
ICT-687655

Delivering Single and Multi-Screen Content Services for Immersive, Customised and Shared Experiences in Homes and Social Spaces



D6.1 r1 Innovation Management and Initial Exploitation Plans

Due date of deliverable: 30th November 2017

Actual submission date: 15th December 2017

Start date of project: 1 December 2015

Duration: 36 months

Lead contractor for this deliverable: IRT

Version 1.1 15th December 2017

Confidentiality status: "Public"

Abstract

The present document presents how the results of the 2-IMMERSE project shall be exploited. It sketches a plan for exploitation by identifying the potential assets that shall be made available outside the project and it gives an overview of the different mechanisms how this can be achieved.

An overview of dissemination activities of the first 6 months is given and a plan for future publications, talks and presentations of project results.

Partners in 2-IMMERSE are very active in relevant standardisation bodies, the document includes an overview of these activities which could be used to contribute project results into standards.

This is the first report of 2-IMMERSE work package 6. An update of this document is issued with the intermediate report in May 2017.

Target audience

General public. Everybody interested how results from 2-IMMERSE are planned to be exploited and disseminated.

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Impressum

Full project title: Delivering Single and Multi-Screen Content Services for Immersive, Customised and Shared Experiences in Homes and Social Spaces

Title of the workpackage: Innovation Management

Document title: D6.1 r1, Innovation Management and Initial Exploitation Plans

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This project is co-funded by the European Union through the ICT programme under H2020.

Executive Summary

Note: This is a revised version of D6.1 and includes as major update a first set of business models for the 2-IMMERSE platform and concepts. The standardization section has been updated to clarify the objectives of this task within 2-IMMERSE. A list of relevant standards bodies and groups is included, as well as an analysis of the MPEG MORE draft that shares similar goals with 2-IMMERSE. The result can be found in Annex 1. The dissemination section documents the improvements to the website, with regular blog posts and including video footage that shows the capabilities of the current 2-IMMERSE platform. The updates also clarify how the project targets various identified user groups.

This document presents the innovation management for the knowledge created in the H2020 Project 2-IMMERSE. Besides being a source of information for the public, it also serves as a guide for the 2-IMMERSE consortium partners and as information source for the European Commission.

Innovation management in 2-IMMERSE includes the exploitation, dissemination and potential standardisation of project results within and outside the member companies. The aim of 2-IMMERSE is to build four different pilots on a novel platform for multiscreen services. The expected assets that shall be exploited from the project are grouped into the following categories:

- **New forms of multi screen programming**
- **Production tools, insights and workflows**
- **Standardisation contributions**
- **Reference architecture**
- **Reference implementation**
- **Guidelines and design specifications**

To structure exploitation efforts 2-IMMERSE reuses an exploitation framework developed in the Vconnect project. The relevant mechanisms that will be used in 2-IMMERSE are

- **Influence the strategic directions of a partner**
- **Integration with an existing product/service**
- **Standardization**
- **Consultancy**
- **Open Source**

For the dissemination of results the target audiences have been identified. Beside typical ones like the general public and academics 2-IMMERSE wants to address especially programme makers and production engineers to make them aware and familiar with new types of programming and technology. The main dissemination channels are the web site, deliverables defined in the technical annex, workshops with practitioners. e.g. programme makers, trade fairs, etc.

The 2-IMMERSE architecture will build on open standards recognised and deployed by the broadcast industry. The project will evaluate their applicability for its four pilots, extending or modifying specifications if necessary. This shall be fed back into standardisation. Active membership of 2-IMMERSE partners in relevant standard bodies are documented.

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1 Introduction

2-IMMERSE is funded under ICT-19. The scope of ICT 19 is described thus:

The focus is on research, development and exploitation of new or emerging technologies (e.g. 3D and augmented reality technologies) for digital content creation to support the creative and media industries and for unlocking complex information and media and interacting with them. The topic will be addressed by the following actions:

2-IMMERSE is an Innovation Action, as opposed to a Research & Innovation action. Its focus is more on taking ideas and concepts out of labs and into trials than on developing concepts within labs. The Work Programme describes innovation actions thus.

