Deliverable

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Grant Agreement number:	688619
Project Title:	*Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices.*

D5.3 - Documentation and technical fact sheets

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Authors:

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Dissemination Level		
P	Public	x
C	Confidential, only for members of the consortium and the Commission Services	

Abstract: This deliverable is a compilation of all printable documentation, mostly used for dissemination and communication purposes. In this first release, there is all content created in the first quarter: a poster and a extended presentation. Both material were used at NEM Summit (Brussels, March 2016).

REVISION HISTORY

Revision	Date	Author	Organisation	Description
0.1	23/03/2016	P.Pamplona	i2CAT	First release
0.2	16/06/2016	S.Fernández	i2CAT	Review and comments
0.3	20/06/2016	P.Pamplona	i2CAT	Improved version
0.4	18/11/2016	P.Pamplona	i2CAT	Updated version (second iteration)
0.5	30/11/2016	S. Delaere	iMinds	Review

Disclaimer

The information, documentation and figures available in this deliverable, is written by the **ImmersiaTV** (*Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices*) – project consortium under EC grant agreement H2020 - ICT15 688619 and does not necessarily reflect the views of the European Commission. The European Commission is not liable for any use that may be made of the information contained herein.

Statement of originality:

This document contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

EXECUTIVE SUMMARY

This document is a compilation of dissemination material (including technical information). In this second release, the original provided documentation (2 Project abstracts, a poster and a presentation) is supplemented by a set of leaflets. One of these leaflets describes the project in general, while the other three prove information on underlying technical components of the ImmersiaTV end-to-end production chain, i.e. production, distribution and display. The leaflets, which were prepared by a task force of the consortium ahead of its presence at IBC 2016 in Amsterdam (where the three mentioned components were shown implemented), have been designed by VRT (following a template set up by the task force) in such a way that additional components can be added later, to form a comprehensive ImmersiaTV technical "brochure".

The rest of the material was already part of the first instantiation of this document. Firstly, the project abstracts are normally created at the beginning of the project and used to provided basic information. In this case, a second (extended) version was also written to dig deeper in the technical details of ImmersiaTV.

Secondly, since ImmersiaTV was present at NEM summit and the mini-cluster meeting in Brussels (15-16th of March 2016), it was necessary to make 2 presentations and more informal f2f presentations in a multi-project showroom with posters and quick presentations. Thus, the consortium collaborated to prepare a A0 poster and a presentation. VRT took the leadership with their team of creatives creating the poster, i2CAT providing content and iterating the final look of the poster. The poster was complemented with a few individual cards to illustrate the architecture, and other complementary information.

Thirdly, a presentation was created by i2CAT, mainly introducing the project and its objectives, through a first analysis of the current market status, followed by the project objectives and finally an explanation on how it is expected to meet the them.

All material is accessible and downloadable through the project website: www.immersiatv.eu/dissemination-materials/

A further update of this document will be released in M20.

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CONTENTS

Revision History 1
Executive Summary 2
Contributors 3
1. Introduction 5
2. Project documentation 6
2.1. List of material 6
3. ImmersiaTV_abstract (v3) 8
4. General. Extended Abstract (v2) 9
5. Cluster meeting presentation 10
6. Cluster meeting Poster 11
7. General project leaflet 12
8. Production tools leaflet 13
9. Distribution technologies leaflet 14
10. Display technologies leaflet 15

1. INTRODUCTION

This document is a compilation of dissemination material (including technical information). The document is mainly structured in two parts. A first part lists all the documents produced during the first year of project. The list provides also a brief description of the document, with the latest release date and its author.

The second part of the doc provides the documents itself, from presentations, to posters, and other “printable” material related with ImmersiatTV.

The document will be released in three instantiations (in M04, M10, M20), each one updating it with the new content.

2. PROJECT DOCUMENTATION

2.1. List of material

Name	Description	Release date	Author
ImmersiaTV_abstract (v3)	Short document introducing the project and its objectives.	25/02/2016	i2CAT
General. Extended Abstract (v2)	This version of the abstract follows the same approach as the previous release, but much more detailed and with additional content.	20/12/2015	i2CAT
Cluster_meeting (bxl, 16 March 2016)_Final	This presentation was used to introduce ImmersiaTV during the Cluster meeting (organised by the EU) in Brussels, and the NEM Summit.	15/03/2016	i2CAT
ImmersiaTVPoster_01_260216LR	Poster introducing the project objectives and how to achieve them. This poster was also used during the Cluster meeting and NEM Summit in March 2016.	29/02/2016	VRT (support i2CAT)
ImmersiaTv_Leaflet_General_LQ	Leaflet providing a general overview of the project.	22/09/2016	VRT supported by all partners
ImmersiaTv_Leaflet_production_LQ	Leaflet providing deeper insights on current production tools.	22/09/2016	VRT supported by all partners
ImmersiaTv_Leaflet_distribution_LQ	Leaflet providing deeper insights on current distribution methods and technologies used for pilot 1.	22/09/2016	VRT supported by all partners

ImmersiaTv_Leaflet_display_LQ	Leaflet providing deeper insights on display developments for pilot 1.	22/09/2016	VRT supported by all partners

3. IMMERSIATV_ABSTRACT (V3)

ImmersiaTV

Grant Number 688619
Period 1/2016-6/2018
Budget 3.8M€
Funding organism: H2020 (EC)

Abstract

ImmersiaTV will create a novel form of broadcast omnidirectional video content production and delivery that offers end-users a coherent audiovisual experience across head mounted displays, second screens and the traditional TV set, instead of having their attention divided across them. This novel kind of content will seamlessly integrate with and further augment traditional TV and second display consumer habits. ImmersiaTV will assemble an end-to-end toolset covering the entire audiovisual value chain: immersive production tools, support for omnidirectional cameras, including ultra-high definition and high dynamic range images, and adaptive content coding and delivery, and demonstrate it through 3 pilot demonstrations addressing both on-demand and live content delivery

Figure 1: on top, Detail of the HMD view with an illustration of the portal approach. Bottom, . Illustration of the home set environment, with synchronized access across devices

Why ImmersiaTV?

The majority of European TV consumers now watch TV programs in a multi-display environment. Second screens -mostly smartphones, tablets or laptops- are generally used to check information not directly related to the events in the TV content being watched. As a result, the attention of the audience is generally divided between these different streams of information. Broadcasters have tried to orchestrate all these different rendering platforms to complement each other consistently. However, their success is limited, and this limited success is due, at least in part, to the very different formats in which information is delivered (web-based texts, mobile apps, traditional broadcast television…)

In this context, the arrival of immersive head-mounted displays to the consumer market introduces new possibilities, but also poses new challenges. Immersive displays impose radically different audience requirements compared to traditional broadcast TV and social media. They require a constant, frequently refreshed, omnidirectional audiovisual stream that integrates sensorimotor information. This means that, at minimum, the visual perspective rendered changes consistently with changes in head position and rotation. In addition, immersive displays challenge the conventions of traditional audiovisual language. For example, cuts between shots, which constitute the very basic fabric of traditional cinematic language, do not work well in immersive displays. From a user perspective, omnidirectional TV offers a new user experience and a different way of engaging with the audiovisual content.

This project will create new forms of digital storytelling and broadcast production that, by putting omnidirectional video at the center of the creation, production and distribution of broadcast content, delivers an all-encompassing experience that integrates the specificities of immersive displays, and the feeling of "being there", within the contemporary living room. We propose a new form of broadcast omnidirectional video that offers end-users a coherent audiovisual experience across head mounted displays, second screens and the traditional TV set, instead of having their attention divided across them. This new experience will seamlessly integrate with and further augment traditional TV and second screen consumer habits. In other terms: the audience will still be able to watch TV sitting on their couch, or tweet comments about it. However, by putting omnidirectional content at the center of the creation, production and distribution processes, the audience will also be able to use immersive displays to feel like being inside the audiovisual stream.

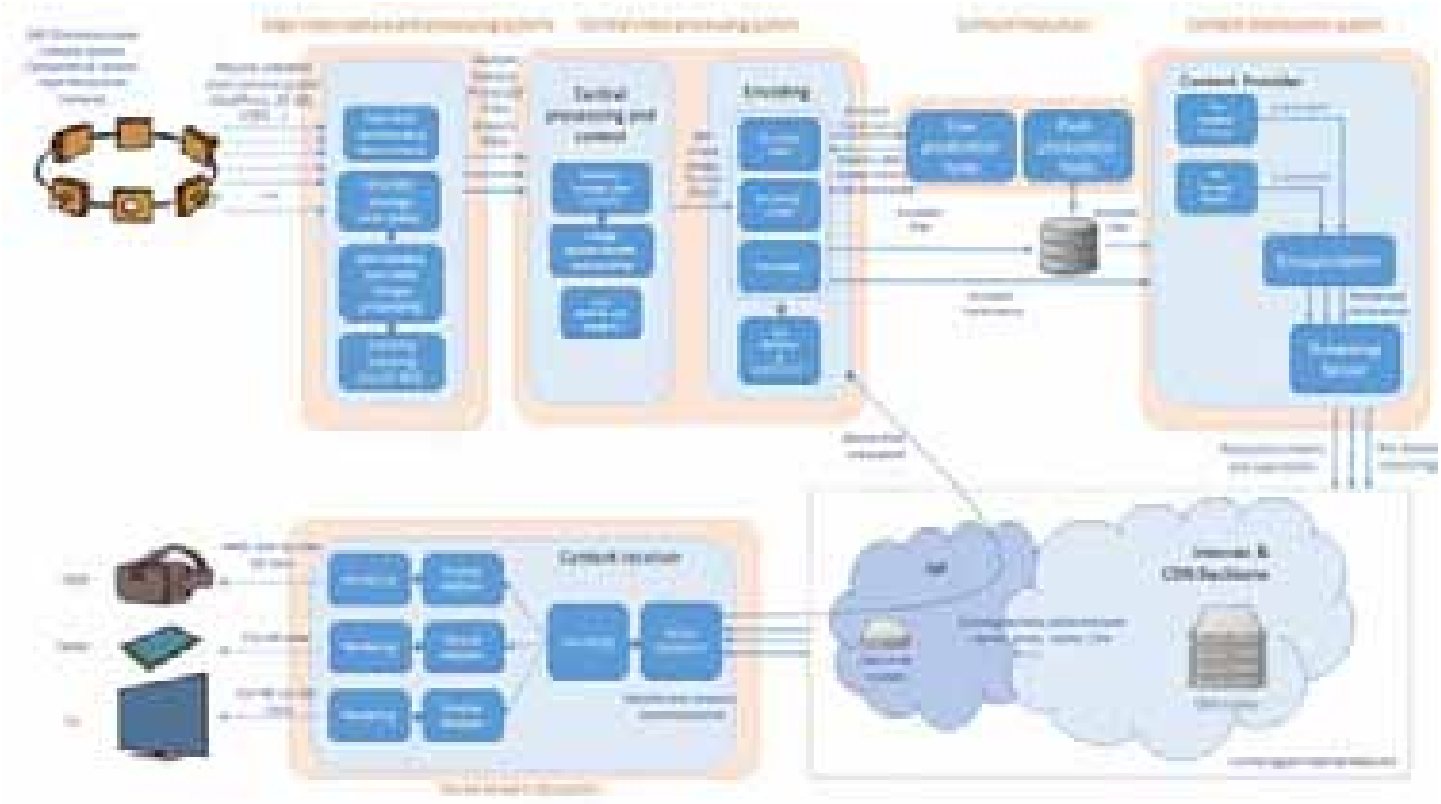

Figure 2. The ImmersiaTV Immersive Broadcast Platform.

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Team

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Tooling Companies	Research Institutes	Production Companies
IP-Based production pipeline Omnidirectional production tools	Stitching Innovative Codecs User Evaluation	Omnidirectional video production Broadcasting

Demonstration pilots to test an end-to-end system

ImmersiaTV will pilot an innovative **end-to-end system** covering the entire audiovisual value chain to enable a novel form of creative audiovisual storytelling based on omnidirectional video. The project will encompass immersive production tools, support for omnidirectional cameras, adaptive content coding and distribution mechanisms, and immersive (HMD) & second screen visualisation. ImmersiaTV will demonstrate the use of its end-to-end system in real production and distribution scenarios via 3 pilots addressing the production of documentaries and live sports event.

