European Commission | Horizon 2020 European Union funding for Research & Innovation

Traction
Opera co-creation for a social transformation

A World Leading SFI Research Centre

Science Foundation Ireland For what's next

EU H2020 TRACTION Project

Using Technologies to Support Opera Co-creation for a Social Transformation

Insight

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FUNDED BY:

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TRACTION Team in DCU

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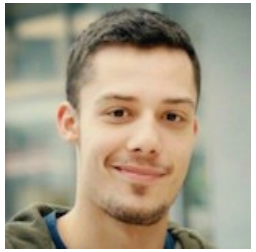

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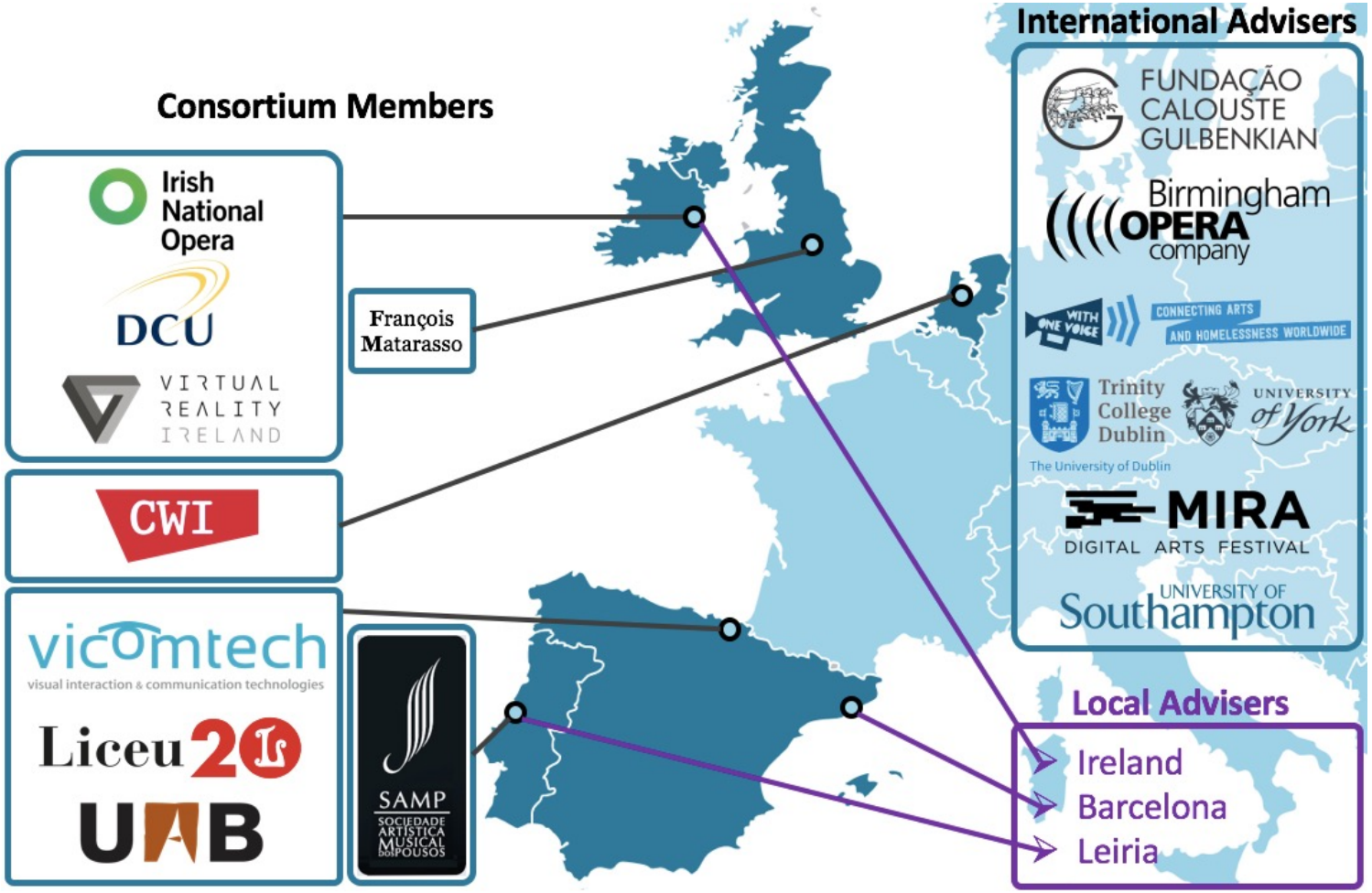
TRACTION Consortium



Motivation

- **Inequality** is the defining issue of our time

- **Opera** is the unavoidable heart of Europe's cultural space.
  - Its colour, passion, beauty and drama have inspired generations
  - Today's typical spectator is a 54-year-old woman with higher education, who travels by car and spends an average of €159 on her evening of culture

- Opera is in danger of becoming a **symbol of European inequality**
  - **Renew itself** and be once again the root of living culture

Challenges

New ideas of co-creation and participatory art to involve citizens in the creative process:

- **Prioritise** those who are currently **marginalised** or ignored by opera: the poor, migrants, people living outside dominant cities or in institutions, disabled people, those of non-white heritage, in short, the majority of our fellow citizens

- **Empower people and communities** to become creators in their own right and express their version of European values

- **Refresh** the form, language and aesthetics of opera
  - Through **innovative experiments** with music, performance and art
  - Unless opera excites people again it is destined for a future of irrelevance

Challenges

It must embrace new technologies to help **overcome** the challenges:

- What can **technology** bring to the process of **co-creation**?
- What can **technology** bring to the artistic language of opera and the ways in which artists **connect** with audiences?
- Bring **new knowledge** and share it so that others can build on it in other cities and with different communities

Objectives

1. Promote, through their empowerment, a **transformation of communities** at risk of exclusion

2. Establish an effective collaborative and participatory production workflow for the **co-creation** and **co-design** of art representations

3. Lay down a **community-centric research** and evaluation methodology to conduct an efficient and measurable community dialogue that will last in time and be replicable

4. Explore **novel audiovisual formats** based in European cultural heritage, such as opera

5. Maximise the **social and market impact** of the TRACTION results

TRACTION Achievements

TRACTION **provided a bridge** between **opera professionals** and **specific communities** at risk of exclusion to foster an effective community dialogue between diverse individuals and collectives:

- Researched, designed and developed a **collaborative and participatory production toolset**
- Defined and implemented a **community-centric research and evaluation methodology** to conduct an effective dialogue with, within and between heterogeneous communities
- Promoted a **sustainable** and **replicable** approach for other art disciplines and communities

Vision and Trials

Opera with residents of Raval

Spain

Raval is a culturally diverse neighbourhood in **Barcelona** that brings together different nationalities and cultures. TRACTION aims to promote social inclusion of migrants through co-design and co-creation of a new opera piece between professionals in LICEU and residents of Raval.

Opera co-creation with young inmates and the community in Leiria

Portugal

A prison for young inmates, EPL-J, in **Leiria**, Portugal, has been chosen with the objective of lowering the rate of criminal recidivism among young inmates by engaging them in an opera co-creation process.

Opera co-creation with diverse communities

Ireland

Use new technology and novel audio-visual formats to create a new digital community opera. The opera developed in the trial will contain contributions from communities in **Tallaght**, **Offaly** and the **Aran Islands**.