Innovation Actions

Demonstration of the viability of new technologies and validation of innovative solutions through large scale demonstrations, pilots or testing of use cases so as to guarantee sustainable deployment that facilitate convergence and integration between broadcasting, broadband Internet-based services, audio-visual and social media. Multimodal and multidisciplinary approaches for searching technologies responding to the new demands from the content side (3D, user-generated, real-time media, social media, ...) and from the user context (context-centric, semantic, relevant community feed-back, ...). This also includes new forms of experiencing environments (immersive, surrounding, multi-sensory and interactive, in any device, always connected).

2-IMMERSE seeks to develop more immersive experiences that bring together TV and on-line services based on the use of multiple screens and an adaptation in the way content is delivered to those screens that enables customised and personalised delivery of content.

This document describes the framework and initial thoughts and activities through which 2-IMMERSE will manage the innovation within the project and seek to maximise the impact of its work and results.

Section 2 of this document describes the framework we use to manage innovation and exploitation. It introduces three key terms, the innovation asset (the thing we believe is exploitable) – the likely mechanism for exploitation and the method (and in particular the next steps) that will be taken to further the exploitation. This section includes descriptions of the assets that we expect the project to create.

Section 3 provides visions for new business opportunities that are enabled by the approach of object based broadcasting which is one of the main concepts behind 2-IMMERSE. These business models describe potential evolutions of the broadcasting eco system which may be built on the 2-IMMERSE platform and service exemplars.

Section 4 describes our dissemination approach with an initial analysis on our target audience and then a breakdown of the different channels we use to reach these audiences. It includes early successes in terms of dissemination.

Section 5 describes our approach to standardisation, highlighting the standards bodies to which we have access and the ways in which the outputs from 2-IMMERSE will be used to help the standardisation process.

2 Innovation Management and Exploitation

The partners in 2-IMMERSE comprise small companies, large corporations and academic and research organisations. Their common purpose is to explore the fusion of broadcast and broadband services through a number of pilots that employ multiple screens and devices to deliver a coherent experience of drama and live sport. Each company is known for its ground-breaking innovations in the value chain of creating, capturing and delivering engaging experiences to audiences. Each partner has its own channels and methods of delivering new ideas and technology to bare in his fields of operation. In this document we will describe our initial intentions for the exploitation and dissemination of the innovations resulting from the project and the mechanisms we intent to employ to achieve them.

2.1 IPR Management

The assignment of intellectual property amongst the partners has been covered in section 8 of the completed and signed Consortium Agreement.

Ownership of intellectual property shall be shared where there is joint invention and where the IPR cannot be broken down into subcomponents for the purpose of applying for, obtaining and maintaining protection.

IPR will be an agenda item for each Project Management Committee meeting and discussed during the weekly conference calls when appropriate, e.g. if a new opportunity to file is identified.

2.2 Exploitation Framework

The framework used to describe exploitation in 2-IMMERSE was developed during the Vconnect project (<http://www.vconnect-project.eu>). It is based on the experiences of the partners involved (as well as on many external discussions with other European projects). The framework is composed of two main concepts:

- **Exploitation mechanisms:** this refers to the different exploitation channels that can result in the commercial use of the technological innovations.
- **Exploitation methodologies:** this refers to the enablers that make it possible to exploit certain technologies in different contexts.

The following sections use this exploitation framework to describe the intentions of the project at this early stage.

2.2.1 Exploitation Mechanism

Because of the different business foci of each partner, several mechanisms will be used for making commercial use of the project results. As we embark on the project and without complete knowledge of what the project will realise, we expect the following mechanisms to be the most relevant ones for 2-IMMERSE.