Specific Objectives

To demonstrate the feasibility of this novel approach for the creation, production, broadcast and display of omnidirectional video, ImmersiaTV has the following objectives:

- **OBJ1. Create a new cinematographic language** where the specificities of immersive displays are taken into account, and which conciliates immersive paradigms with traditional storytelling techniques.
- **OBJ2. Extend the production pipeline** to create omnidirectional content for a multi-platform environment.
- **OBJ3. Re-design the distribution chain** to address the specific technical challenges that omnidirectional content imposes in terms of capture, compression, distribution, reception, and rendering.
- **OBJ4. Maximize the quality of the end-user experience**, across devices, and within the technical limitations of existing production structures, distribution facilities and reception devices to create an optimal immersive experience.
- **OBJ5. Maximize the impact of the ImmersiaTV solutions** within the ecosystem of content creators, broadcasters, and consumers.

4. GENERAL. EXTENDED ABSTRACT (V2)

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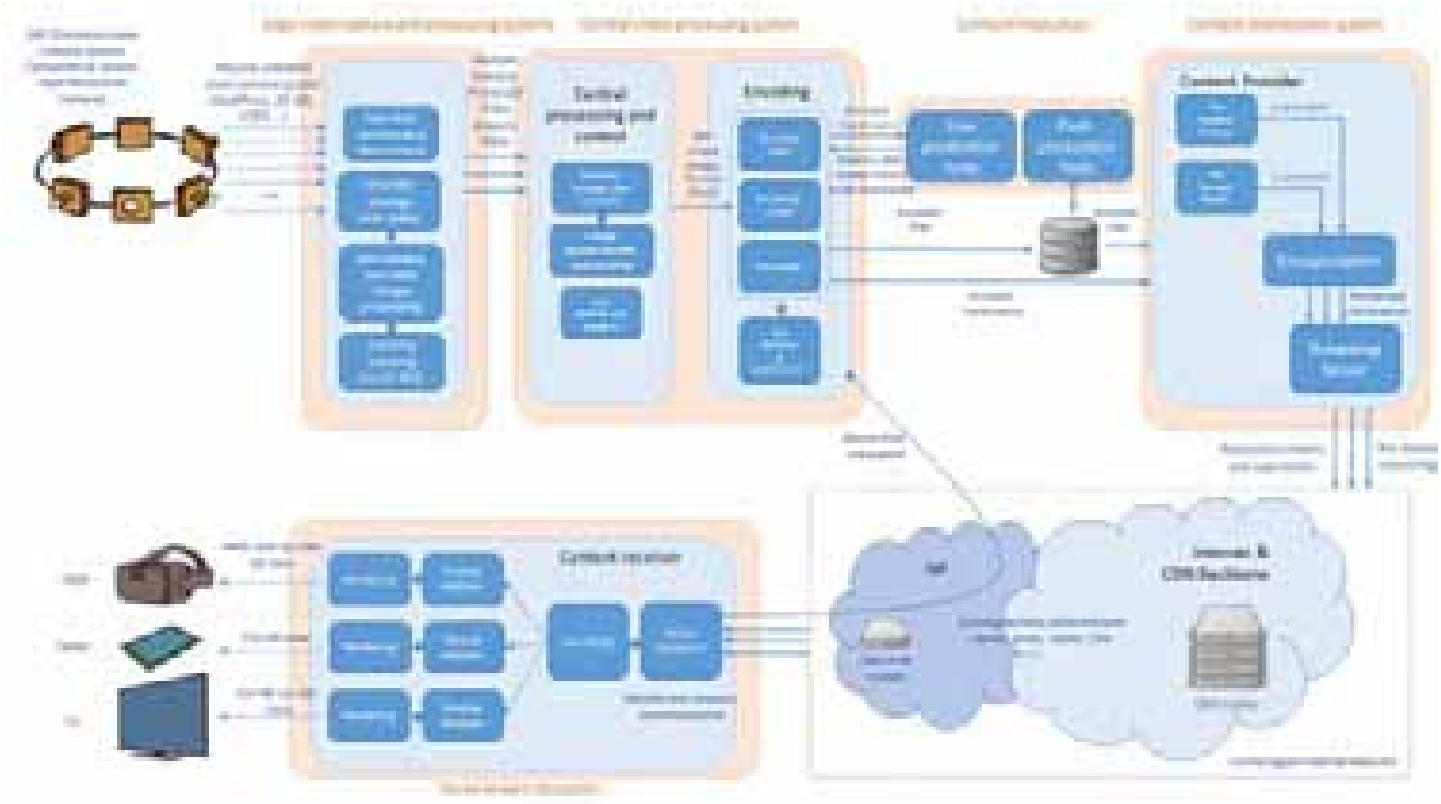

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Team

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Specific Contributions

To achieve the previous objectives, ImmersiaTV will work to progress beyond the state of the art in the following domain areas.

Omnidirectional video capture	Immersia TV provides a new approach to video capture. At this time, there is no solution for automatic seamless stereoscopic full omnidirectional capture, but the market has been introducing different options: single-lens 360° cameras, custom rigs for multiple cameras and professional omnidirectional cameras. ImmersiaTV is developing a system for video capture, replay and processing based on a distributed architecture that is ground up designed for omni-directional video. The architecture consists of a novel kind of "edge" processors, that combine raw camera data storage and replay and low level image processing and camera control found commonly in cameras or recorders, with per-camera sub-tasks in the stitching process, now responsible for the need of a heavy compute cluster linked with the cameras via expensive long-range very high bandwidth links. The resulting partially processed video data with the ImmersiaTV capture system is ad-hoc coded to allow transport over affordable long-range links to be blended on a central processing unit that is much lighter than in current practice.
Immersive content production tools	ImmersiaTV is developing new and adapting existing content production tools, both for live and offline editing. Most of the current commercial solutions have been conceived from a classical video edition perspective, and therefore do not support efficiently omnidirectional video editing. This process becomes even tougher when multiple omnidirectional streams are managed jointly with regular streams. This leaves a short range of options for editing omnidirectional contents in offline scenarios. In this context, ImmersiaTV proposes a custom production workflow from the only commercial tool that currently exists for stitching and editing omnidirectional video live streams, Vahana VR, developed by the company Video-Stitch. This software solution is currently being combined with Cinegy's software solutions, capable of managing a large amount of video sources in offline and live production setups. ImmersiaTV complements these tools with low-level advanced algorithms in stitching, coding and distribution to provide a first real software based solution to edit complex production scenarios integrating omnidirectional video editing and distribution in both offline and live scenarios.
Encoding /Decoding of Omnidirectional video	ImmersiaTV is developing new codecs adapted to omnidirectional video. The encoding of omnidirectional video sequences currently requires sphere-to-plane mapping, since currently available off-the-shelf video compression algorithms where designed for rectangular video formats. ImmersiaTV proposes a solution based on state-of-the-art knowledge on this subject, providing codecs that go beyond the assumption of rectangularity. These novel coding schemes will also be adapted to a multi-platform multi-resolution reality through foveated coding, a technique that allows having

	different resolutions on a single image. The goal will be to balance dynamically the available bandwidth with the resolution, and select the resolution differently in particular regions of interest defined from the user's focus on a particular field of view of the scene being watched.
Content Delivery and Reception	Video distribution is one of the main challenges in Internet traffic, as it is one of the most resource demanding content format, not only in terms of bandwidth, but also concerning Quality of Service and Quality of Experience for users. In ImmersiaTV, we are performing a deep analysis of novel coding and decoding techniques to come up with a technology capable to satisfy the project requirements at 3 levels: in a broadcast production environment, in the main distribution infrastructure, and within the end-user local network, where several devices need to synchronize around the television set. Insofar, the main approach followed has been the use of CDNs on its two main variables (edge servers and edge networks). HTTP is well adapted to these solutions, despite it was not conceived to deliver video services. This fact brought market to take over other variants, such as HTTP file based streaming and Enhanced Streaming over UDP, but there is not still a leading option guiding these process. There are also challenges in the end-user local network: the content format developed in ImmersiaTV assumes that several devices synchronize around the television set. The distribution of omnidirectional video among synchronized devices in a local network requires taking into account that different devices will have a different performance regarding video processing. This fact implies that within the transmission pipeline additional buffering is required to ensure that all contents are visualized at the same time in all devices, smoothly switching from one to another.
Visualization and interaction	How should omnidirectional contents be consumed? What visualisation and interaction principles allow a good end-user experience? Head mounted displays seem to be naturally adapted to deliver and visualise immersive videos. However, end-users will still want to experience television with the language and conventions they are used to. They will also want to consume content through mobile phones and tablets. Broadcast content formats are not ready for this multiplatform reality. The central purpose of ImmersiaTV is to demonstrate a novel kind of audiovisual content format, compatible with immersive displays, coherent across devices, and ready for broadcast distribution. Moreover, natural technology evolution (e.g.: new devices launching) demands a holistic approach that could work with existing devices, but also with those that will be commercialized in a near future. Last but not least, interaction is also key in ImmersiaTV and it opens a huge range of possibilities for narrative and new experiences for users. The project will put great effort to find out what are these possibilities and how to adapt (and demonstrate) them to the TV industry.

Progress beyond the state-of-the-art

To illustrate the innovation potential of this project, we further detail the different fields in which Immersia TV will provide progress beyond the state-of-the-art:

1. Omnidirectional video capture

Omnidirectional video capture has a long history[1]. Many rigs, including one or more cameras, either without or with one or multiple planar or curved mirrors, in combination with customized or off-the-shelf, lenses, have been proposed in literature or built for specific projects[2]. Rigs have been proposed both for monoscopic and stereoscopic omnidirectional video[3] [4]. At this time, there is no solution for automatic seamless stereoscopic full omnidirectional capture yet. We can distinguish three basic groups of omnidirectional cameras on the market:

- **Single-lens 360° cameras**. There are several relatively inexpensive 360° degrees camera devices on the market (e.g. Kodak SP360[5], Ricoh Theta[6], Bublcam[7] or Giroptic 360cam[8]) which are able to produce omnidirectional video for consumer and stream it over wireless network interfaces. Some of such small and lightweight omnidirectional cameras are being announced regularly in crowd-funding campaigns, but did not yet hit the stores. The quality of video coming from such compact devices is usually sufficient for mobile applications, but cameras are not able of producing high resolution or high frame rate video for more demanding users and immersive entertainment
- **Custom rigs for multiple cameras**. Custom rigs for inexpensive cameras such as Gopro (360 heros[9] or freedom 360 usual*ly) are very popular. They provide high resolution a*nd a good frame rate, in a light-weight, compact, unthettered and affordable package, but they lack inter-camera synchronisation and central exposure and white balancing control. More advanced rigs are usually still custom-build rigs, with high end cinema cameras such as ARRIflex or RED, or based on machine vision cameras, high end to very low cost board level depending on budget, skills and desired image quality.
- **Professional omnidirectional cameras.** Some companies are working on more **advanced omnidirectional camera systems** constructed using multiple high-resolution cameras places on specialized rig. Such ready-made omnidirectional camera heads include the point grey ladybug. Cameras are perfectly synchronised and sensors are consistently controlled, but often frame rate and/or resolutionare not adequate. Examples of such cameras are JauntVR[10], Panono Ball Camera[11], Panocam 3D[12], Samsung 360 Camera[13], Camargus (Qamira)[14].