TRACTION Toolset

Co-Creation Space
Co-creation process

Co-Creation Stage
Representation phase

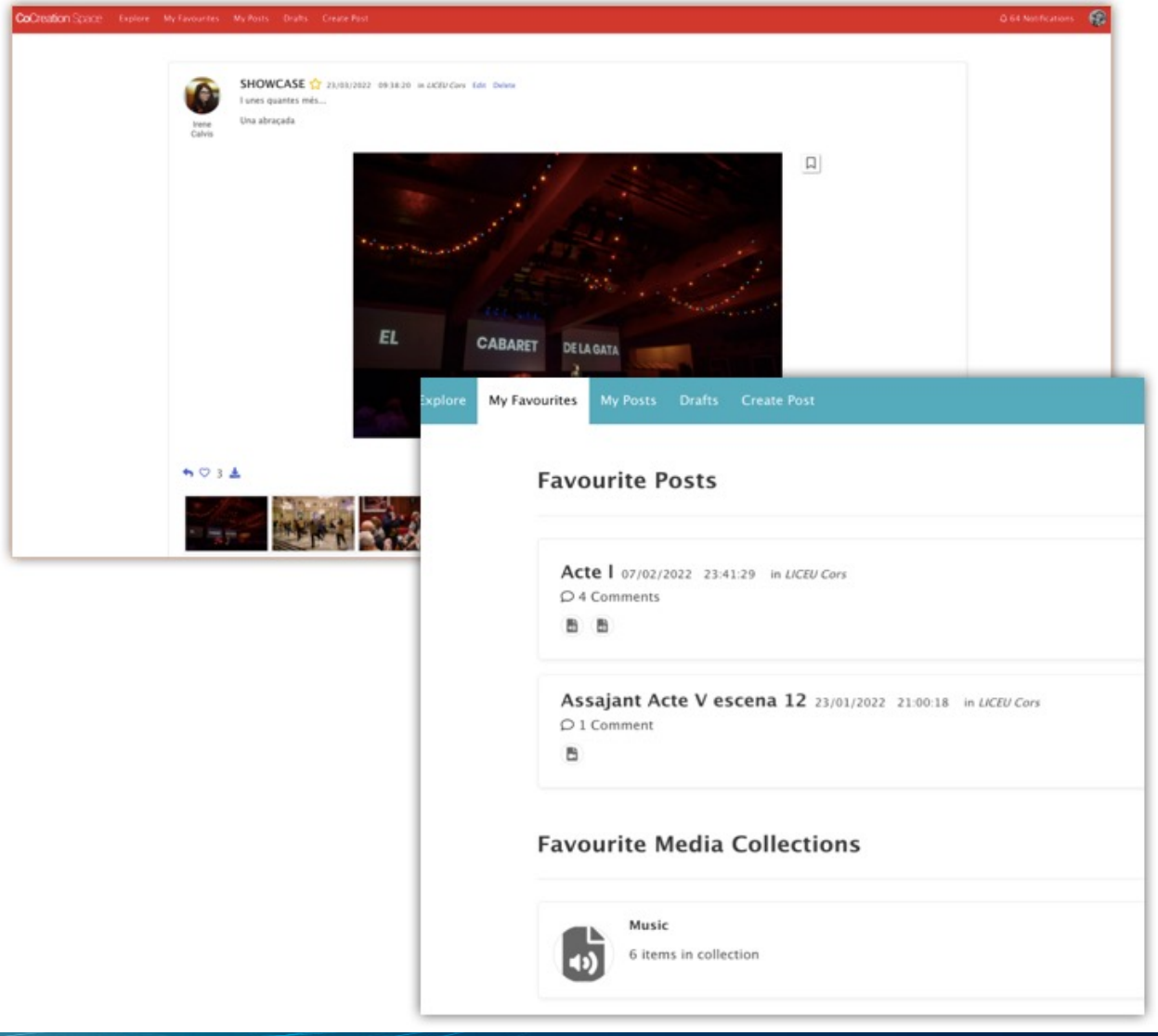
Social VR, 360 Player, VR Opera
Virtual Reality support

Three different tools, according to the different stages of the co-creation

TRACTION Toolset – Co-Creation Space

- It allows for the **storage** of a heterogeneous group of media objects (2D and 360 videos, volumetric media)
- It enables asynchronous **communication** between users around the **uploaded** content, for **conversation** and **co-creation**
- Includes functionality for **generating stories** based on the stored content
- A strong requirement on **accessibility** at the user interface, for supporting its use by people with cognitive and sensory disabilities

TRACTION Toolset – Co Creation Space



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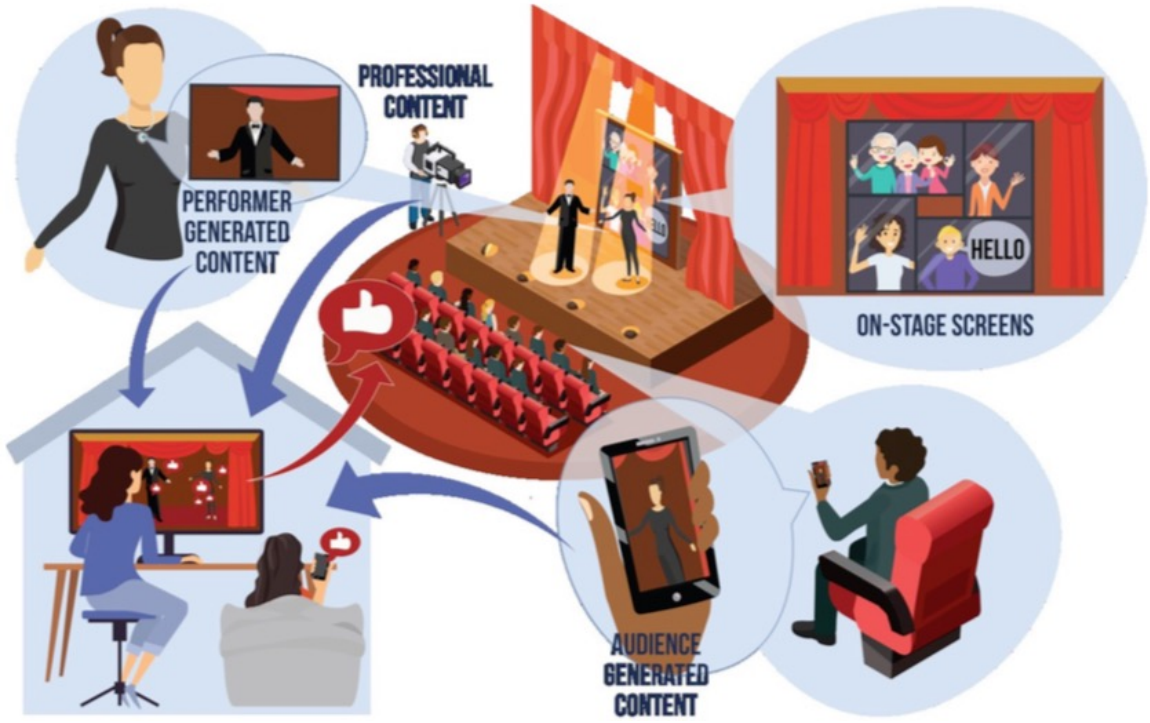
TRACTION Toolset – Co Creation Stage



- It is a **communication infrastructure**, deployed at the **theatre** or in the **rehearsal** rooms
- It enriches the live performance by **orchestrating** the stage in **real-time**
- It allows for remote participants to **see** the show and to **contribute** to it
- This communication infrastructure does not only enrich the show, but as well enables synchronous **communication between actors and spectators**.

TRACTION Toolset – Co Creation Stage

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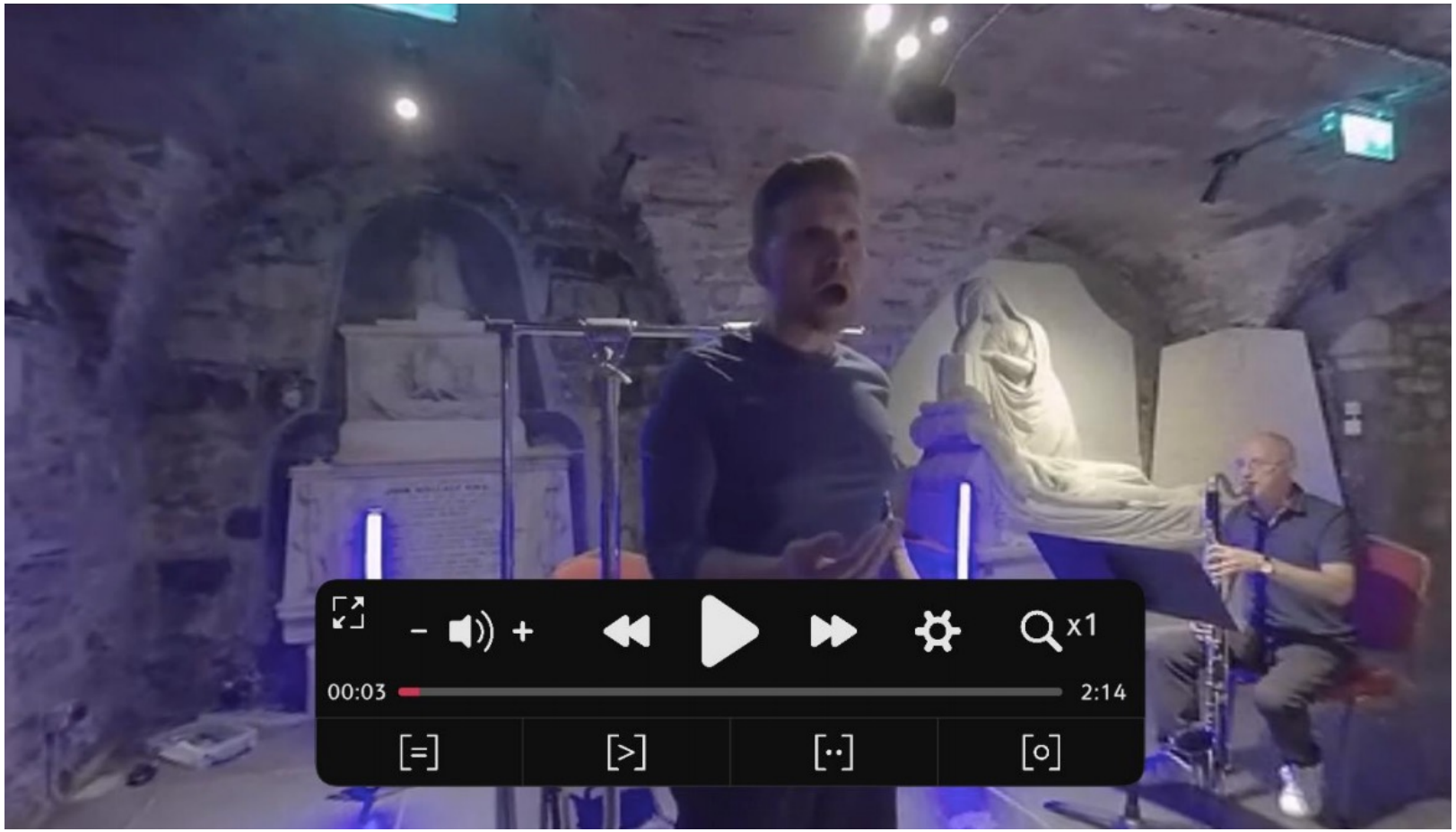
TRACTION Toolset – Immersive Media

