtitlers**, audio describers or singers.
  - Publication interface (PU) for publication status.

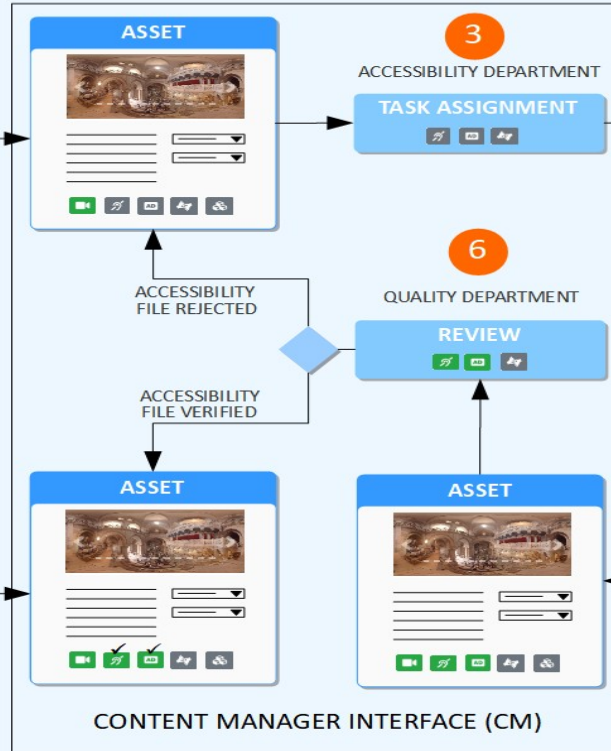
# ImAc production workflow

## BROADCASTER SYSTEMS



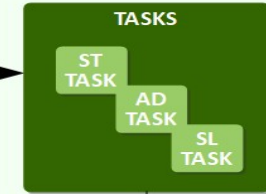
## ImAc PLATFORM FOR PRODUCTION

### BROADCASTER



### PROVIDERS

#### EDITION INTERFACE (ED)



EDITORS (ST, AD, SL)

FILE

# ImAc ST production workflow

1. Broadcaster indicates in their systems that one or more ST services are required for a 360 programme, the MAM creates a LQ 360° video file and a metadata file.
2. ACM receives the LQ video and metadata files and creates a new Asset for the 360° programme. The Asset is accessible from the Content Manager (CM) interface and will contain all the files and metadata available for the 360° programme.
3. The broadcaster's accessibility department team uses the CM interface to assign the production tasks for those required ST services to producers (audio describers).
4. The producers use the Edition (ED) interface to access the ST tasks that have been assigned to them and start the production. At this moment the Web ST Editor is automatically executed with the LQ video and ST file.
5. The producer uses the Web ST Editor to edit ST file and save it back to ACM.
6. The broadcaster's quality department team uses the CM interface (ST file list) to verify (with the Web ST Editor) and validate or reject each production.
7. Once validated, the ST files are catalogued on ACM so that the broadcaster's playout system can access them when the 360 programme is published or broadcasted.

# Thank you

Thank you for your attention!

Enric Torres i Feixas

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Immersive  
Accessibility



Funded by the Horizon 2020  
Framework Programme of the  
European Union