In this context, ImmersiaTV will deploy its own approach and capture set, taking into account the existing approaches in the market. In other terms: to exploit the current rapid evolution of sensor and camera hardware technology, data interfaces, optics, stitching algorithms in the context of omnidirectional video broadcasting, ImmersiaTV will not focus on building its own rigs, or stitching algorithms, but rather on developing a video capture, replay and processing distributed architecture that is ground up designed for omni-directional video. The architecture consists of a novel kind of “edge” processors, that combine raw camera data storage and replay and low level image processing and camera control found commonly in cameras or recorders, with per-camera sub-tasks in the stitching process, now responsible for the need of a heavy compute cluster linked with the cameras via expensive long-range very high

[1] Shree K.Nayar, Terry Boult, Omnidirectional Vision Systems: 1998PIReport
[2] Shree K.Nayar, Catadioptric Omnidirectional Camera
[3] Terry Boult, Remote Reality via Omnidirectional Imaging
[4] T.E.Boult,R.J.Micheals,M.Eckmann,X.Gao,C.Power,S.Sablak, Omnidirectional Video Applications
[5] Kodak SP360, http://kodakpixpro.com/Americas/cameras/activeCam/sp360.php
[6] Ricoh Theta, https://theta360.com/en/
[7] Bublecam, http://www.bublcam.com/
[8] Giroptic 360cam, http://www.giroptic.com/
[9] Gopro 360 heros, http://www.360heros.com/
10 JauntVR, http://www.jauntvr.com/
11 Panono Ball Camera, http://jonaspfeil.de/ballcamera
12 Panocam 3D, http://www.panocam3d.com/camera.html
13 Samsung 360 camera, http://gizmodo.com/samsung-built-its-own-360-degree-camera-for-streaming-v-1657936437
14 Camarcus now owned by Qamira, http://qamira.com/

bandwidth links. The resulting partially processed video data with the ImmersiaTV capture system is ad-hoc coded to allow transport over affordable long-range links to be blended on a central processing unit that is much lighter than in current practice.

Omnidirectional video has been used in the past for TV broadcast purposes on first or second screen (e.g. in the iMinds explorative television ICON project in 2011-2012), but resolution and frame rate was perceived too low, stitching too cumbersome, processing too slow and capture and processing equipment too costly and delicate. ImmersiaTV will result in capture infrastructure design that addresses all these issues enabling omnidirectional video to become mainstream in the broadcast and videoconferencing world[15].

2. Immersive content production tools

The creative editing of omnidirectional video is still a quite challenging undertaking. Off the shelf software to edit offline video, such as Adobe Premiere, or Final Cut X, offer limited support for these. It is possible to edit omnidirectional video through post-production software suites like Adobe AfterEffects, or Nuke, but this process is far from efficient. It is very time-consuming, and unpractical to use. Moreover, traditional editing environments, typically composed of a preview screen and an output screen, are ill-suited to edit omnidirectional video. Editing is therefore often done with "flattened" images, or with portions of the field of view. Moreover, mainstream production tooling has not been designed to easily combine several video streams, both omnidirectional and not omnidirectional, in a coherent experience. As a result, despite it is feasible to produce such content offline, it is unpractical, and it is not possible with the software solutions currently existing to produce such content live.

The technical needs raised by the creative concept underpinning the ImmersiaTV content, where portals need to appear, grow, or move as a result of both the content creator and the end-users behavior, will steer the technical development of production tools. In this context, it is worth highlighting that the ImmersiaTV consortium, will develop its approach from the only commercial tool that currently exists for stitching and editing omnidirectional video live streams, Vahana VR, will made available through the company Video-Stitch. This will also allow customizing concrete aspects of this software solution if the need appears. In this context it is worth highlighting that Video-stitch was started as the natural continuation of creative projects involving omnidirectional video. By that time, the offline editing of omnidirectional video required massive amounts of manual labor for video stitching, and ad-hoc video processing scripts. The limitations found in this creative process, and the technical solutions developed, were the backbone on which Video-stitch was started. Similarly, Cinegy was started to address the need for a software solution capable of managing a large amount of video sources. ImmersiaTV will leverage this background expertise and radically increase the efficiency to create its defining novel content formats.

An additional advantage of the ImmersiaTV consortium is that it also includes access to low-level advanced algorithms in stitching, coding and distribution, and efforts to integrate these within the existing production tools. This will further allow a tighter integration of the end-to-end broadcast pipeline, and increase even further the quality and efficiency of content production. The ImmersiaTV consortium is therefore uniquely placed to deliver an innovative tool allowing to manage several video streams, both omnidirectional and non-omnidirectional, in coordination with standardization bodies and leading academic researchers, as well as testing of these by professional creatives with large experience in the audiovisual industry.

[15] Fernando De la Torre Carlos Vallespi Paul E. Rybski Manuela Veloso Takeo Kanade , Omnidirectional Video Capturing, Multiple People Tracking and Identification for Meeting Monitoring

3. Encoding /Decoding of Omnidirectional video

Encoding of omnidirectional video sequences, which represent time-varying 360° environments, requires sphere-to-plane mapping, at least when using off-the-shelf video compression algorithms originally designed for rectangular video data. Typical mapping schemes that have been explored so far include cylindrical projection[16] [17] [18] [19], Cube-map projection[20], and Rhombic-dodecahedron mapping [21]. However, the efficiency of these mapping schemes has not been studied in depth especially in terms of their influence on coding efficiency. Inappropriate mapping approaches may lead to insufficient sampling of omnidirectional video frames causing aliasing. In-depth analysis and experiments needs to be conducted to evaluate spherical parametrization and their influence when off-the-shelf coding schemes are used.

In addition, relatively large amount of data in omnidirectional video sequences challenges the current video compression approaches in terms of real-time processing, especially real-time encoding. In order to deliver real-time streaming of 360° omnidirectional video or its parts, low complexity and low latency constraints needs to be taken into account and implemented into encoder while maintaining the high video quality level. One way to face the real-time processing constraints is a foveated encoding, where region of interest of user is estimated and a priority saliency map determining the progressive hierarchical coding of the content is computed. Several solutions to estimate user attention exist in the literature mostly for high definition resolution [22] and rarely for ultra-high definition resolution.[23] However, there is no salient model or solution to estimate user attention in the omnidirectional video or its parts.

4. Content Delivery and Reception

Nowadays several studies[24] state that multimedia data is the most significant part of the data flowing over the Internet, with a radical increased in recent years. However, this recent growth might not be the most relevant fact: what is remarkable is that the future estimations on Internet traffic suggest that video content over the internet is expected to keep growing dramatically. In fact, video delivery is now and it still will be a challenge in terms of efficiency, scalability, QoS and QoE. In order to accelerate Internet and provide scalability for mainstream Internet services (media delivery, web apps and HTTP traffic in general) CDNs platforms were born. Main CDNs solution to this problem relies over two different approaches:

- Edge Hosts: Based on adding infrastructure (mainly hosts or servers) at the edge of the internet network, inside ISP premises.
- Edge Networks: Based on adding huge central deployment (big CPDs at the internet backbone) were edge networks (ISP providers) have a direct peering network.

This is the way CDNs tend to deploy content closer to the end user and in consequence reduce network throughput variability and network congestion. These approaches are feasible and well adapted to HTTP based services, however

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[16] D.-S. Lee, B. Erol, J. Graham, J. J. Hull, and N. Murata, “Portable meeting recorder,” in Proc. 10th ACM Int. Conf. Multimedia , 2002, pp. 493–502

[17] C. Grünheit, A. Smolic, and T. Wiegand, “Efficient representation and interactive streaming of high-resolution panoramic views,” in Proc. Int. Conf. Image Processing, 2002, vol. 3, pp. 209–212

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[19] A. Smolic and D. McCutchen, “3DAV exploration of video-based rendering technology in MPEG,” IEEE Trans. Circuits Syst. Video Technol. , vol. 14, no. 3, pp. 348–356, Mar. 2004

[20] K.-T. Ng, S.-C. Chan, and H.-Y. Shum, “Data compression and transmission aspects of panoramic videos,” IEEE Trans. Circuits Syst. Video Technol. , vol. 15, no. 1, pp. 82–95, Jan. 2005

[21] J.-S. Lee and T. Ebrahimi, “Perceptual video compression: A survey," Selected Topics in Signal Processing, IEEE Journal of 6(6), 684{697 (2012).

[22] Z. Wang, L. Lu, and A. C. Bovik, “Foveation scalable video coding with automatic fixation selection," Image Processing, IEEE Transactions on 12(2), 243{254 (2003)

[23] M. Rerabek, H. Nemoto, J.-S. Lee, T. Ebrahimi, “Audiovisual focus of attention and its application to Ultra High Definition video compression”, Proc. SPIE 9014, Human Vision and Electronic Imaging XIX, 901407 (February 25, 2014)

[24] http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

HTTP was not designed for video services. In live video streaming technologies these two approaches shown emerged recently and are taking over the market:

- HTTP file based streaming: based video segmentation into files and serve them via HTTP.
- Enhanced Streaming over UDP: based on adding reliability to UDP at application level (e.g. scalable coding,Forward Error Correction techniques, retransmissions of lost packets, etc.) and at network level (multipath streaming and/or other advanced SDN features).

However mature and older technologies like RTMP must be considered still; as there is quite a good, functional and stable infrastructure already supporting this technologies (it is a supported technology in many commercial CNDs and delivery services), and they still represent an option to get quickly into the market. But is also relevant to note that majors in video delivery such as Netflix, YouTube or even Adobe (inventors of the above mentioned RTMP) are clearly moving to HTTP open standards like MPEG-DASH at the same time they are starting to provide UHD services.

	HTTP	**ENHANCED UPD**	**RTMP**
SERVER COMPONENTS	Open	Specialized	Specialized
SECURITY AND IP PROTECTION	Available, but lack of unified approach	Specialized	Available
CHACHING	Native	Specialized	Specialized
MULTICAST SUPPORT	None	Supported	Supported
PLUGIN AND PLAYERS PENETRATION	Emerging	Specialized	Extensive
FIREWALL OR PROTOCOL/PORT ISSUES	None	NAT transversal and firewall restrictions	Firewall restrictions
VARIABLE BITRATE	No impact at server side	No impact if scalable coding techniques are used	Susceptible to data spikes

Table 1 Feature comparison between HTTP, UDP and RTMP

UDP streaming, as noted in the table has to cope with two relevant issues and barriers, reliability and scalability. Reliability in UDP usually is faced by the use of FEC technologies and some sort buffering to enable retransmission of lost data which forces both complex and costly (in computation terms) streaming servers and clients. Technically speaking basic scalability issues using UPD might be easily solved by using multicast transmissions so each representation of the stream would only be transmitted once over the Internet, but multicast support in OTT networks is not widely extended and many ISP doesn't support it.

However there several ongoing initiatives like Automatic Multicast Tunnelling draft standards[25] already supported by major network equipment vendors such Cisco[26] and Juniper[27,] 5G and C-RAN emerging technologies[28] [29] or SDN like approaches[30] and the omnipresent switch from IPv4 to IPv6; all growing and expanding technologies that enhance multicast support. Multicast streaming over UDP might have a relevant role in future networks as they get gradually updated infrastructure and management techniques, this is the approach considered strategic like Akamai, who recently acquired Octoshape[31], a reference in the novel media delivery systems. In the comparison table, maybe the most relevant fact related to HTTP streaming is that is reliable, runs over wide spread technologies without requiring specialized infrastructure and can easily implement some adaptation features by using smart clients. This are the main reasons behind the industrial interest in the new open standard for HTTP streaming MPEG-DASH, key actors of the

[25] https://tools.ietf.org/html/draft-ietf-mboned-auto-multicast-18
[26]http://www.cisco.com/c/en/us/td/docs/routers/crs/software/crs_r4-3/multicast/configuration/guide/b_mcast_cg43xcrs/b_mcast_cg43xcrs_chapter_011.pdf
[27] http://www.juniper.net/documentation/en_US/junos12.1/topics/example/mcast-amt.html
[28] http://eeweb.poly.edu/~elza/Publications/icassp08.pdf
[29] https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf
[30] http://link.springer.com/article/10.1007%2Fs10922-014-9322-8
[31] http://www.akamai.com/html/about/press/releases/2015/press-040615.html

media delivery (Akamai, Netflix, Adobe and Cisco among many others) are currently member of the Dash Industrial Forum[32] promoting the usage MPEG-DASH. With the expansion of HTTP 2.0 these technologies are expected to get relevant improvements related to QoS because of properly addressing the Head-Of-Line (HOL) issue[33] and improving HTTP caching possibilities.

As it has been already noted ImmersiaTV targets multiple devices, expected to provide a simultaneous coherent experience (synchronization and adaptations of flows) to the users. For in-house live streaming (from the media centre to the display devices) different techniques will be analysed, this is a pretty different scenario, as in will be a controlled LAN that includes Ethernet and WiFi as the main network technologies to consider. Streaming only small portions of the global sphere to tiny displays must be considered while keeping interactivity and the capability to move around over whole sphere. For such a purpose very low latency streaming is needed, as the media centre must react accordingly to the user movements in real-time. Extensions to the current real time streaming strategies might be considered here the RTSP extension proposed by the Osaka University and Osaka Institute of Technology[34]. Other options might be focused on ROI estimation so only the ROI is transmitted to the display, or the whole stream is transmitted but just the ROI gets the full resolution and quality. The approach will be in strict relation with the novel coding and decoding techniques adopted by the ImmersiaTV.