- It includes both the **authoring** tools (for creating) and the **rendering** engines (for deploying) immersive and interactive experiences in the form of capsules for **novel** Opera productions
- This environment will enable **static** (dome-based) and **moveable** (VR headset-based) installations, pushing the boundaries of immersive media consumption
- It will as well enable **browser-based** remote experiences.

TRACTION Toolset – Immersive Media



TRACTION Toolset – DCU Contributions

Immersive Media:

- 360° videos DASH adaptation
- Ambisonics/Immersive Audio
- Multisensorial Media

Co-Creation Space:

- Face recognition for auto tagging

Co-Creation Stage:

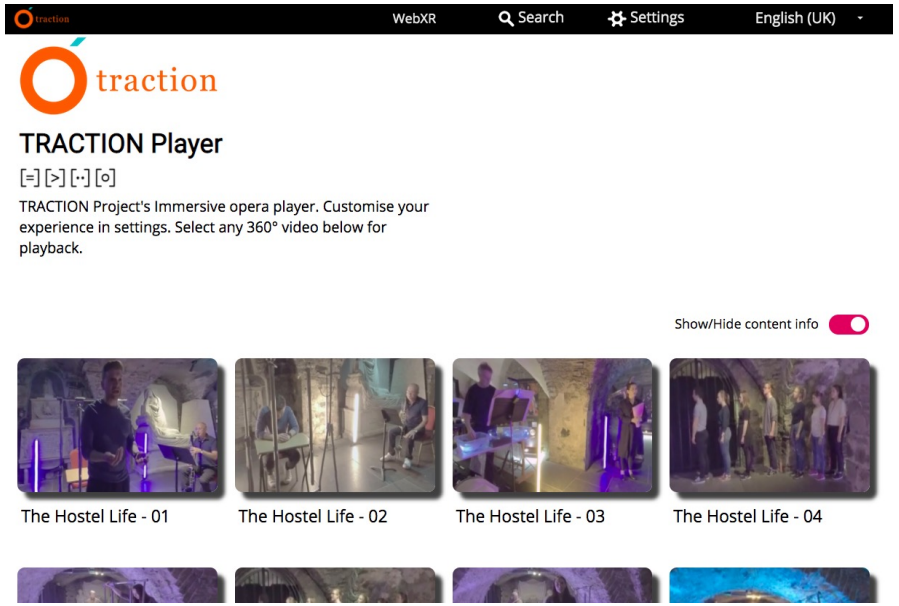
- Live Content Adaptation
- Pre-Recorded Content Adaptation

Immersive Player

- The immersive player is viewed on web browsers (mobile, desktop and VR head
- Offers ambisonics in any stereo device and headphones.

Immersive Player

- Player supports manual Subtitles, Sign Language, Audio Description and Audio Subtitles (when tracks/files are available).
- Accessible features to support opera, with lyrics and subtitling.
- Player now supports questionnaires at the end of videos for feedback.
- Main proposed use: **dissemination of content to a wider audience.**



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Immersive Player - Phase 1 Tests

- **24 remote participants** (15 males and 9 females) from Spain, Ireland, United Kingdom, India and China.
- Participants **used their preferred device** (i.e., smartphone, laptop, desktop, VR headset)
- Participants were exposed to **6 clips (2-4 mins) with diverse combinations of 3 audio and 3 video quality levels**
- The **multimedia sequences** (opera plays) were from:

"This Hostel Life" (Irish National Opera) and **"Romeo and Juliet" (Gran Teatre del Liceu Barcelona)**

- Participants answered **questions about the perceptual experience** of video and audio quality after each clip.
- Finally, participants filled a **usability questionnaire** about the player and the experience as a whole.
- The duration of the study was about 36 minutes.

Immersive Player - Phase 1 Tests

User Groups	Romeo and Juliet - Perceptual Audio Tests			The Hostel Life - Perceptual Video Tests		
	2m50s; 2m49s; 2m48s (all 3840x2160)			Low: 1024x512 - 4m03s; Medium: 2048x1024 - 3m12s; High: 3840x1920 - 1m40s		
	Video 1	**Video 2**	**Video 3**	**Video 4**	**Video 5**	**Video 6**
Group A	Ambisonics	Mono	Stereo	High	Medium	Low
Group B	Mono	Stereo	Ambisonics	Medium	High	Low

User Groups	The Hostel Life - Perceptual Video Tests			Romeo and Juliet - Perceptual Audio Tests		
	Low: 1024x512 - 4m03s; Medium: 2048x1024 - 3m12s; High: 3840x1920 - 1m40s			2m50s; 2m49s; 2m48s (all 3840x2160)		
	Video 1	**Video 2**	**Video 3**	**Video 4**	**Video 5**	**Video 6**
Group C	Low	Medium	High	Stereo	Ambisonics	Mono
Group D	High	Low	Medium	Ambisonics	Stereo	Mono

	Mono	Stereo	Ambisonics
Channels	1 channel	2 channels	4 channels
Sample Rate	48kHz	48kHz	48kHz
Bitrate	90kbps	90kbps	256kbps
Codec	AAC	AAC	AAC

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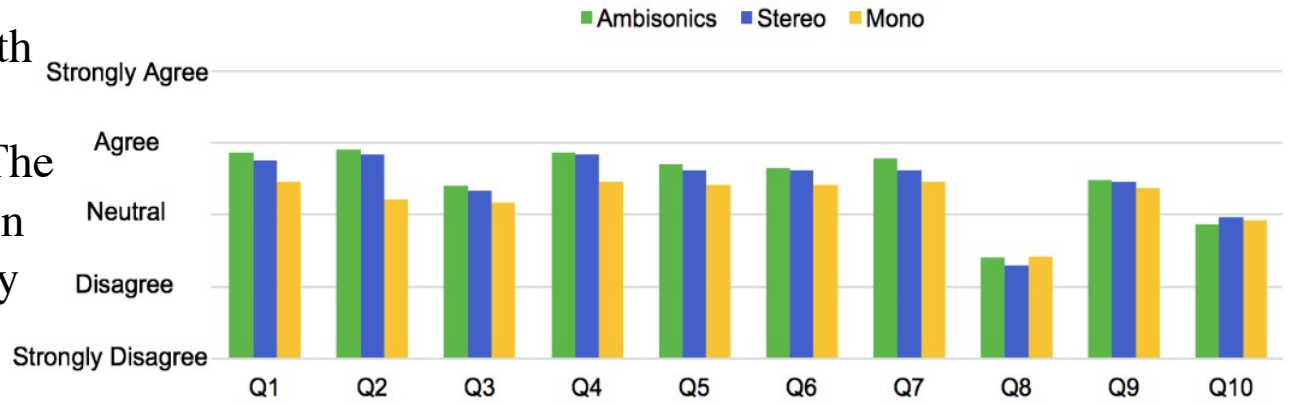
Immersive Player - Phase 1 Tests



More participants agreed or strongly agreed that the clip with ambisonic audio improved the immersiveness of the experience (Q1), especially in comparison to mono audio. The audio quality was perceived as good (Q2) more frequently in stereo and ambisonics modes. Even though the video quality was the same across the 3 clips, more participants felt the video quality was good (Q3) when ambisonics and stereo were used (i.e. 14 participants answered agree or strongly agree for ambisonics while 9 participants answered the same for mono audio). Ambisonics and stereo audio also received more positive answers than mono when participants were asked if they enjoyed the experience presented (Q4), if the immersive experience helped assimilating the performance (Q5), if the immersive experience helped engaging with opera (Q6), and if it was enjoyable to watch the opera piece as an immersive experience (Q7). In all three scenarios, participants found that the 360°/VR effects were not disturbing during the videos (Q8). The perception of the colours of the footage being clear/vivid (Q9) did not seem to be affected by audio quality. Finally, participants were more neutral regarding the immersive experience being comparable to a live opera (Q10).