Integration with an existing product/service: The consortium represents businesses across the workflow from capture of sound, images and data to editing, compositing and delivery and finally to engagement with audiences. For the larger companies channels to the businesses are good and involvement with editorial and production is good. Through Illuminations TV we have our associate partners, the Royal Shakespeare Company and Illuminations' capacity to deliver experiences at scale. Similarly, Chyron-Hego is a fast moving digital innovator in the area of sports data capture and delivery. BBC, BT, Cisco and IRT all have R&D functions with links through company structures to enable the flow of IP into products and services. As broadcasters BBC and BT are keen to discover how they can increase the enjoyment of their live and on-

demand sport and drama content by audiences through integrated and augmented multi-screen services. Cisco is an important network services partner in this delivery value chain.

IRT has developed a cloud service-based Second Screen Framework as part of the EU FP7 FI-CONTENT project. IRT may extend this framework to include the new features of HbbTV 2.0 if it fits with the 2-IMMERSE architecture.

Influence the strategic directions of a partner: All the commercial partners intent that 2-IMMERSE results will have a strategic impact on the way their companies deliver experiences to audiences. BBC, BT and IRT are looking for effective and engaging ways to tell stories and convey live events across broadcast and broadband routes that fuse the capabilities of scale and personalisation. 2-IMMERSE will inform these strategies. The form through which this impact is realised may depend on whether the company is a Public Service Broadcaster or a subscription content provider. Both BT and the BBC have innovative Sports service teams making the most of the crossflow between broadcast and broadband services. These teams are keen innovators and explorers of new capabilities. In the network service space the 2-IMMERSE consortium includes Cisco's innovation team responsible for the 'Fresco' multi-screen pilot. We intend that the technical knowledge acquired during the 2-IMMERSE project will influence the strategic directions within our organisations. Results from the project will be used as showcases and discussions with higher-level management regarding live coverage of events and the synergistic strategies across broadcast and online content and services. Through BBC R&D's Taster platform a number of new online services are tested in the public arena, most recently Story Arc a way for exploring the stories and characters in a popular drama 'Peaky Blinders'.

Standardization: Our aim is to build on existing and emerging standards to accelerate the developments of the capabilities and services we hope to enable. Our primary focus is on HbbTV 2.0 as it appears to cover many of our ambitions, but currently only exists as an approved specification. We will also work through our links with W3C and others on specifications such as WebRTC and TAL, as they become appropriate to our success. The 2-IMMERSE platform's reference architecture and APIs will be aimed at sustainable delivery, enabling others to extend and augment the services available to producers and audiences. Enabling new distributed media apps beyond the life of the project will extend the coverage to other content genres increasing the impact and the market for multi-screen content.

Consultancy: The wisdom and know-how derived from the experience of building the capabilities to deliver the four pilots and the feedback from audience and production team data will almost certainly shape the relationships of the partners within the value chain. Though formal consultancies might be pursued by academic partners' presentations, demonstrations and papers will also be a route to impact more broadly.

Spin-Off: It is hard to say whether the circumstances of the market and the individuals and organisation participating in 2-IMMERSE will lead to spin-off/start-up activity. We have no intentions at this point to do other than exploit the results within the consortium and to the benefit of the industry as a whole.

Licensing: Decisions about licensing will be made in the light of the progress and the solutions developed to meet the needs of the pilots and the sustainable architecture that evolves. The consortium agreement covers the methods by which licensing opportunities may be pursued by the consortium partners but see 'Open Source' below.

Open Source: The 2-IMMERSE consortium fully intends to make the technology open to the industry, following the success of previous open source packages (e.g., AmbulantPlayer or VideoLat by CWI). The capabilities we will enable will need a community of practice to develop

around them to fully exploit the opportunities created and the challenges still to be addressed. Though there is no immediate monetary return the indirect benefits from this type of exploitation are high, as it helps to build an industry heavily dependent on partnerships and innovation.

2.2.2 Exploitation Method

We expect market exploitation of project outputs from within the consortium and as a result organisations external to the consortium building on the published papers and open source code we deliver. We will develop prototype services as we progress through the build of our four feasibility pilots. We will make accessible tools, libraries and APIs for further development during and beyond the project whilst taking full advantage of the opportunities to file IP significant to the businesses of the partners. In the area of Open Source tools, BBC has already posted - VideoContext - a set of media libraries for composition and rendering on the Web and CWI maintains – Ambulant Player – a media video player, enabling rich composition and synchronization.