5. Visualization and interaction

Historically, Immersive Displays have been used mostly to render virtual reality involving computational graphics, generated with methods similar to 3D games or 3D animation movies (for example [35]). The creation of Omnidirectional Video has been a technical possibility for long, but not its live delivery. It is only now that the confluence of affordable hardware for immersive display, live delivery of omnidirectional streams and improvements in omnidirectional video hardware enables the delivery of video-based omnidirectional content. However, content formats are not ready for this reality.

The central purpose of ImmersiaTV is to demonstrate a novel kind of audiovisual content format, compatible with immersive displays, coherent across devices, and ready for broadcast distribution. This requires progress on several aspects. Omnidirectional video distribution has already been demonstrated[36] [37] .However, these attempts do not address the problem of synchronization among devices in a local network. Despite there exist approaches to guarantee synchronization of multimedia streams between devices, [38] [39], existing approaches do not take into account the specifics of immersive displays, where the highest priority should always be to keep a very fast sensorimotor loop between head movements and rendering of the immersive display. These constraints require an update of the approach where “the slower device wins”, where the less powerful device is taken as the temporal reference to ensure synchronization. In other terms: the extra need for temporal buffering and the larger field of view needed by immersive displays might impose needs to consider such devices “slower” than less powerful devices, just to be able to guarantee the extra buffering needed to address the demanding requirements of immersive displays. In addition,

[32] http://dashif.org/members/

[33] http://www.streamingmedia.com/Articles/Editorial/Featured-Articles/HTTP-2.0-and-DASH-Planning-Tomorrows-Improved-Video-Delivery-98653.aspx

[34] http://onlinelibrary.wiley.com/doi/10.1002/ecj.10375/pdf

[35] Spanlang, B., Normand, JM., Borland, D., Kilteni, K., Giannopoulos, E, Pomés, A, González-Franco, M., Perez-Marcos, D., Arroyo-Palacios, J., Navarro Muncunill, X., Slater, M. How to build an embodiment lab: achieving body representation illusions in virtual reality Front. Robot. AI, 27 November 2014

[36] https://littlstar.com/

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[38] Bang, Y., Han, J. and Lee, K. Yoon, J. Joung, J, Yang, S. Rhee, J-K K., (2009) Wireless Network Synchronization for Multichannel Multimedia Services}, Proceedings of the 11th International Conference on Advanced Communication Technology - Volume 2, ICACT'09 1073-1077

[39] Rautiainen, M., Aska, H., Ojala, T., Hosio, M., Makivirta, A., & Haatainen, N. (2009, June). Swarm synchronization for multi-recipient multimedia streaming. In Multimedia and Expo, 2009. ICME 2009. IEEE International Conference on 786-789

current synchronization methods [40] [41] do not address the problem of device discovery: a novel device, not existing at the time of the implementation of the software, might impose different parameters on the overall synchronization mechanism. We will therefore take inspiration of solutions proposed for musical devices in live environments[42] to address synchronization in a way that enables device discovery.

In addition to synchronization, the display also needs to blend seamlessly with interaction with the available video streams. Despite there have also been some exploratory studies on interaction with omnidirectional video[43] [44], to the best of our knowledge there has not been an explicit attempt to:

- Develop an audiovisual language based on combining several video streams, both immersive and non-immersive, which enables creating narratives adapted to immersive displays.
- Adapt the rich audiovisual language of traditional TV to this novel kind of display, where the use of travellings, cuts, and complex camera movements would provoke sickness if rendered in an omnidirectional field-of-view.
- Explore the possibilities of interaction within such immersive display narratives
- Deliver an experience coherent across devices.

Overall, by developing a software solution that addresses, on one hand, the adaptation of audiovisual language and interaction and, on the other side, synchronization among devices in a distributed way, ImmersiaTV will deliver a unique update of the broadcast model, particularly adapted to the reality of the contemporary living room, where immersive displays arrive to join traditional TV and second displays.

[40] Mahmood, A., & Gaderer, G. (2009, October). Timestamping for IEEE 1588 based clock synchronization in wireless LAN. In Precision Clock Synchronization for Measurement, International Symposium on Control and Communication, 2009 1-6

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[42] Bergstrom, I., & Llobera, J. OSC-Namespace and OSC-State: Schemata for Describing the Namespace and State of OSC-Enabled Systems. Nime Conference 2014

[43] Benko, H., and Wilson, A. D. Multi-point interactions with immersive omnidirectional visualizations in a dome. In Proc. of the ACM Int. Conference on Interactive Tabletops and Surfaces, ITS (2010), 19–28

[44] Rovelo Ruiz, G.A. Vanacken, D., Luyten,K. Abad,F. Camahort, E. Multi-viewer gesture-based interaction for omni-directional video Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 4077-4086

5. CLUSTER MEETING PRESENTATION

IMMERSIATV

21st NEM GA

Sergi Fernández, Project Coordinator

Brussels, 15th of March 2016

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, CINEGY, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

IMMERSIATV

Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices.

Call: H2020-ICT-19-2015-IA

Start January 2016
30 Months
Budget 3.8M€

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LICHTBOX, Cinegy, PSNC

_A project funded by: European Commission

Consortium

Research institutions

Broadcaster

Tooling SMEs

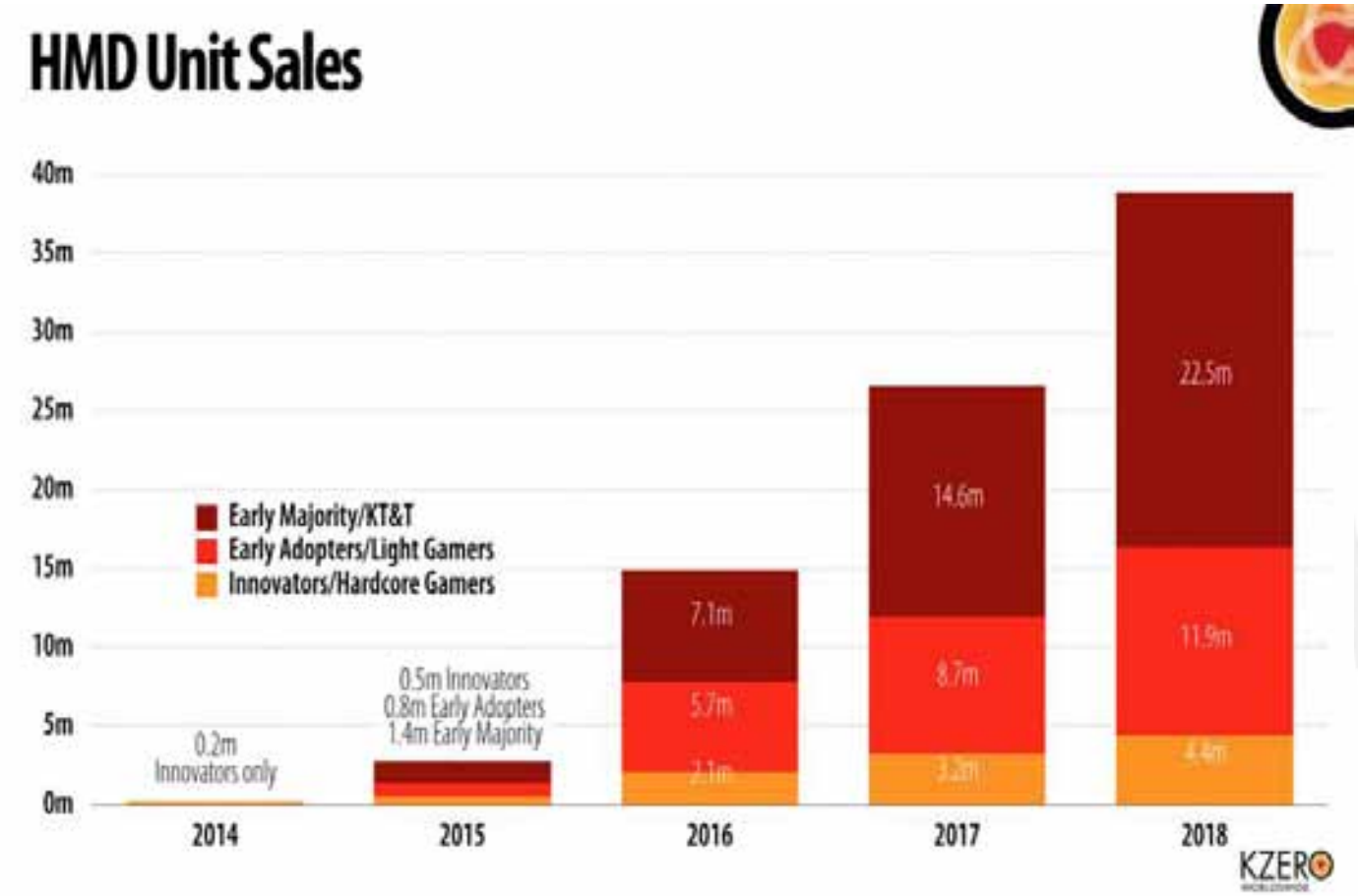
Production SME

_Partners:

_A project funded by:

IMMERSIATV

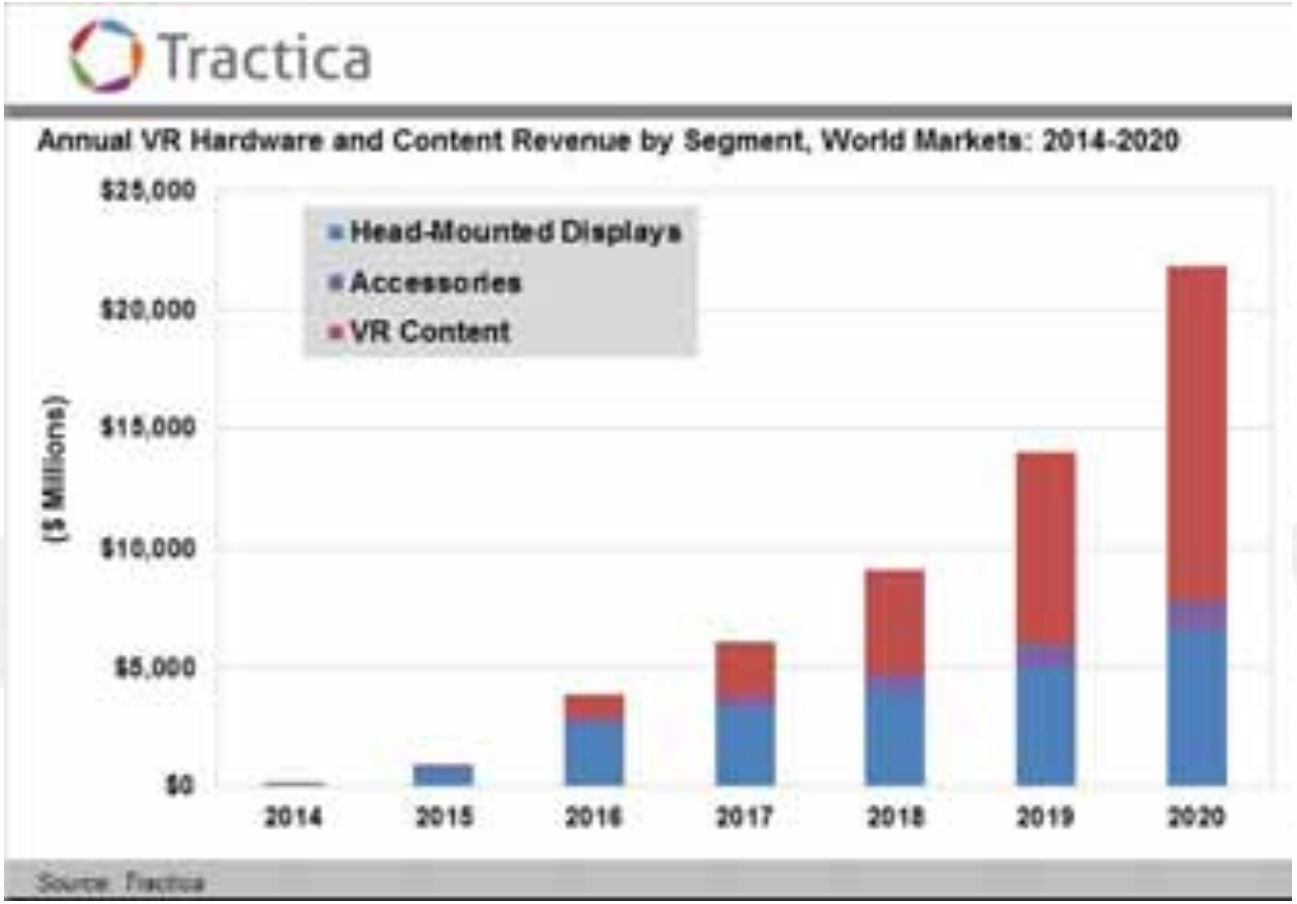
Market



_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

Market

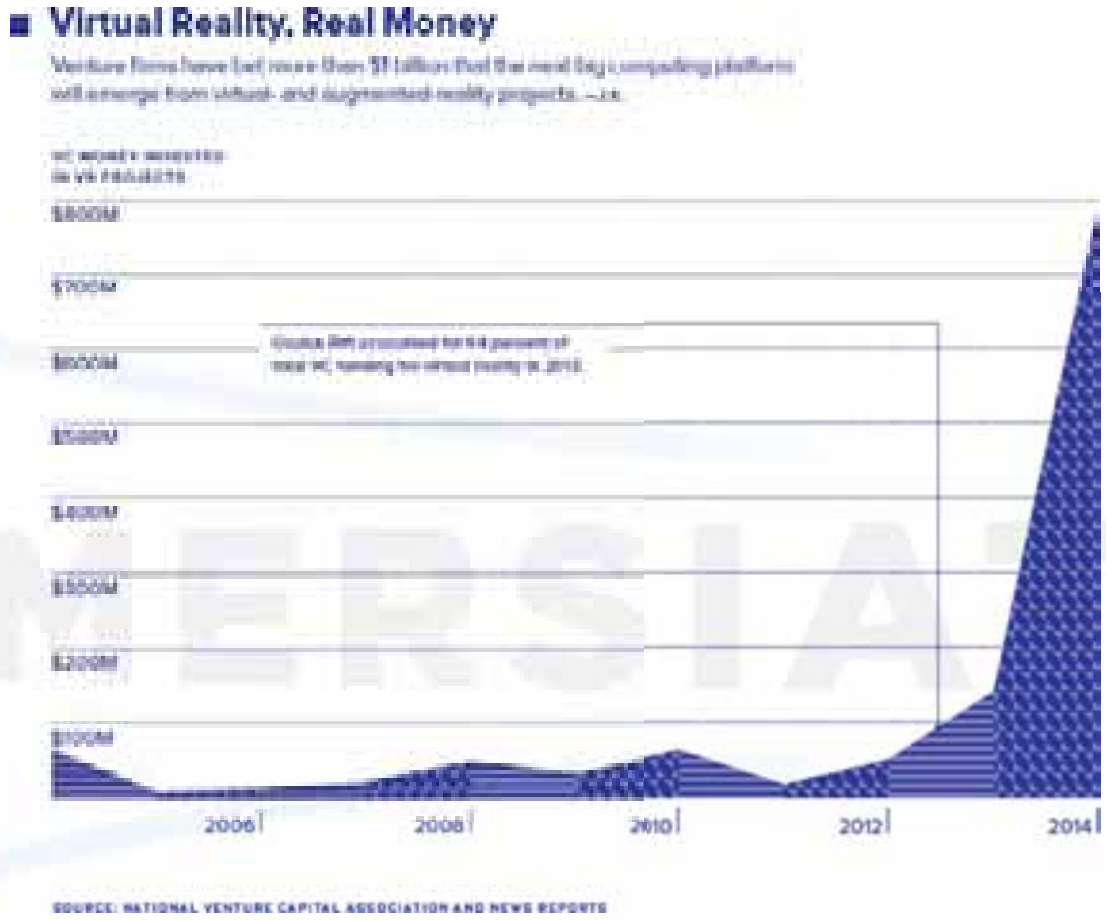


_Partners:

_A project funded by:

European Commission
Horizon 2020
European Union funding for Research & Innovation

Market



IMMERSIAFV

_Partners:

_A project funded by:

European Commission

Horizon 2020
European Union funding
for Research & Innovation

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LICHTBOX
Cinegy
PSNC

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European Commission

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European Union funding
for Research & Innovation

IMMERSIATV

Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices.

_Partners:

_A project funded by:

_Partners:

_A project funded by:

European Commission

Horizon 2020
European Union funding
for Research & Innovation

ImmersiaTV: challenges

OBJ1.

Create a new cinematographic language where the specificities of immersive displays are taken into account, and which conciliates immersive paradigms with traditional storytelling techniques.

_Partners:

_A project funded by:

European Commission

Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ2.

Extend the production pipeline to create omnidirectional content for a multi-platform environment.

Broadcast quality rigs

_Partners: i2cat, iMinds, VideoStitch, vrt, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ2.

Extend the production pipeline to create omnidirectional content for a multi-platform environment.

Stiching Edition tool

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LICHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ2.

Extend the production pipeline to create omnidirectional content for a multi-platform environment.

Multiplatform Edition Tool

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ2.

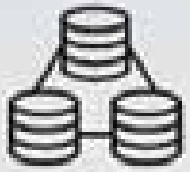
Extend the production pipeline to create omnidirectional content for a multi-platform environment.

Multiplatform live production tool

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges



OBJ3.

Re-design the distribution chain to address the specific technical challenges that omnidirectional content imposes in terms of capture, compression, distribution, reception, and rendering.

JPEG XS

Codification. Extening JPEG XS scope to Omnidirectional video

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ3.

Re-design the distribution chain to address the specific technical challenges that omnidirectional content imposes in terms of capture, compression, distribution, reception, and rendering.

MPEG DASH

Adaptive streaming. Reducing latencies, ensuring highest video quality, enabling video interaction.

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, CINEGY, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ3.

Re-design the distribution chain to address the specific technical challenges that omnidirectional content imposes in terms of capture, compression, distribution, reception, and rendering.

HbbTV android tv

android iOS

oculus Samsung Gear VR

Multiplatorm synchronization and other interoperability problems

_Partners: i2cat iMinds VideoStitch vrt EPFL LIGHTBOX Cinegy PSNC

_A project funded by: European Commission Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ4.

Maximize the quality of the end-user experience, across devices, and within the technical limitations of existing production structures, distribution facilities and reception devices to create an optimal immersive experience.

Professional users & Content creation

_Partners: i2cat, iMinds, VideoStitch, vrt, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

ImmersiaTV: challenges

OBJ4.

Maximize the quality of the end-user experience, across devices, and within the technical limitations of existing production structures, distribution facilities and reception devices to create an optimal immersive experience.

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_Partners: i2cat, iMinds, VideoStitch, vrt, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission, Horizon 2020 European Union funding for Research & Innovation

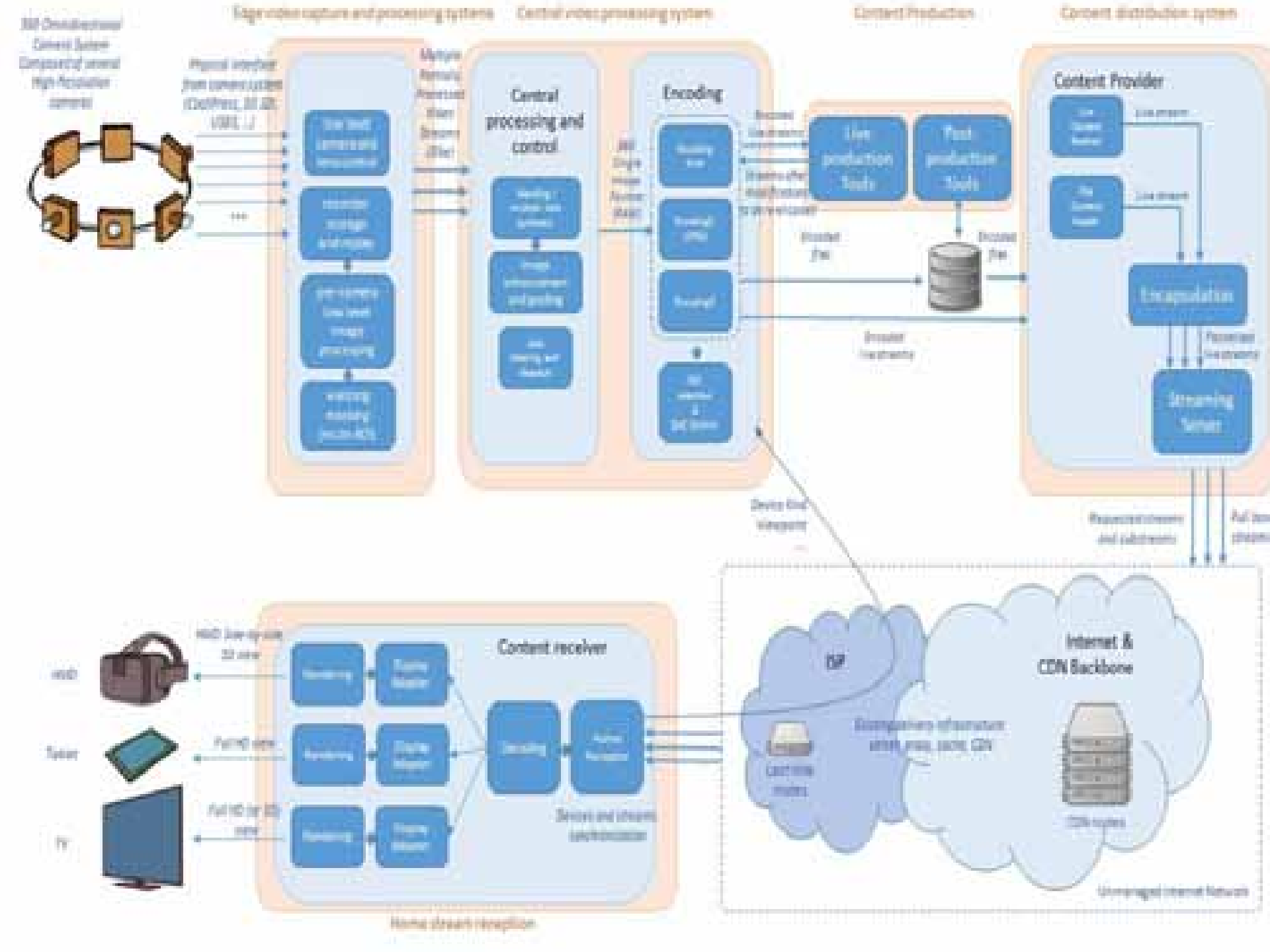
ImmersiaTV: challenges

Content Creators.
Tooling companies.
Broadcasters.
Content agregators.
TV/STB Manufacturers.

_Partners:

_A project funded by:

European Commission
Horizon 2020
European Union funding for Research & Innovation


Content Provider
Encoding
Central processing and control
Live production Tools
Post production Tools
Encapsulation
Streaming Server
Content receiver
ISP
Internet & CDN Backbone
Home stream reception

_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, Cinegy, PSNC

_A project funded by: European Commission | Horizon 2020 European Union funding for Research & Innovation

Pilots

	WORK PACKAGES	YEAR 1												YEAR 2												YEAR 3					
		J 1	F 2	M 3	A 4	M 5	J 6	J 7	A 8	S 9	O 10	N 11	D 12	J 13	F 14	M 15	A 16	M 17	J 18	J 19	A 20	S 21	O 22	N 23	D 24	J 25	F 26	M 27	A 28	M 29	J 30
WP1	**Management**																														
T1.1	Administrative, financial and contractual management																														
T1.2	Reporting and controlling																														
T1.3	Quality management																														
D	Deliverables																														
WP2	**Requirements, format and creation of Immersive experiences**																														
T2.1	End User Requirements																														
T2.2	Professional User Requirements																														
T2.3	Content Ideation, Production scenarios, requirement analysis																														
T2.4	Content creation																														
D	Deliverables																														
WP3	**Immersive Broadcast Platform**																														
T3.1	Platform design and architecture																														
T3.2	Capture																														
T3.3	Production Tools																														
T3.4	Encoding & Decoding																														
T3.5	Delivery & Reception																														
T3.6	Interaction & Display																														
T3.7	Quality of Experience																														
T3.8	Workflow integration & End-to-end tests																														
D	Deliverables																														
WP4	**Demonstration pilots**																														
T4.1	Execution & Evaluation Plan																														
T4.2	Pilots																														
T4.5	User and Technical Evaluation																														
D	Deliverables																														
WP5	**Dissemination, exploitation and communication**																														
T5.1	Market Analysis & Strategies for successful exploitation																														
T5.2	Business clinics																														
T5.3	Communication																														
T5.4	Innovation transfer																														
T5.5	Standarization																														
D	Deliverables																														

_Partners:

i2cat

iMinds

EPFL

LICHTBE

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_Partners: i2cat, iMinds, VideoStitch, VRT, EPFL, LIGHTBOX, CINEGY, PSNC

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6. CLUSTER MEETING POSTER

IMMERSIATV

OBJECTIVES

OBJ1.
Create a new cinematographic language where the specificities of immersive displays are taken into account, and which conciliates immersive paradigms with traditional storytelling techniques.