The answers to the questionnaires provided to participants indicated that higher quality audio and ambisonics positively affects the perception of the 360° experience.

Immersive Player - Phase 2 Tests

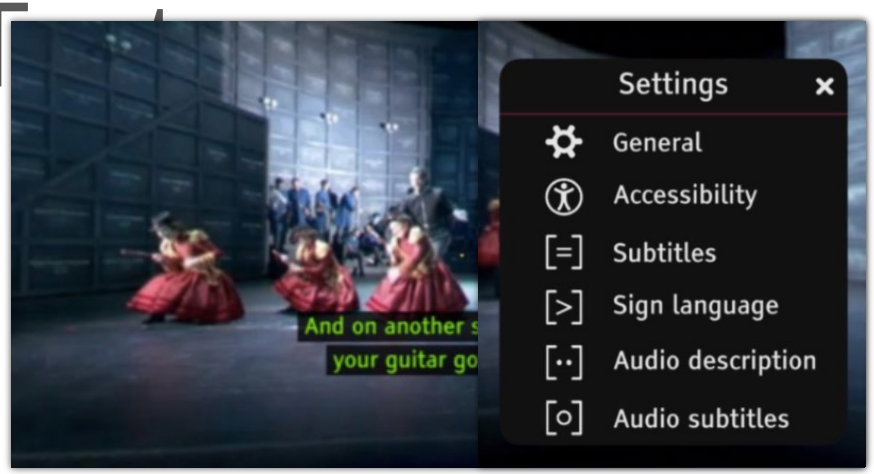
- Assesses the DASH-based adaptive algorithm for 360° degree video, prioritizing audio, for opera dissemination.
- Metrics including network bandwidth and quality switching are used in the adaptation while prioritizing the audio content.
- This test took place in the Performance Engineering Laboratory of Dublin City University, with **24 participants**, 19 males and 5 females, from various nationalities.
- Each participant viewed **4 different 360-degree videos**, encoded in high video resolutions with ambisonic audio.
- In this experiment, each video was played with a different DASH-based adaptive algorithm: the baseline algorithms **BOLA, DYNAMIC and THROUGHPUT**, and the novel algorithm **360-ADAPT**, developed during TRACTION.
- Participants were divided in 4 groups, so the 4 videos were seen in different order and with different adaptation algorithms.

Immersive Player - Phase 2 Tests

Video Title	Group A		Group B		Group C		Group D	
	Order	Algorithm	Order	Algorithm	Order	Algorithm	Order	Algorithm
Che Faro Senza Euridice	1st video	BOLA	1st video	360-ADAPT	4th video	DYNAMIC	2nd video	THROUGHPUT
This Hostel Life 1	2nd video	360-ADAPT	2nd video	BOLA	1st video	THROUGHPUT	1st video	DYNAMIC
This Hostel Life 2	3rd video	THROUGHPUT	3rd video	DYNAMIC	2nd video	BOLA	3rd video	360-ADAPT
Romeo and Juliet	4th video	DYNAMIC	4th video	THROUGHPUT	3rd video	360-ADAPT	4th video	BOLA

Immersive Player - Phase 2 T

Fig. 1: The 360-degree videos used in the adaptation experiment.



Please, rate the audio quality *

	1	2	3	4	5	
Worst	○	○	○	○	○	Best

Please, rate the video quality *

	1	2	3	4	5	
Worst	○	○	○	○	○	Best

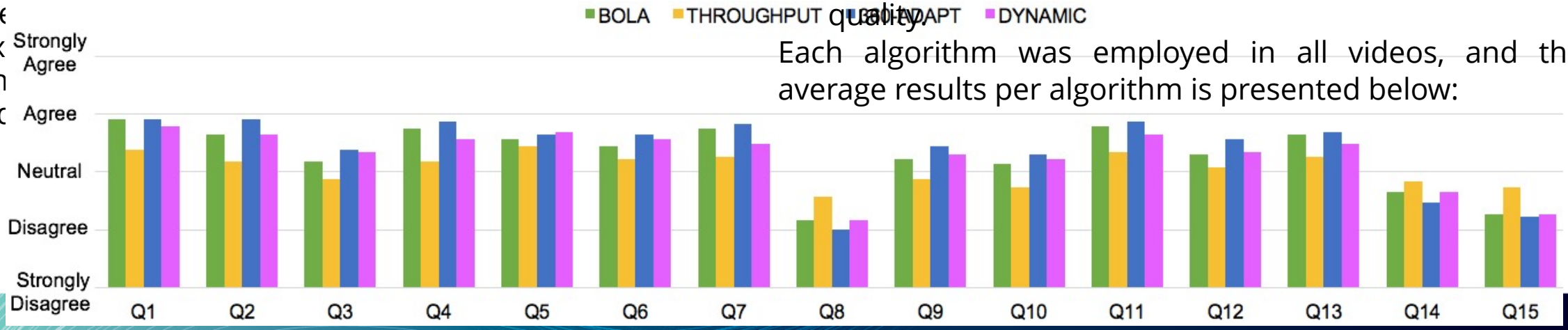
Fig. 2: Assessment form used in Phase 2 tests

Immersive Player - Phase 2 Tests

For each video, users answered 15 questions:

1. The audio improved the immersiveness of the experience.
2. The audio quality was good.
3. The video quality was good.
4. I enjoyed the experience presented.
5. The immersive experience helped me to better assimilate the performance.
6. The immersive experience helped me to be more engaged in opera.
7. I e
ex
8. Th
vic
9. The colors of the footage are clear/vivid.
10. I believe that the immersive experience is comparable to a live opera.
11. Please, rate the feature: audio quality
12. Please, rate the feature: video quality
13. Please, rate the feature: immersiveness
14. My enjoyment was negatively affected by the video quality.
15. My enjoyment was negatively affected by the audio quality.

Each algorithm was employed in all videos, and the average results per algorithm is presented below:



The proposed 360-ADAPT algorithm outperformed the other algorithms, due to its ability to control bitrates and play higher quality audio, while minimising video stalls and quality switches. This was also verified by the collected logs at the server side.

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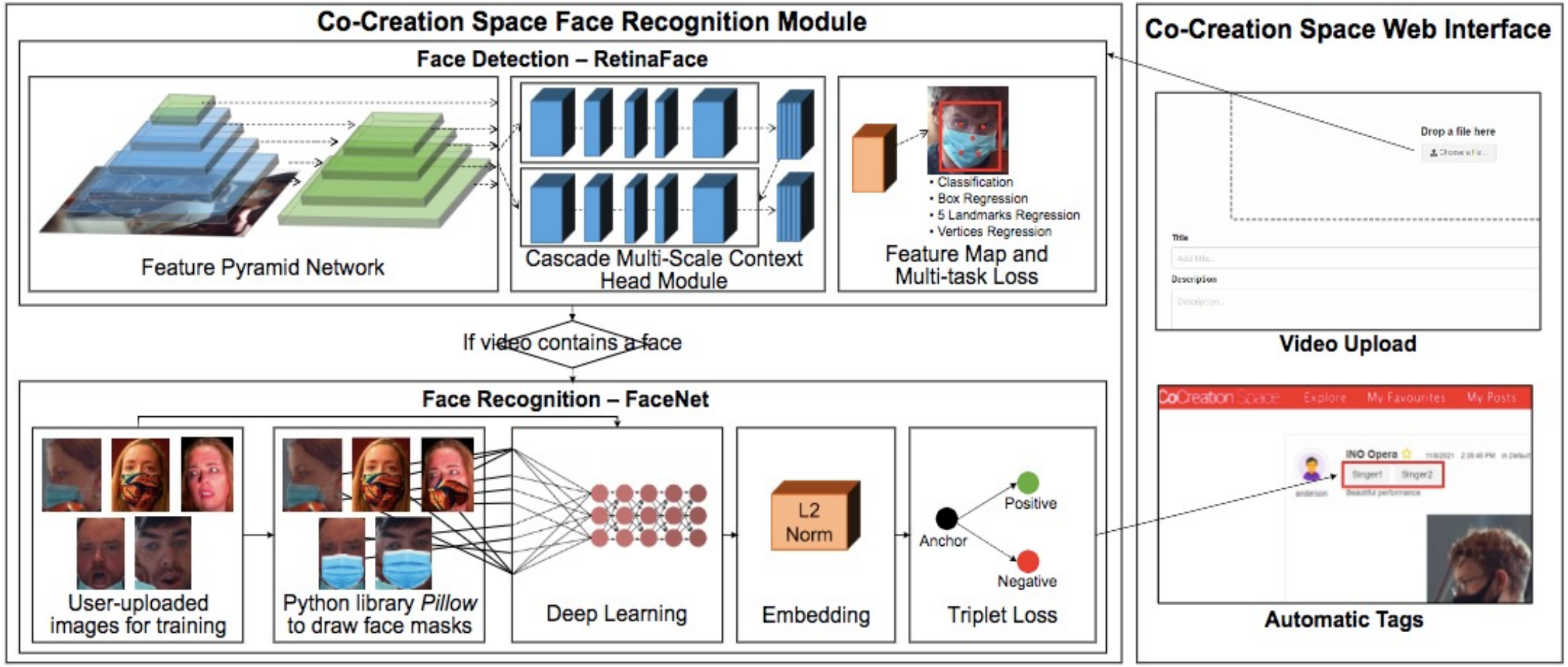
Immersive Player - DEMO