Individually, the partners will augment their own current processes for assessing IP and innovation opportunities from the work of their employees. At the BBC regular review meetings with the Partnerships team cover the opportunities for impact and considerations for IP protection and contributions to Open Source and Standards communities. The BBC, IRT, BT, CWI and Cisco have good track records for contributions to Industry Standards. Methods may differ across organisations but the end results are the same: careful choices made between research, management and legal professionals intimate with the organisations businesses and strategic directions. In the case of the BBC the impact strategy is to fulfil its public purposes as a Public Service Broadcaster; for BT it is to build on the success of its entry into the Broadcasting market and its long established position as a networking and telecommunications technology and service provider; for CWI is to enable an open ecosystem based on early research on novel technological areas.

Illuminations will seek to incorporate features of the service prototype provided they have a clear ability to better achieve the aims of those that commission the content. Thus (for example) if the RSC are persuaded that the multi screen aspects of the productions clearly improve engagement and educational outcomes then work will commence to deliver the new multi-screen experiences for schools.

Within the consortium the three-day quarterly meetings within which the PMC sessions are hosted will provide the main forum for tactical and strategic decisions with regard to the best routes to optimise the projects impact. Innovation workshops within these meeting will explore the potential of technology and knowhow created in the Work Packages to be exploited within the partners, the industry and the wider community.

At the heart of the pilots are the audience benefits and their impact on economic, social and cultural health. To deliver the pilots prototype services, production and delivery tools, experience designs and process innovation are expected to be created. These will form the seeds for broader impact. Enablers of impact will include architecture designs, prototypes, papers, trial results and feedback from academic and industrial review.

Individually and locally, each of the teams contributing to the 2-IMMERSE project will be reviewed objectively by the stakeholders within their organisation. In addition Consortium innovation workshops will report back to these internal processes and be guided by the enquiries they make.

2.3 Exploitation Assets

The project will conduct innovation workshops to ensure we identify, and build a plan for the exploitation of, innovation assets at the earliest opportunity. We anticipate generating assets such as: New forms of multi screen programming; Production tools, insights and workflows; Standardisation contributions; Reference architectures; Reference implementations and Guidelines and design specifications.

The table below shows the relationship between the work packages the forms of asset generated.

Workpackage	Asset type
WP1 – Project coordination and Management	None
WP2 – Distributed media Application Platform WP5 – Components for Multi Screen Entertainment	<p>Standardisation contributions</p> <p>The two technical work-packages will develop insights that may be relevant for standardisation bodies – such as use-cases that are not well supported by the current suite of standards.</p> <p>Reference Architecture</p> <p>The early work of D2.1 has already described an architecture for the 2-IMMERSE project. This architecture, which has been designed to enable the four multi-screen service prototypes that will be delivered through the project, is layered as a set of platform services, a client application architecture and production architecture. The publication is a public deliverable available through the web site.</p> <p>Reference Implementation</p> <p>This is a work in progress. D2.2 will document APIs and other enablers that will allow the project (and others) to build the reference architecture. This deliverable will also be available on the web site when completed.</p>
WP3 – User Interaction Design	<p>Guidelines and Design Specifications</p> <p>Insights about the design and production of multi-screen experiences as they relate to the user experience. This tacit knowledge may be exploited through making the knowledge explicit in the form of guidelines and design rules.</p>
WP4 – Prototype Services Development and trial	<p>New Form of Multi Screen programming</p> <p>New forms of multi-screen programming which can act as exemplars of subsequent production investment.</p> <p>Production Tools, Insights and Workflows</p> <p>New content forms usually need some instructions (or at least knowledge) about how to make them efficiently. Such knowledge will be generated during the development of the trial prototypes</p>
WP6 – Innovation Management	None - though it will manage exploitation activity on other WPs

Being more specific we highlight some assets that we anticipate and the bodies to whom such assets may be useful:

Asset: New forms of multi screen programming	
based on Filmed Theatre for a school audience.	Royal Shakespeare company, BBC, BT, Illuminations
based on Filmed Theatre for people at home	BBC, BT, Illuminations
related to MotoGP for people at home	BT, Dorna Sports, BBC
related to Football for people in pubs and clubs	BTSport, BBC

Asset: Production tools, insights and workflows	
New production tools that support new workflows for Object Based Production of Content.	BBC, BT, Chyron Hego, CWI
Insight and know how about content capture and handling to support the production of multi screen programming	BBC, BT, Chyron Hego, CWI

Asset: Standards related	
Adaptation and extension to the HbbTV 2.0 specification that will enable more compelling multi screen programming types based on objet based Production to be experienced.	HbbTV association and associated /referenced standards bodies
Exemplar implementations using HbbTV2.0 that may inspire and accelerate market evolution.	Manufacturers (of TV's and Set top boxes),

Asset: Reference Architecture	
Development of a reference architecture which has been validated through iterative implementation over the four service prototypes.	CISCO, BT, BBC, IRT, CWI, ChyronHego

Asset – Reference Implementation	
A set of platform service components, client applications and Distributed Media Application components, which we aspire to open source at the conclusion of the project	CISCO, BT, BBC, IRT, CWI

Asset: Design specifications	
Design specifications for the proven delivery of content streams, to multiple devices and multiple users simultaneously (future smart TV, set top box, content steamer, iPlayer)	CISCO, BT, BBC, CWI
Designs recommendations and proof of concept for the successful delivery of coherent and appropriately synchronised content across multiple devices.	CISCO, BBC, BT, CWI
Design recommendations for effective and user-friendly set up and management of end-user multi-device environments (building on the specific examples of Drama and Sport).	RSC, BT, BBC
Design recommendations for effective end-user interaction within multi-device experiences (building on the specific examples of Drama and Sport).	RSC, BT, BBC
Guidelines for the development of distributed media applications to extend the services and experiences offered to users of multi-screen environments	BBC, BT

3 Business models

2-IMMERSE is advocating for an object based broadcasting approach as we believe it offers viewers the opportunity to more deeply immerse themselves in media experiences.

In section 2 we describe the 2-IMMERSE exploitation strategy and the concrete assets that will result from the project and are expected by each individual partner to be employed. The main assets will be the 2-IMMERSE platform consisting of a number of production tools, cloud services and exemplar client applications accompanied by design guidelines. This section presents a set of business opportunities that are based on the object based broadcasting approach as the major concept behind the 2-IMMERSE platform. The models reflect a broader vision of the project partners' perspective as commercial and public service broadcasting houses, as content producers and technology providers.

The following six business models are analysed:

1. **Flexible content packages:** The development of flexible content packages for upselling/differentiating subscription based content experiences
2. **3rd Party App Insertion:** The opportunity for third party providers to situate their app in a context that is relevant to the viewer and likely to enhance the viewers overall experience and at the same time meet the objectives of the third party app provider
3. **Object protection:** Managing and enforcing the rights to access the different packages by viewers.
4. **Premium pricing for enhanced cultural content:** Cultural experiences, watching a filmed performance of a play for example, are available through OTT video service providers today. The object based approach offers providers the opportunity to positively differentiate their offering and create a higher value and / or a more popular service through such differentiation.
5. **Customer usage analytics:** On-line media experiences can reveal much richer analytical data that can help with (for example) more precise customer segmentation. Knowledge of the viewer segments can be used by service providers and ad agencies to increase the value of the advertising spots they sell within an object based media experience.
6. **Targeted ad insertion:** A feature of the object based broadcasting approach is that the service provider will glean more knowledge of their viewers, either explicitly - through registration - or through implicit means, making inferences from expressed preferences. Knowledge of the viewer enables service providers to sell ad space that is targeted to specific demographics/customer segments.

In the following sections, each of these different value creation opportunities is described with reference to a business model canvas. The form of the business model canvas is shown in Figure 1 below. It offers a way to describe some of the key characteristics of the business that could be created through the object based media approach that the 2-IMMERSE platform illustrates.