OBJ2.
Extend the production pipeline to create omnidirectional content for a multi-platform environment.

OBJ3.
Re-design the distribution chain to address the specific technical challenges that omnidirectional content imposes in terms of capture, compression, distribution, reception, and rendering.

OBJ4.
Maximize the quality of the end-user experience, across devices, and within the technical limitations of existing production structures, distribution facilities and reception devices to create an optimal immersive experience.

OBJ5.
Maximize the impact of the ImmersiaTV solutions within the ecosystem of content creators, broadcasters, and consumers.

WE WILL ACHIEVE THESE GOALS THROUGH THE FOLLOWING MILESTONES:

1. Create omnidirectional videos for immersive displays which also integrate traditional broadcast videos and interactivity, both for offline and for live productions.
2. Deliver an experience that is synchronized across immersive displays, tablets and traditional TV.
3. Re-design all the production, distribution and delivery chain to allow the synchronised production and delivery of content through all devices.
4. Demonstrate our approach in 3 pilots.

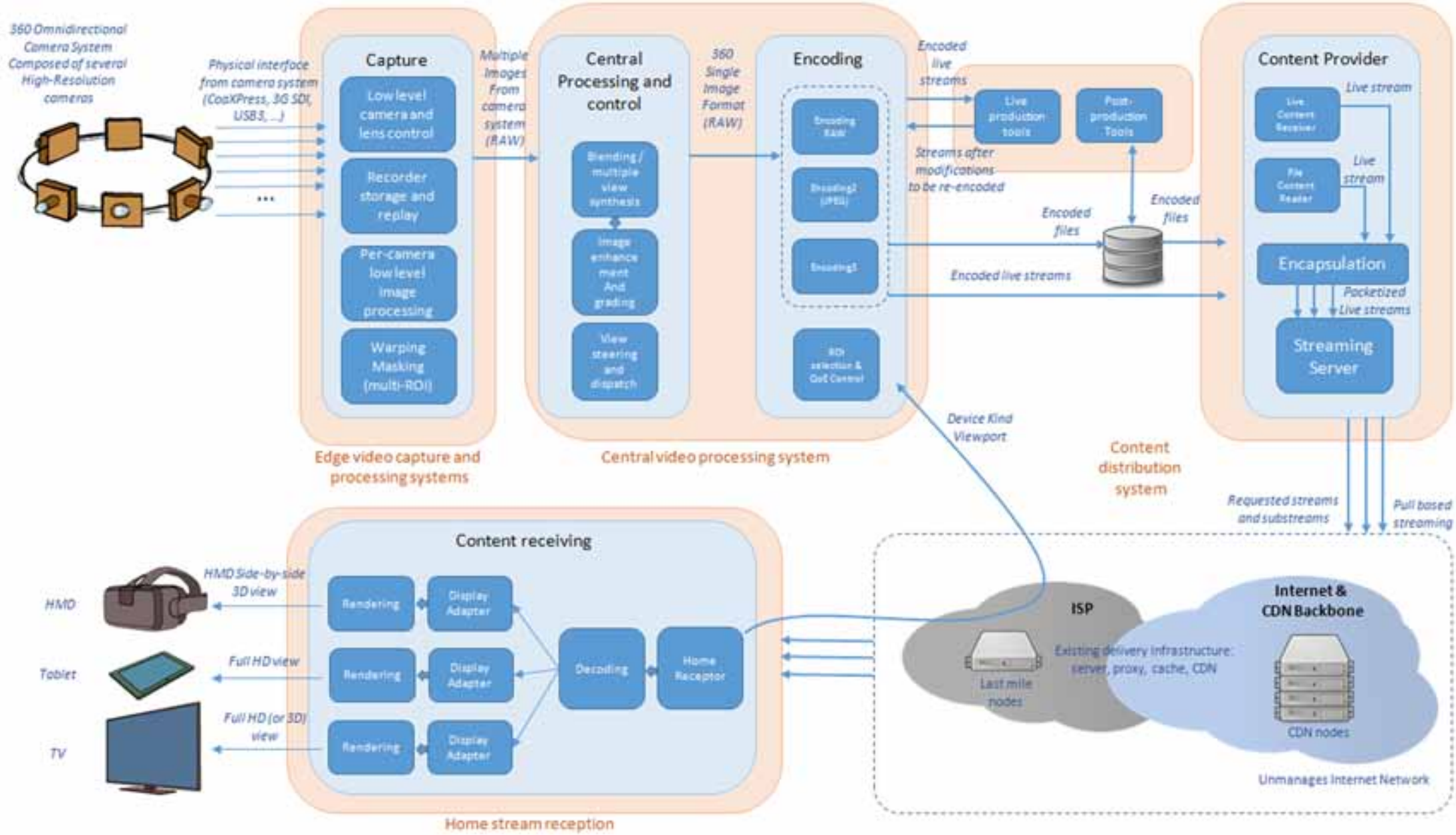
To achieve these objectives, ImmersiaTV has assembled a unique combination of content creators (Lightbox), broadcasters (VRT), tooling specialists (Video-Stitch, Cinegy), and research centers covering the whole production chain, from capture (iMinds), encoding (EPFL, iMinds) and delivery (i2CAT, PSNC).

@immersiatv
to be defined yet
WEBSITE www.immersiatv.eu
CONTACT INFORMATION sergi.fernandez@i2cat.net

GRANT NUMBER 688619
PERIOD 1/2016-6/2018
BUDGET 3.8M€
FUNDING ORGANISM H2020 (EC)

This project has been funded by the European Commission as part of the H2020 program, undert the grant agreement 688619

Architecture



Multi-platform delivery

Immersive and interactive scenes

7. GENERAL PROJECT LEAFLET

IMMERSIATV

A TOOLSET FOR THE PRODUCTION AND DISTRIBUTION OF IMMERSIVE CONTENT ACROSS DEVICES

OBJ1.
Create a new cinematographic language where the specificities of immersive displays are taken into account, and which conciliates immersive paradigms with traditional storytelling techniques.

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OBJ5.
Maximize the impact of the ImmersiaTV solutions within the ecosystem of content creators, broadcasters, and consumers.

PROJECT WORKFLOW

CAPTURE → PRODUCTION → ENCODING → DISTRIBUTION → DISPLAY

❶ Capture and stitching: New models of omnidirectional camera shooting multiple 4K videos that are processed and stitched together by advanced VahanaVR software.

❷ Off-line and live: Set of tools for off-line and live production of omnidirectional video content, combined with traditional 2D video portals and new features such as transitions and effects in 360° media content.

❸ New lightweight and low-latency video codec with Regions of Interest and QoE evaluation enables efficient encoding basing on real-time user's viewport feedback

❹ Adaptive MPEG-DASH streaming of omnidirectional video with multi-platform content synchronization (DVB-CSS) and metadata defining interactive video portals.

❺ Multi-platform player based on Unity3D engine enables synchronized displaying of omnidirectional content with additional video portals on HMD, phones, tablets and TV sets.

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GRANT NUMBER 688619
PERIOD 1/2016-6/2018
BUDGET 3.8M€
FUNDING ORGANISM H2020 (EC)

This project has been funded by the European Commission as part of the H2020 program, undert the grant agreement 688619

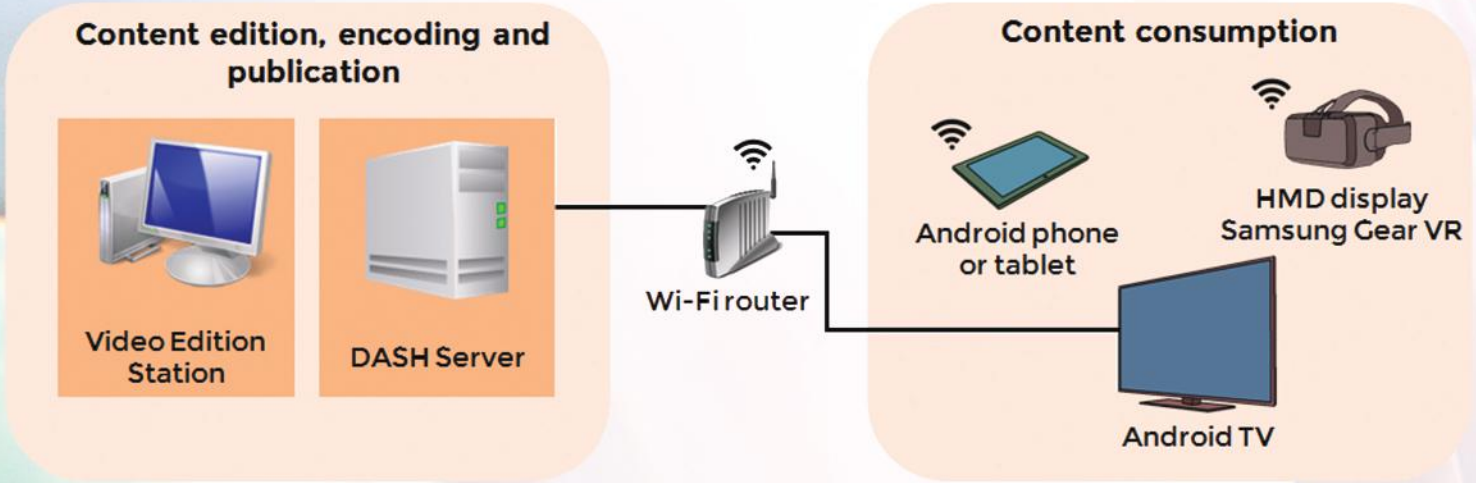
THE DEMO

ImmersiaTV is creating a novel form of omnidirectional video content production and delivery that offers viewers a coherent, simultaneous broadcast experience across head mounted displays, second screens and the traditional TV set.