https://b8b4-136-206-26-104.ngrok.io/ImmersiveAdaptivePlayer/

Face and Object Recognition for Co Creation Space



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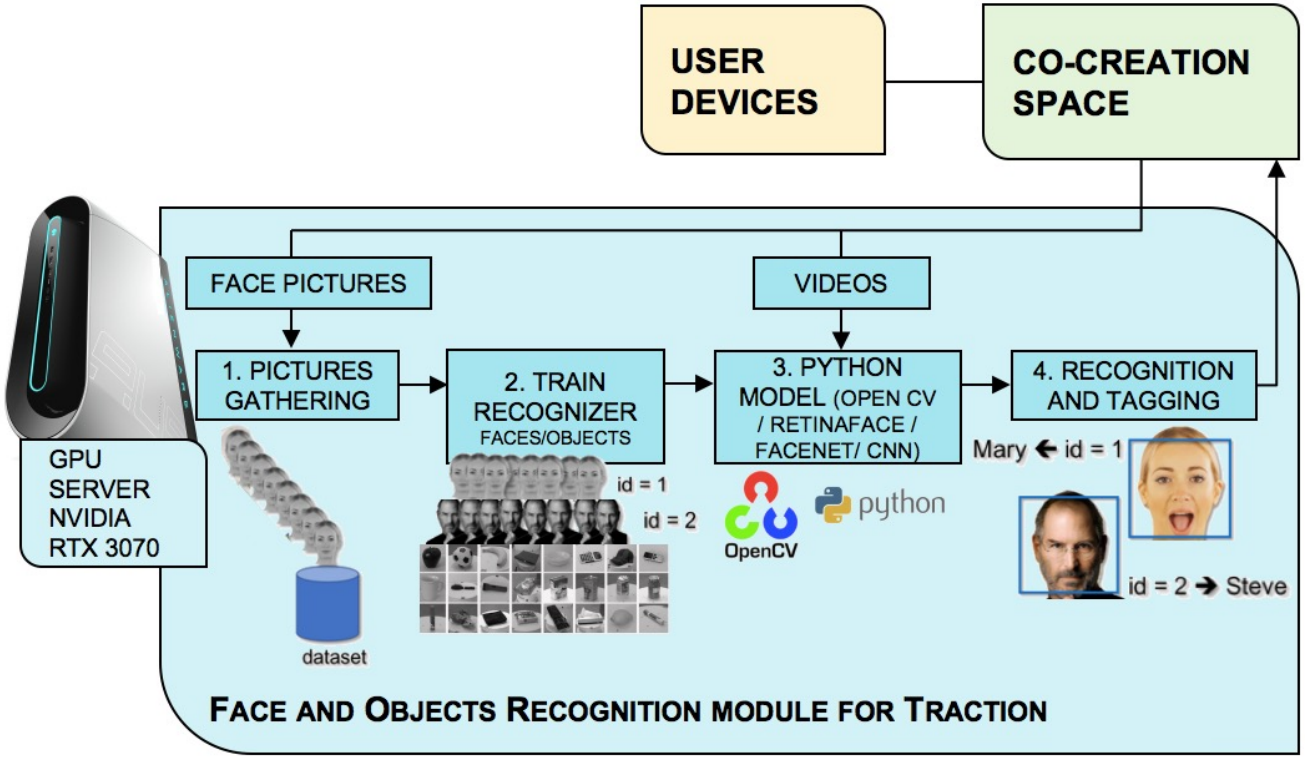
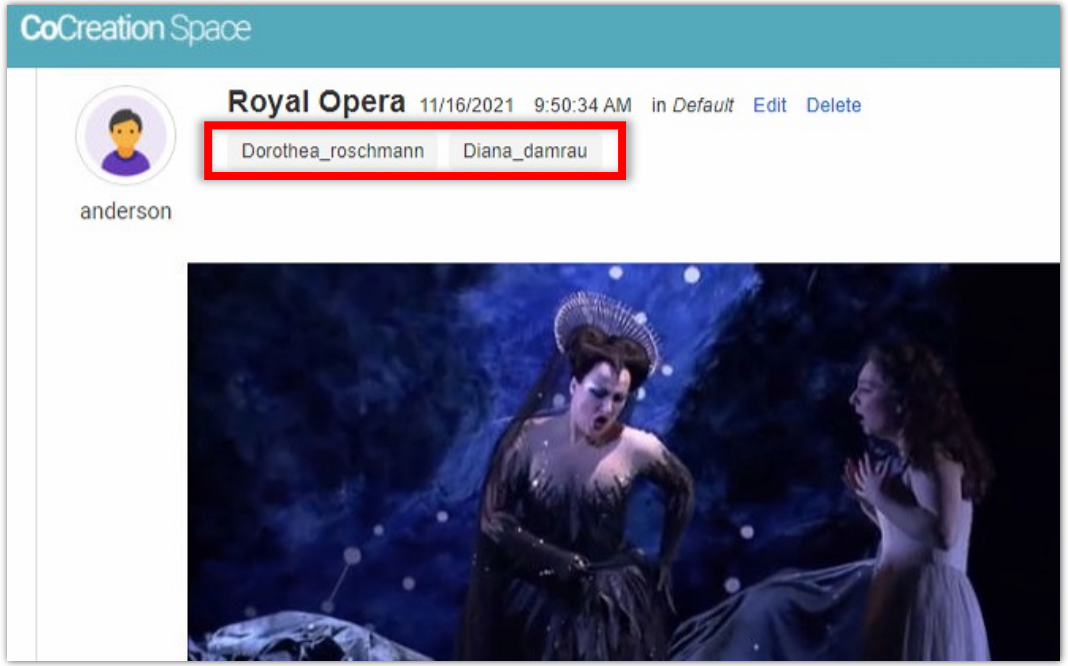
Face and Object Recognition for Co Creation Space



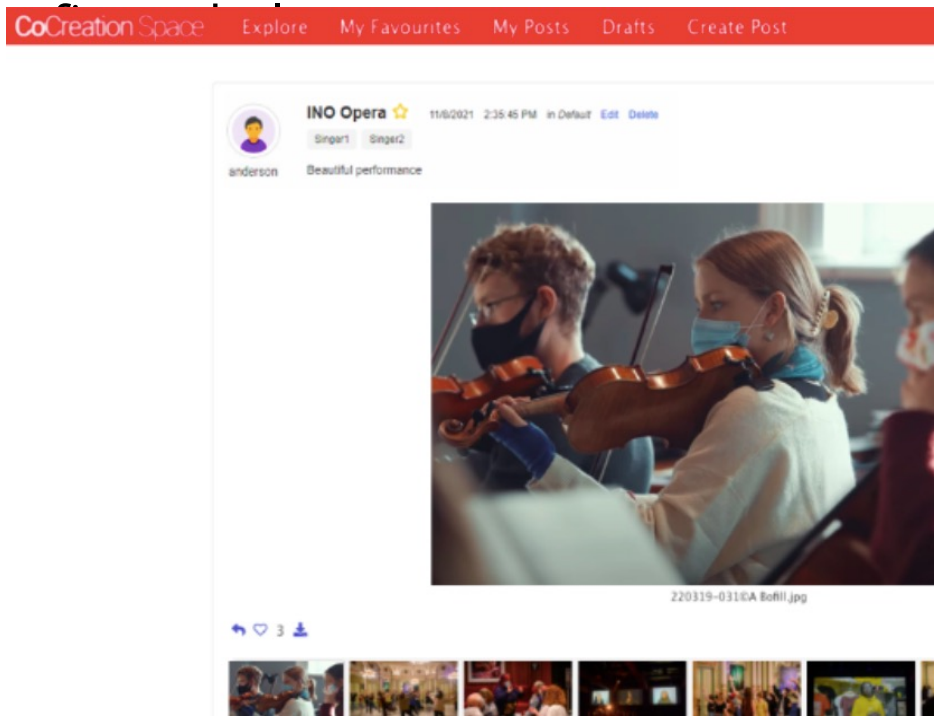


When testing the face recognition feature of the module on the public dataset LFW[1], the achieved recognition accuracy is approximately 99%.