Business type				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> ..what roles must the business conduct to realise the value? 	<ul style="list-style-type: none"> ..with which other business types will this business need to make effective working relationships? 	<ul style="list-style-type: none"> Why will the customer buy this service/product rather than an existing alternative? This should be answered per facet of the business model. 	<ul style="list-style-type: none"> (per segment) 	Business models may be multi faceted And within each facet there may be particular customer segments that are clear targets.
	KEY RESOURCES		CHANNELS	
	<ul style="list-style-type: none"> That distinctive roles that must exist within the business for it to operate effectively 		<ul style="list-style-type: none"> (per segment) 	
COST STRUCTURE			REVENUE STREAMS	
<ul style="list-style-type: none"> Key costs to which the business will be subjected 			<ul style="list-style-type: none"> Where is the money coming from? 	

Figure 1: Business Model Canvas template

This business model canvas approach is used in helping new ventures to develop and is discussed in some detail at the following link: <https://www.alexandercowan.com/business-model-canvas-templates/>. The two key boxes (in red) are the value proposition and the customer segment boxes. Prospective ventures that cannot populate these two boxes convincingly seem unlikely to thrive. We report the results of applying the business model canvas approach to each of the opportunities identified above.

3.1.1 Flexible content packages

The business canvas described in Figure 2 below outlines the way this business opportunity works. The fundamental premise is that the object based nature of the viewing experience will allow service providers to present a given core rights asset (let’s say Football) in different packages offering different value to the viewers.

For deaf viewers, for example, additional components could be included such as signing or auto subtitling; likewise blind viewers might benefit from different commentary streams that included more description than typical TV commentary. Such services could help service providers to meet accessibility goals.

More commercially, subscription and ad supported services may be able to offer versions of a service that include enhanced features such as additional always available statistics, additional camera views or more control over the audio – possibly including selecting alternate commentaries or by varying the audio mix perhaps emphasising crowd noise over commentary – or vice versa.

Likewise some viewers may seek greater participation through messaging capabilities and through gaming and gambling services that could be added in to the service as part of particular bundles.

Flexible Content Packaging				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> Content package development Marketing and sales Content scheduling Content curation Customer analytics 	<ul style="list-style-type: none"> Content producers Data providers Rights owners Analytics providers 	<p>From a TV service operator Broad flexible portfolio of content services with different associated rights costs and customer value propositions</p> <p>To viewers Choice & control over your content experience</p>	Billing relationship with the account holder and direct viewer profiles mediated through sign in and customer IDs	<p>Viewers</p> <ul style="list-style-type: none"> Subscribers to bundled TV services Subscribers to OTT content services (multiple niche).
	<p>KEY RESOURCES</p> <ul style="list-style-type: none"> Content producers curators Content distribution platform Software developers 		<p>CHANNELS</p> <ul style="list-style-type: none"> To viewers - Direct 	
COST STRUCTURE			REVENUE STREAMS	
<ul style="list-style-type: none"> Content rights Network distribution / platform management Software development and maintenance Billing/customer service 			<ul style="list-style-type: none"> Increased number of viewers/subscribers Increased ARPU Increased retention 	

Figure 2: Business Canvas for "Flexible Content Packaging"

The flexible content package would, in the first instance, address subscribers to particular content services but the nature of the service would mean that much greater customer segmentation could be achieved. Currently, it is hard for TV companies to meet the needs of those with hearing or sight loss specifically. Likewise, the programming is largely a “one size fits all” option with editorial decisions being taken to appeal to the viewership “in general”. The flexibility of the object based approach would enable service providers and viewers to negotiate the features and characteristics they want and for clear customer segments to emerge – so the sports fan with a deep keenness for statistic could be distinguished from the social sport fan who wants atmosphere rather than possession stats.