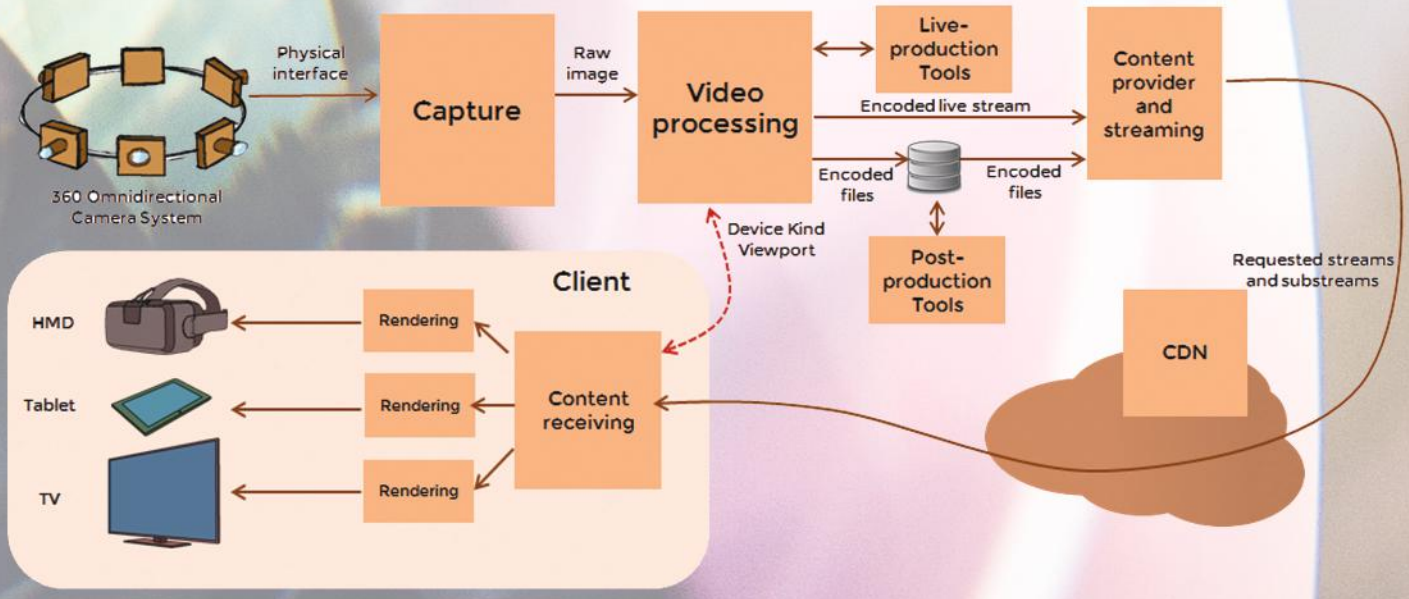
In order to do this, we create an end-to-end toolset covering the entire audiovisual value chain: immersive production tools, support for omnidirectional cameras, adaptive content coding and delivery. We take advantage of the large field of view available in head mounted displays to create experiences where the user can navigate through and interact with video inserts. Besides this, we also explore the possibilities of synchronized content delivery to use second screens for the display of complementary aspects of the broadcast, in an attempt to reconcile second screen consumer habits with a more integrated and coherent multi-platform experience around the TV.

Our tools will be extensively piloted through two new formats: one pre-recorded documentary and one live event, both conceived and implemented by our media partners.

OFFLINE PILOT DEMO



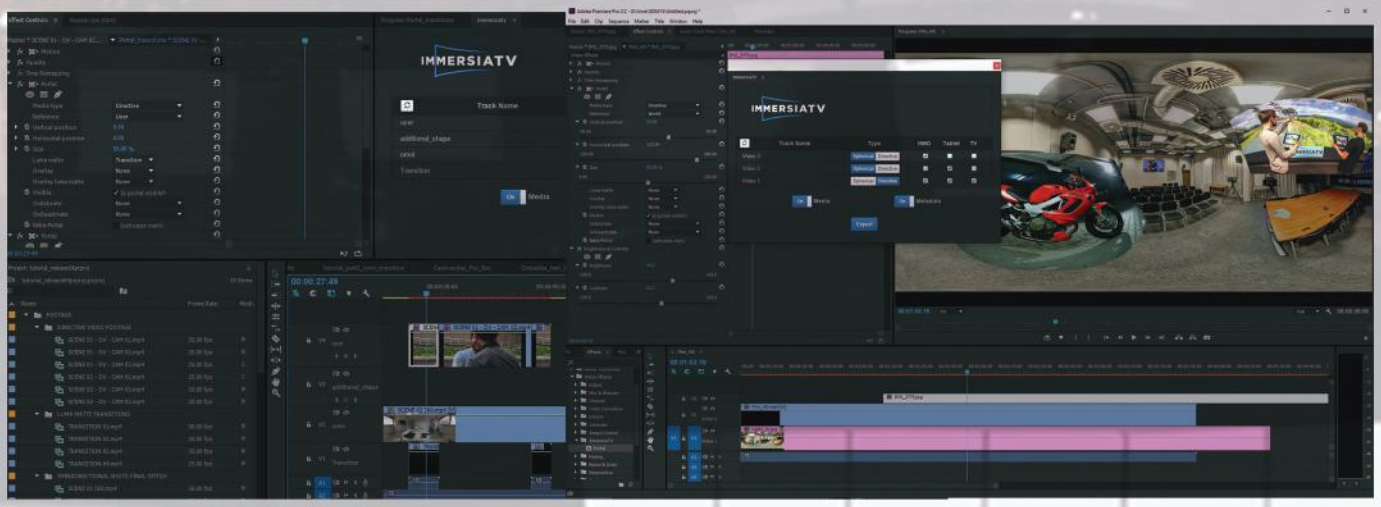
THE PROJECT ARCHITECTURE



8. PRODUCTION TOOLS LEAFLET

IMMERSIATV

THE MULTI-DIRECTIONAL, MULTI-DEVICE BROADCASTING EXPERIENCE



PROJECT WORKFLOW

CAPTURE → **PRODUCTION** → ENCODING → DISTRIBUTION → DISPLAY

Key innovative features in ImmersiaTV - Production component:

- Combine immersive experiences with traditional content and introduce elements of interaction
- Bring the live production experience to omnidirectional content
- Simultaneous off-line and live production for different devices
- Simple controls with complex reactions

ImmersiaTV offers two sets of tools for the production of omnidirectional content. Firstly, the offline production tools simplify omnidirectional video editing and post-production. These applications enable synchronization and combination of both immersive and traditional video clips into a single production pipeline in Adobe Premiere Pro, simply creating transition portals from an omnidirectional scene to directed videos. Secondly, a set of live production tools bring this new storytelling format to live events broadcasting in an easy and intuitive way. Through the visual representation of live omnidirectional sources combined with traditional video feeds, a Live Operator is able to initiate complex and appealing transitions and cuts. Moreover, the complete scene can be re-defined or extended from the same UI when necessary, allowing last minute adjustments.

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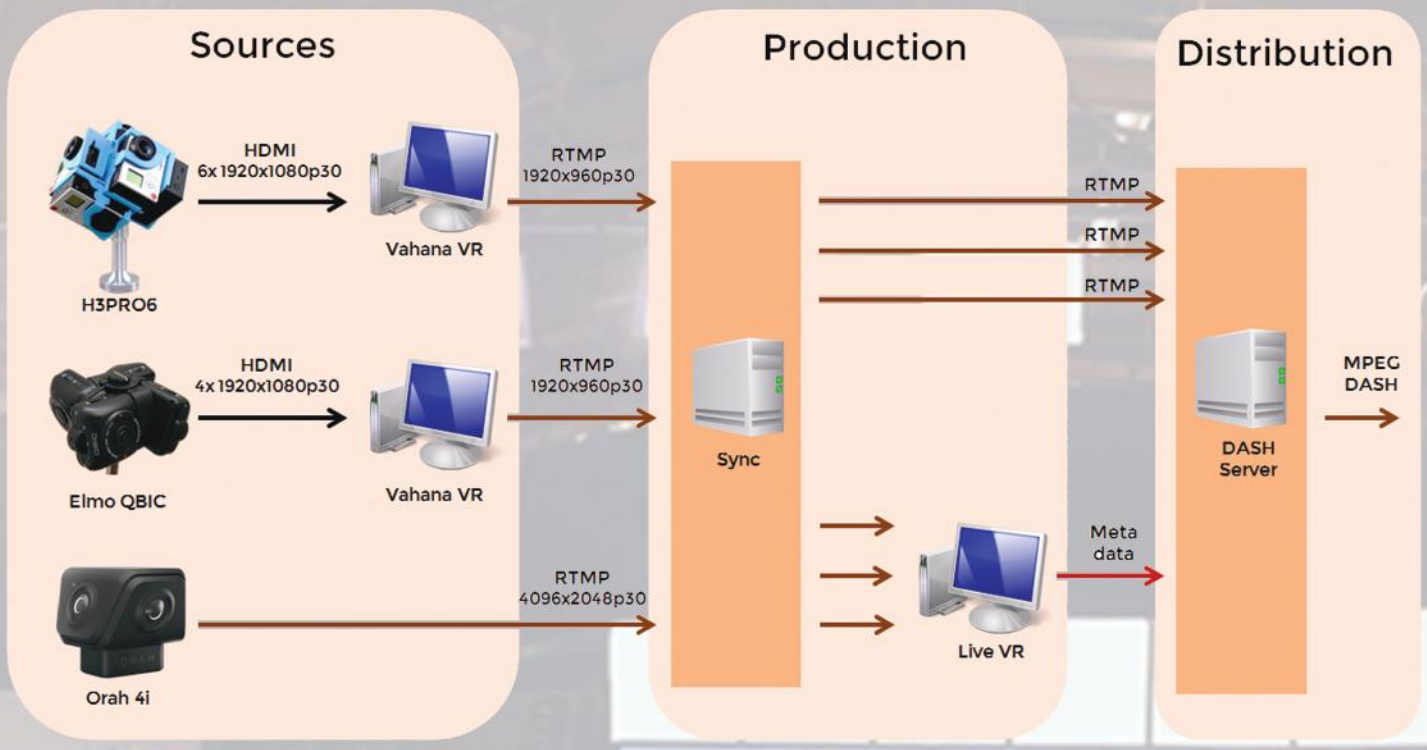
PRODUCTION DIAGRAM



INSIGHTS

The ImmersiaTV integrated workflow requires the development of a set of tools to enable new forms of immersive storytelling. Our offline production tools consist of a set of Adobe Premiere Pro plugins that provide an interface to define scenes for immersive and directive video displayed in multiple devices. With this approach it is possible to define different content timelines for different devices, synchronize and set relations between them, thereby mixing immersive and non-immersive footage into an appealing end user experience. The editor can introduce elements of interactivity with the portal effect, allowing viewers to influence the content shown. The final project is straightforwardly exported to be directly delivered to the multi-platform audience devices.

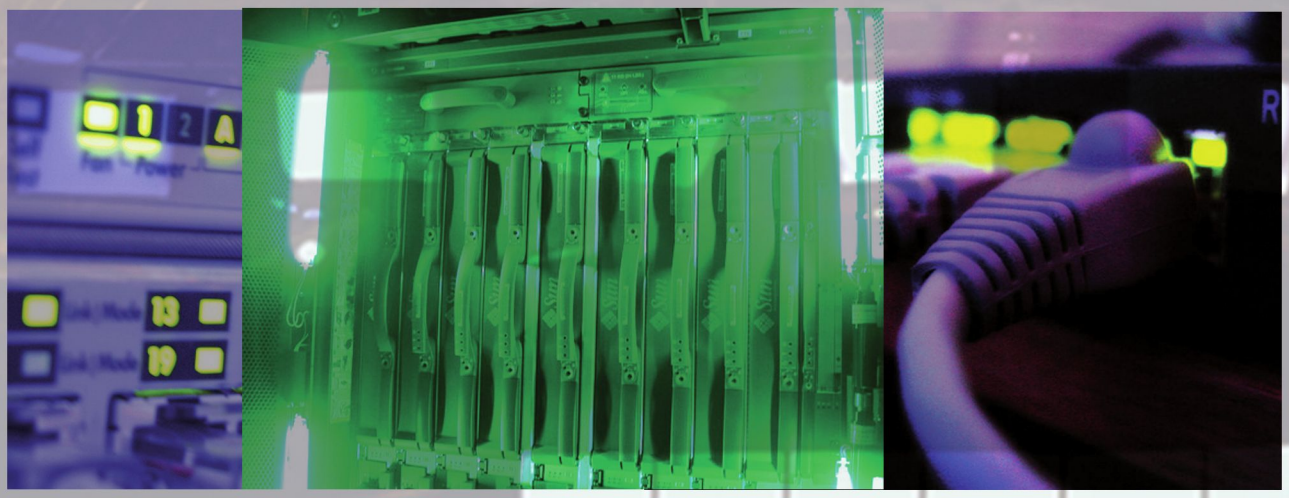
The Live Production scenario consists of several stages. First the video from camera rigs is stitched in real-time using Vahana VR. The stitched streams from different cameras go into the Sync unit, synchronizing between cameras. The synced streams are presented to the Live VR operator and pre-defined scripts are activated to modify the VR scene and change the visual experience for the user. The final rendering of the programme is done on the customer side and depends on the device used.

The Live VR user interface is customizable and allows live composition of the visual experience for different devices. In order to reduce the operational complexity, the pre-defined sets of actions will be available for selection via single click or tap on touch devices. Additionally certain options to modify existing actions (changing the portal position, defining its shape, etc) are available to the operator in order to adapt to changing conditions.