[1]http://vis-www.cs.umass.edu/lfw/

Face and Object Recognition for Co Creation Space

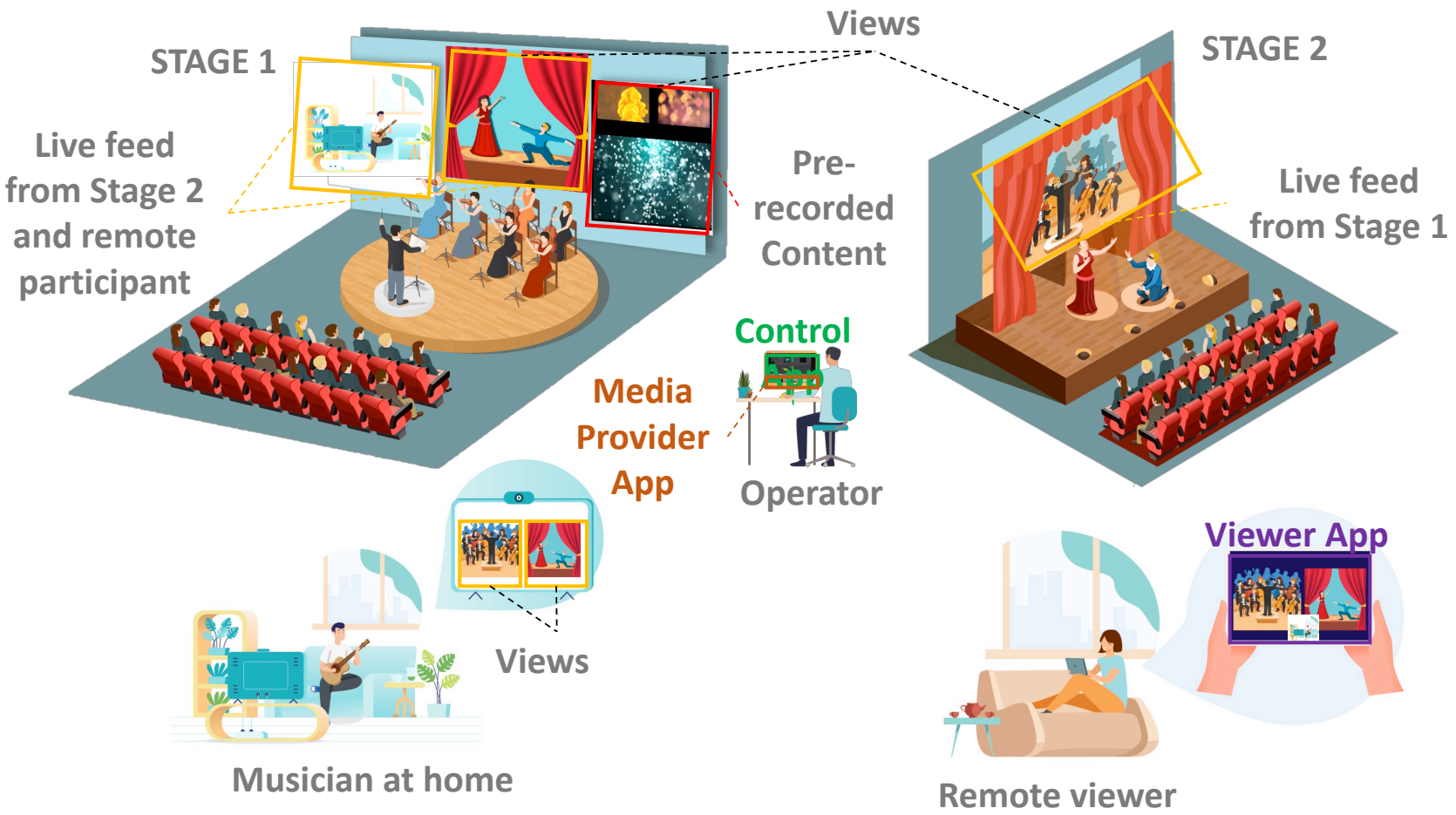
- As TRACTION had many workshops and much content was developed during the COVID pandemic, a number of videos and images contain participants wearing masks, as seen in the



- An additional test was performed with the recognition module to demonstrate the accuracy in footage containing face masks.
- As shown below, a technique used for training the module to recognize participants wearing masks is to draw the mask on

The accuracy of face recognition for footage containing face masks is approximately 78%.

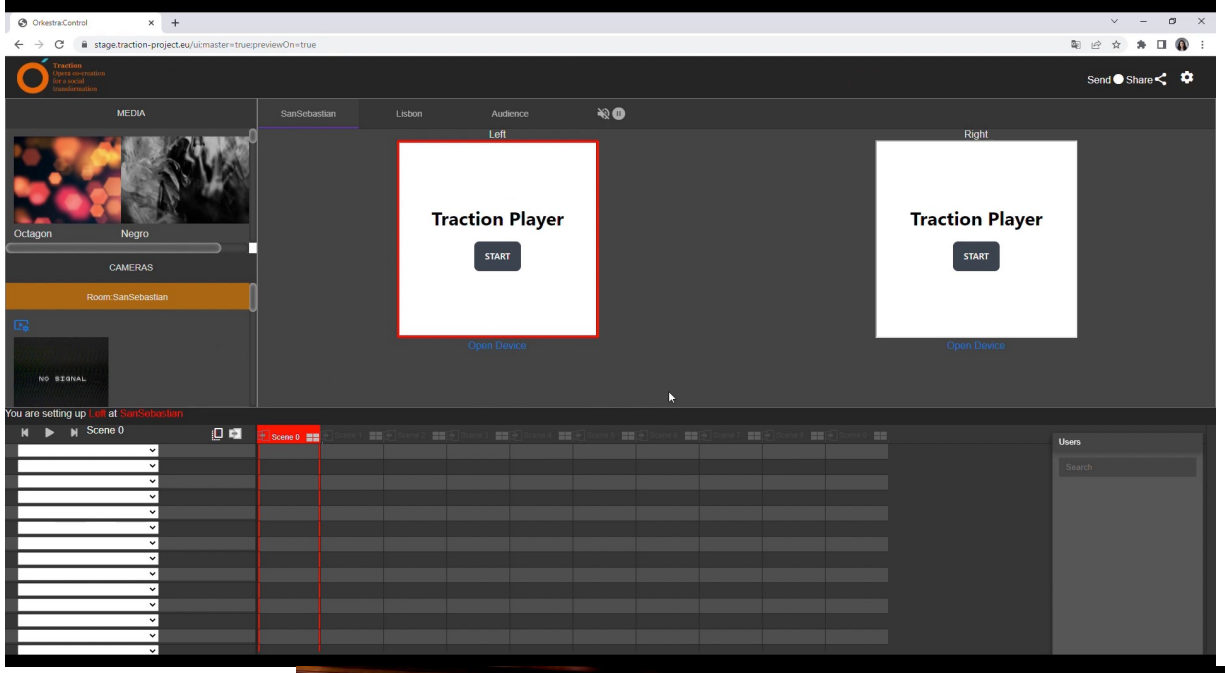
TRACTION Co-Creation Stage (CCS)