The value proposition is multi-faceted offering value to viewers, advertising agencies (and ultimately brands) and to those developing content components that could sit within the object based experience. So, we have three segments, viewers, ad agencies and content component owners

The flexible content packages would operate within the normal world of content service provision and would be sold using the same mechanisms that content service providers currently use, for example

- Transactional video on demand (tVoD)
- Subscription based video on demand (sVoD)
- Ad supported video on demand
- Public service broadcasting (PSB)

Value, for each of these models is measured differently, particularly for Public Service Broadcasters. In many cases it can be correlated with the numbers of viewers and for ad supported services with the accuracy with which viewers can be identified for advertisers and the value of the targeted demographic.

The value proposition to viewers is that they could control and augment their viewing experiences through access to additional content, services and data related to the main content. In the context of sport (football say), the ability to review replays, to observe match player and league statistics or to view additional camera feeds or hear alternative commentaries may all offer value to the viewer. (Note – another example for the cultural experience business model, is described in the section related to the enhanced cultural content business model.)

The value proposition to those generating content components is complex and unclear. We anticipate that cash flows could be in both directions. Sometimes the owner of the flexible content packages may feel the value added to the experience of the viewer by incorporating a particular content component is worth paying for. In other cases a content component creator may really value being present in this particular context and be prepared to pay for that privilege. For example, sports data adds to the experience of watching sport and that data may be paid for by the flexible content package owner. Betting applications also increase the value of watching sport for some viewers, but being the betting available in a context that is likely to be a fertile sales ground for the betting vendor would be of value to betting companies and they would, presumably be prepared to pay for that.

The value proposition to advertising agencies is that the ad spots are more valuable as more is known about the viewers, due to understanding of the viewer gleaned from registration and inferred from the preferences they have expressed. Clearly an ad spot that is known to be seen by a Female aged 20-30 would be more valuable than a generic ad spot that may be seen by any demographic.

Likewise ad sales would operate within the current advertising chain. The content component may (as described above) appear like content rights acquisition (for example, sports data) or ad sales as in the case of the betting app example.

3.1.2 Insertion of 3rd party applications

TV and film famously depend upon a wide range of highly skilled teams to create the content that we watch. But we, the viewers, have no opportunity to deselect or to promote the contributions of particular teams to change the way we enjoy a particular programme. Enabling this is the opportunity of 3rd Party App insertion. With object based delivery and access to a flexible multi-screen canvas we think it should create a market for apps that can augment and enhance certain programming.

Insertion of 3 rd Party Apps				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> - Negotiations with app providers and content producers - Advertising new services - Compliance checking - Content curation - Content scheduling 	<ul style="list-style-type: none"> - Content authors - Tracking data provider (sports) - Betting agencies 	<ul style="list-style-type: none"> - Improving attractiveness of service for viewers - Keep or increase number of subscriptions - Cost effective outsourcing of content production - Higher reach of service (the 3rd party app) by sharing viewers 	<ul style="list-style-type: none"> - direct - Open app store 	App providers <ul style="list-style-type: none"> - Bookmakers - Sports content, e.g. stats - Accessibility service provider - News, stock feeds - Weather
	KEY RESOURCES <ul style="list-style-type: none"> - Infrastructure to embed 3rd party apps, e.g. app store 		CHANNELS <ul style="list-style-type: none"> - direct - 3rd party app store 	
COST STRUCTURE			REVENUE STREAM	
<ul style="list-style-type: none"> - Content rights - CDN and platform management - Development and operation of 3rd party apps platform incl. service interfaces - Billing and customer service 			<ul style="list-style-type: none"> - 3rd party provider sharing revenue with service provider - 3rd party to be paid by service provider - Subscription fees 	

Figure 3: Business Canvas for "3rd Party Applications"

For example, with sports programming, a viewer may be particularly keen on the statistics relating to the game and may value additional components that allow them to access and display such statistics. It is possible that a number of providers of statistics packages, all with access to broadly the same core numbers, generated and sold by companies like Opta, may compete with each other based on the way they present the data, perhaps on the ease of use of their service or the granularity of the statistics or

the frequency and accuracy of updates. It is quite conceivable that such providers could either compete to be the provider of choice in the bundles the service provider creates for their customers, or they could be accessible through an open market sold direct to viewers as ‘add-ins’, much like phone-apps compete within the app stores of iOS and Android.