9. DISTRIBUTION TECHNOLOGIES LEAFLET

IMMERSIATV

THE MULTI-DIRECTIONAL, MULTI-DEVICE BROADCASTING EXPERIENCE



PROJECT WORKFLOW

CAPTURE → PRODUCTION → ENCODING → **DISTRIBUTION** → DISPLAY

Key innovative features in ImmersiaTV - Distribution component:

- Adaptive streaming based on the DASH standard
- Multi-platform content synchronization at the frame level based on emerging broadcast standards (DVB-CSS)
- Innovative metadata format that allows defining interactive content

The ImmersiaTV distribution module is in charge of delivering the content to the different devices, and to do so synchronously between them, in such a way that the end user can switch freely among displays and still follow the storyline. It also delivers the metadata required for the end-user to be able to interact with certain aspects of the experience delivered like transitions between scenes, location and interaction with portals or mask effects.

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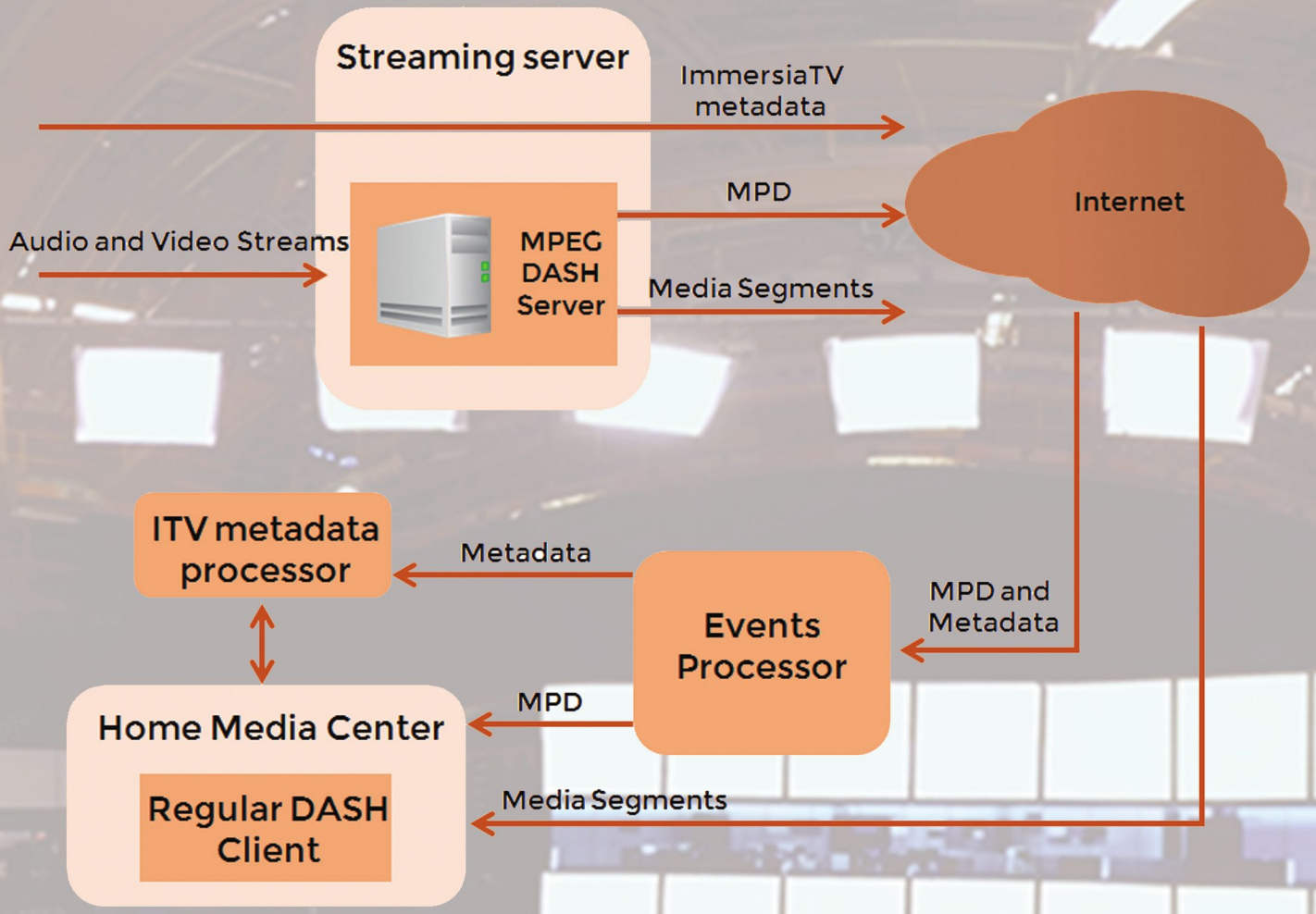
DISTRIBUTION DIAGRAM



INSIGHTS

This functional block handles communication between offline encoded content or live streams and the end-user's player. It encapsulates selected video streams into network protocols and provides synchronized video and auxiliary streams to the player. It consists of 2 components:

1) MPEG-DASH (mpd) and media segments. MPEG-DASH appears to be the only widespread solution that might get a wide adoption in the industry, as many of the main industrial actors already announced support to it (Microsoft, Adobe, Netflix, Google, etc.). There are three main reasons to choose MPEG-DASH as the standard to follow in the ImmersiaTV project:

- MPEG-DASH is getting adopted by the major players. This is a very important point in order to get ImmersiaTV close to the market. Ideally, the content providers using mature MPEG-DASH services would not need to drastically update their distribution scheme in order to provide immersive experiences.
- It is based on HTTP, which means it is easily supported by many CDN services that operate over the top and by any platform or infrastructure adapted for web content (i.e. mobile networks).
- It is an adaptive standard. This might be of special interest in ImmersiaTV as the project will handle different devices, screens and resolutions (up to 4K in 360° video).

2) Metadata

All the metadata in ImmersiaTV is sent in XML format and is used to define events within a Scene, which is the basic ImmersiaTV container. Metadata can be added, removed or updated at pre-established times. Interaction is also defined in the metadata, and therefore it can be changed in response to user actions.

A Scene contains a sequence of Shapes placed in 3D that renders media (video, audio, etc.). Each shape contains media files, an anchor to specify where they are inside the 3D scene, and callback specifications to define the interactive behavior.

10. DISPLAY TECHNOLOGIES LEAFLET

IMMERSIATV

THE MULTI-DIRECTIONAL, MULTI-DEVICE BROADCASTING EXPERIENCE

PROJECT WORKFLOW

CAPTURE → PRODUCTION → ENCODING → DISTRIBUTION → **DISPLAY**

Key innovative features in ImmersiaTV - Display component:

- Multi-platform solution based on advanced Unity3D engine
- Content synchronization at the frame level based on emerging broadcast standards (DVB-CSS)
- Interactive playback with QoE feedback and codec quality adaptation

The display component is responsible for integrating the video, audio and data streams in a coherent omnidirectional scene adapted to immersive displays and second screens. It supports interaction, parsing the user input (head movements, tablet moved around, finger gestures) and adapting the environment appropriately to the reactions expected. It also allows to synchronize end-user devices and second screens, using a multimedia server to orchestrate the different video streams.

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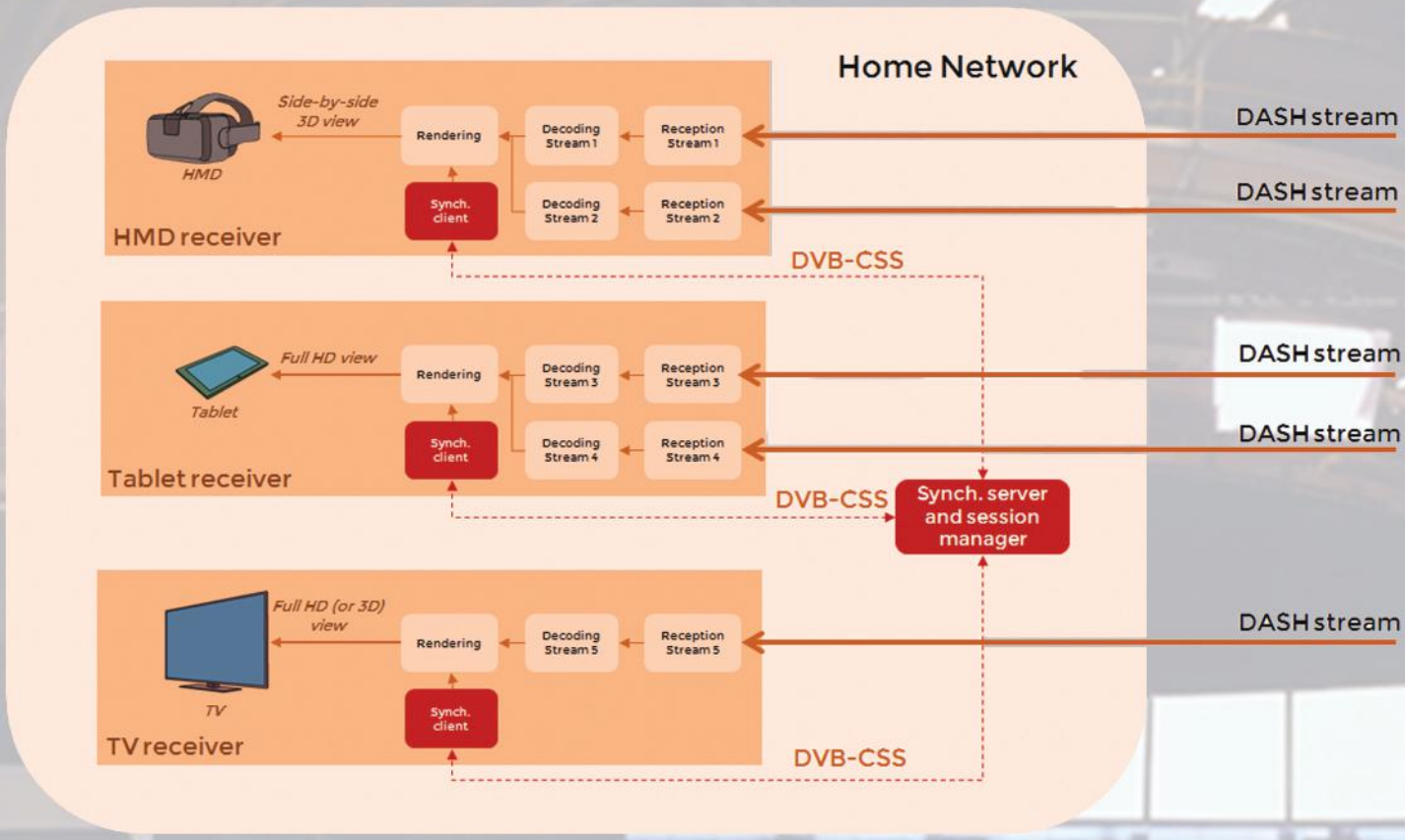
DISPLAY DIAGRAM



INSIGHTS

The display component is a multi-platform software solution that is able to:

- synchronize and integrate different video and audio streams in a consistent experience,
- handle the interaction specific to each device (head movements for the HMD, device movements and finger gestures for the tablet, etc.),
- synchronize content at the frame level with other displays in the local network.

The architecture of the display component contains two kinds of connected devices: receiver devices (TV Set, HMD, Tablet) and a session management device.
The receiver device runs the ImmersiaTV interaction and display software (in short, the ImmersiaTV player). This software is a multi-platform player targeting the general consumer. It is based on the Unity3D engine, allowing deployment on a wide variety of end-user devices and adapting the aexperience to the particular characteristics of each device. The processing of the media streams is performed using the GStreamer open-source framework. It receives and decodes different audio and video streams and delivers resulting frames to Unity3D for rendering. The ImmersiaTV player is designed to be compatible with emerging broadcast synchronisation standards (like HbbTV 2013), and work on the main platforms available to deliver the ImmersiaTV experience.

The session management device is connected to the same local network as the players and coordinates the distributed playback experience. Its main task is to make sure that all players synchronize to the same clock and get appropriate content. In the initial stage it is an application independent from other players, running on a separate machine. The goal, however, is to integrate it with the player application, so any player can act as session manager, removing the need for an additional device on the network.