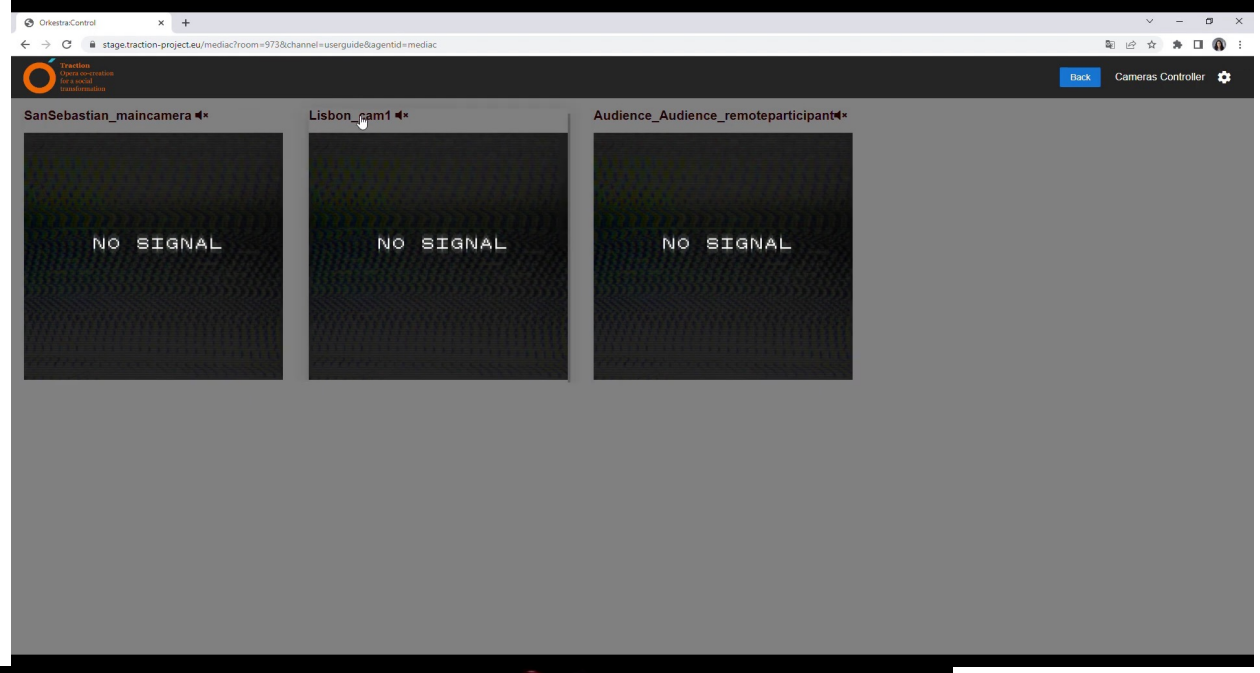


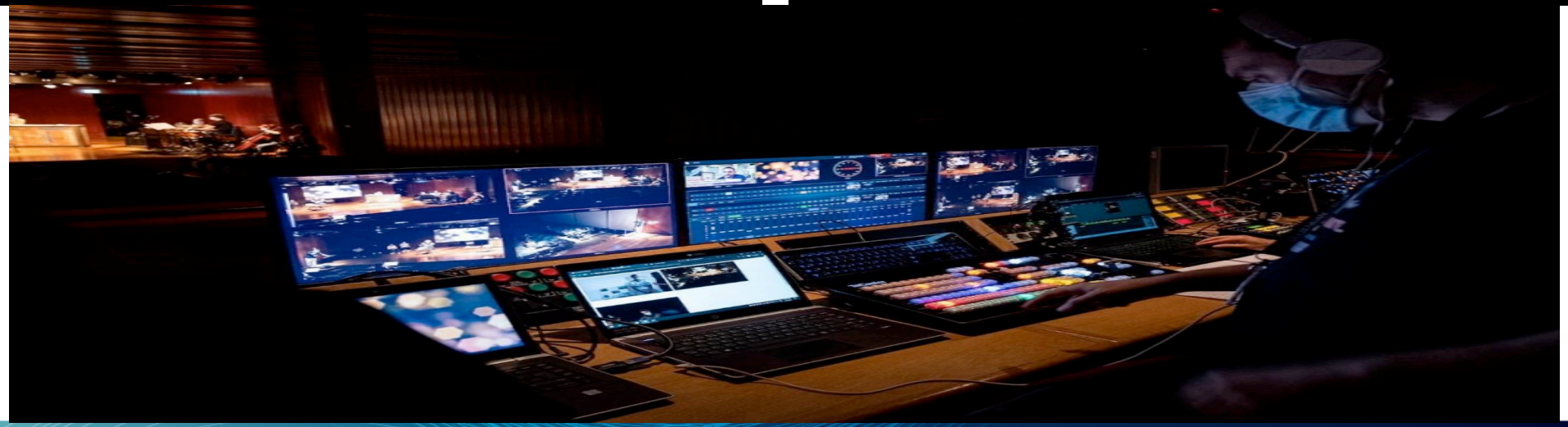
Control: provides the GUI for the creation of shows

Media Provider: offers the functionalities to integrate audio and video streams

Viewer: used to visualise the content on different devices







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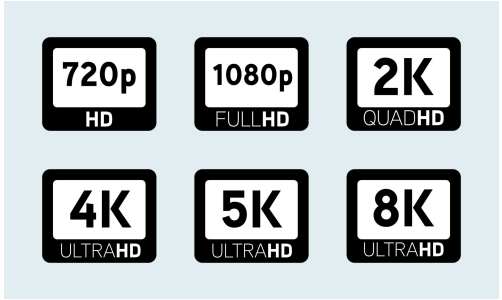
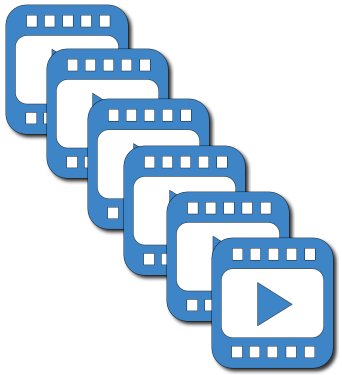
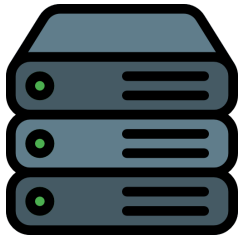
MPEG-DASH



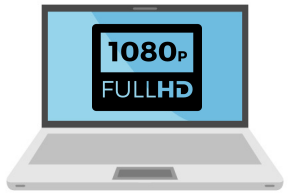
Video



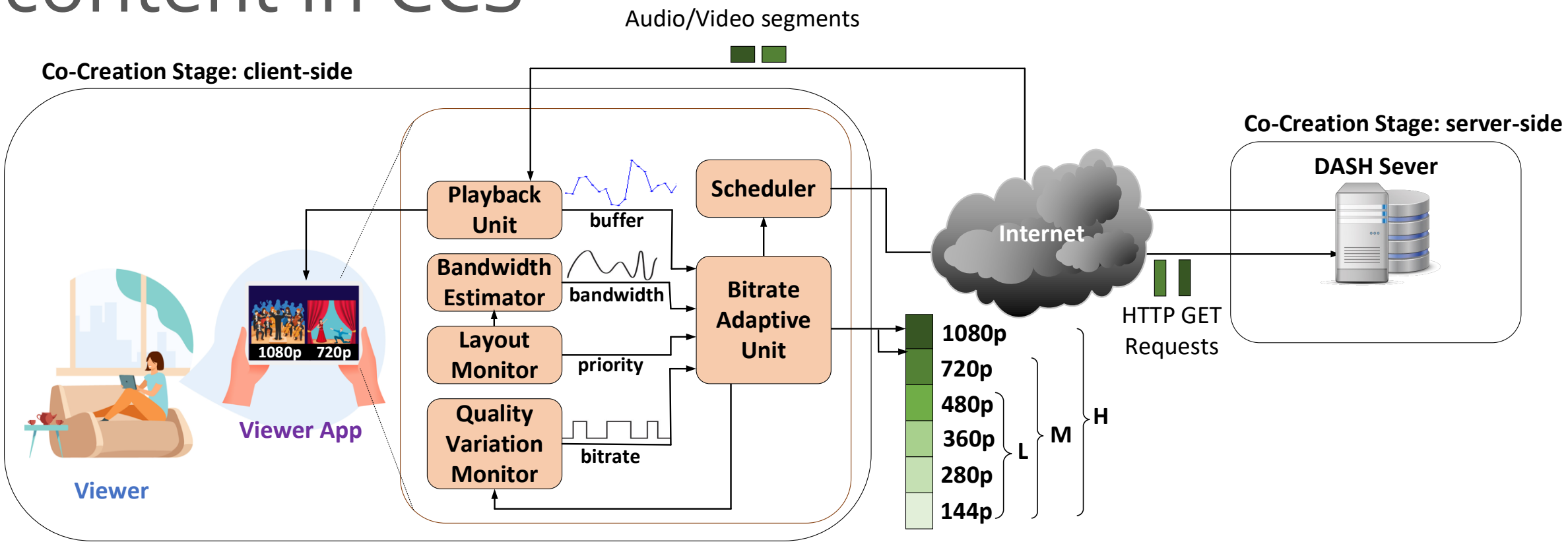
Segments



DASH server

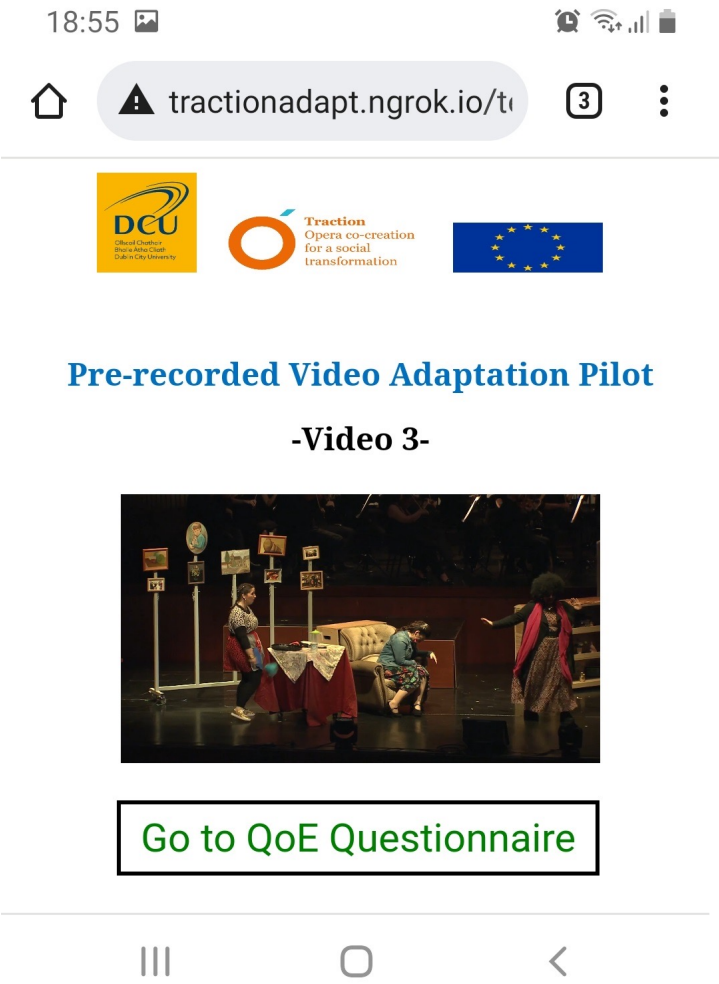


PADA: Efficient delivery of pre-recorded content in CCS

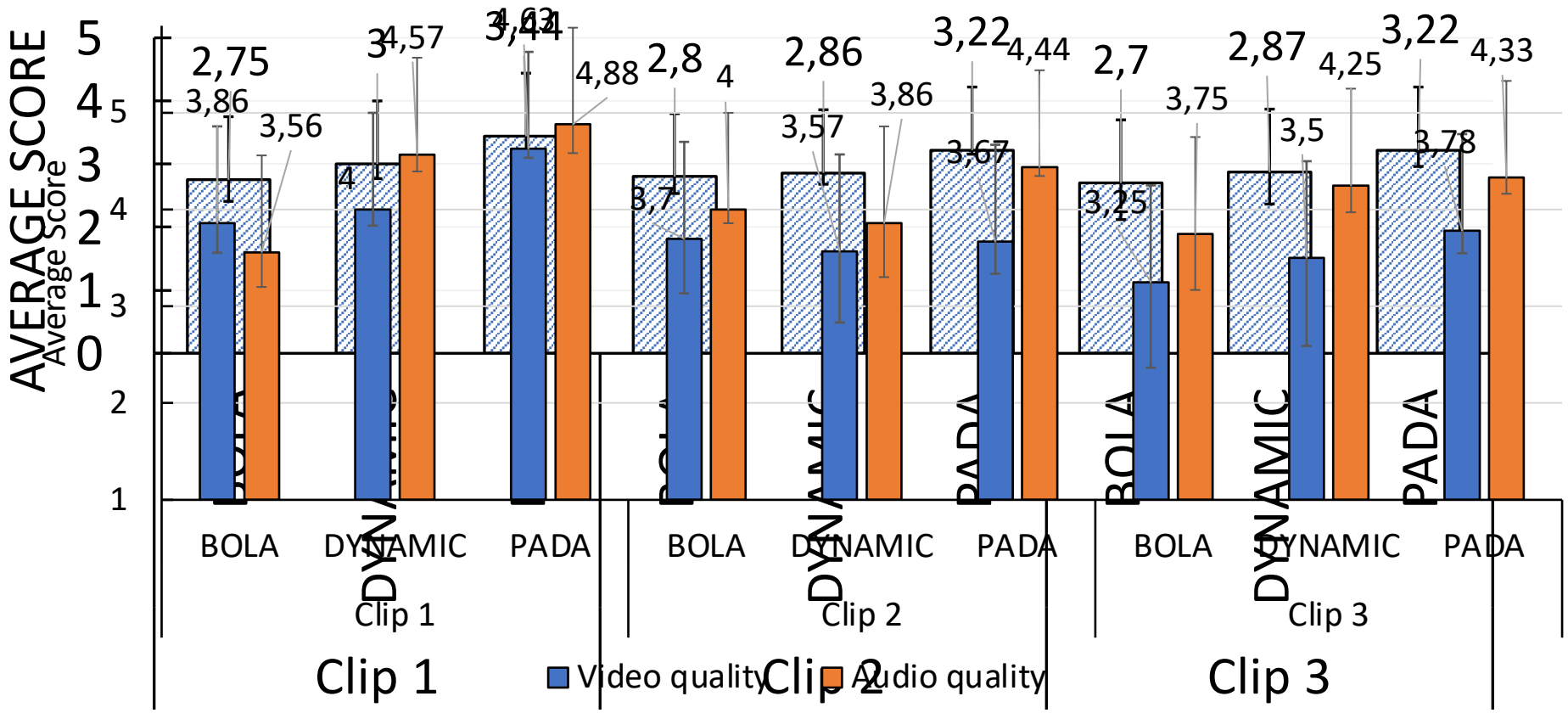


Experimental Testing

- 33 participants, aged 20 to 70, from 11 countries
- They streamed 3 opera clips encoded in 5 video and 3 audio qualities
- Viewers assessed video and audio qualities and level of enjoyment



Experimental Testing



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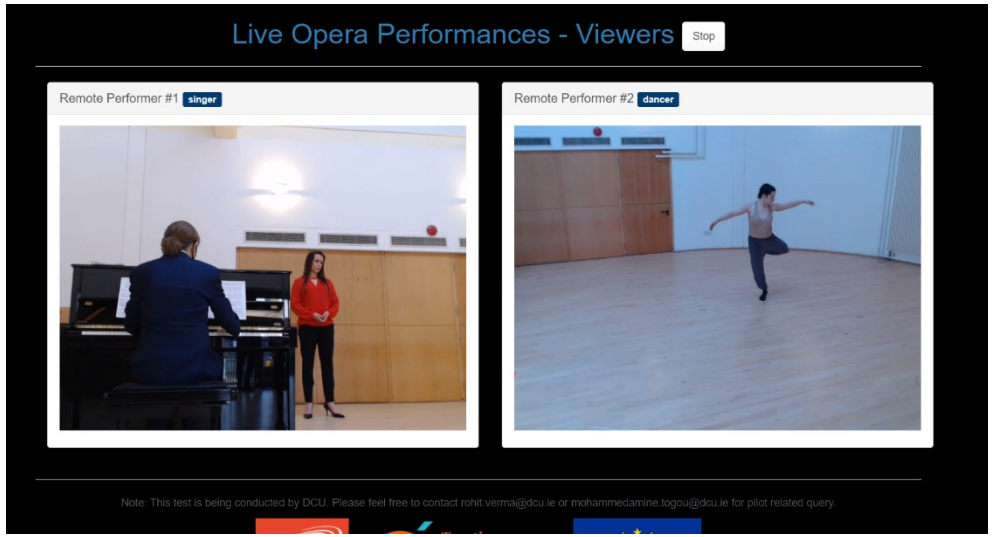
Live Stream Adaptation Solution (LSAO)

- Adaptive algorithm for WebRTC
  - Considers bandwidth and buffer level
- Experiment: 41 participants aged between 20 and 70 from 11 countries.
  - 4 performances: 2 with LSAO and 2 without
  - Participants enjoyed higher video and audio qualities with LSAO
  - Participants also rated their enjoyment higher with LSAO
- Next step: assess LSAO's performance in the presence of pre-recorded content



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Thank you for your attention

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