Commercially a different model is to include service components from 3rd parties that improve the attractiveness of the broadcasters offering or help to fulfil the broadcasters obligations for providing accessibility services like sign language and audio description. The coverage with sign language currently is rather poor, public broadcasters in Germany have only one program a day (news) that includes a burnt-in video with a sign language interpreter. A reason is that production costs are quite high. With the 2-IMMERSE platform that allows to embed external AV sources via Internet a third party can provide authoring and production of single A/V service components. This kind of offering could be included through bilateral agreement between the broadcaster and the 3rd party including a revenue flow from the broadcaster to the 3rd party or from the viewer to the 3rd party.

Whilst these 3rd Party apps may offer some viewers more value, the payment model is not yet clear but here there are three options:

- The TV service provider pays for the apps and bundles them into packages that are then promoted and sold to subscribers/viewers (see Flexible content packages)
- Apps could be free to the viewer – like apps that may enhance accessibility and these may be paid for by the service provider and available to all as part of a regulatory and compliance obligation.
- Apps, like betting apps for example, may be freely available to the viewer but the betting companies may pay to be the betting app provider of choice – or they may enter into revenue share deals with the TV service providers.

3.1.3 Provision of premium cultural content

In Europe and the United States there is a developing marketplace for the provision of cultural content, including arthouse films, theatre performances, opera and dance, directly to individuals as OTT media as well as to educational organisations. The cultural organisations that own this content and that create it in partnership with media producers are seeking ways both to distinguish their offerings in a strongly competitive marketplace and to justify premium pricing, whether of individual events or as subscriptions.

The 2-IMMERSE platform will offer the opportunity for cultural organisations to offer enhanced and enriched services that complement their existing offers. The cultural organisations can attract larger audiences and grow their subscriber bases with these enhanced services, at the same time as being able to develop a premium pricing structure. And this is applicable both to transactions for individual events, for consumer subscriptions and for the provision in bundled form to educational establishments.

In many contexts, however, the provision of cultural content is motivated by concerns other than direct revenue. Cultural organisations supported by public subsidy and/or philanthropy wish to see their productions disseminated as widely as possible, to be extensively available for educational use and to be explored and used intensively.

The enhanced services facilitated by the 2IMMERSE platform can differentiate the offers of the cultural organisations that develop them, as well as deepening their value to users, and as a consequence the organisations can secure extended subsidy and more sponsorship support.

Provision of premium cultural content				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> Media and DMApps production and provision of support Creation and delivery of enhanced cultural content Operation of complementary services 	<ul style="list-style-type: none"> Cultural orgs; e.g. film distributors, theatre companies Media producers Streaming services 	<ul style="list-style-type: none"> Offer of enhanced and enriched cultural media with related content and services Differentiation of cultural media offerings in competitive marketplace 	<ul style="list-style-type: none"> Online activities of cultural institutions OTT platforms 	<ul style="list-style-type: none"> Cultural consumers seeking in-depth experiences Members/friends of arts organisations Life-long learners Educational institutions
	KEY RESOURCES		CHANNELS	
	<ul style="list-style-type: none"> Cultural rights Production expertise 		<ul style="list-style-type: none"> Real-world + online presence of cultural organisations OTT platforms 	
COST STRUCTURE			REVENUE STREAM	
<ul style="list-style-type: none"> Creation of additional media Acquisition of additional rights Production and support costs 			<ul style="list-style-type: none"> Premium charging to individuals and to educational institutions for subscriptions and access to individual events Greater opportunities for sponsorship attracted by distinctive and enhanced service 	

Figure 4: Business Canvas for "Premium Cultural Content"

Related to such provision by cultural organisations is the business model available for development by media producers such as the 2IMMERSE partner Illuminations. Media producers partner with cultural organisations to develop their content for broadcast and online provision. This activity is funded by the cultural organisations, by providers such as broadcasters and via public subsidy and sponsorship. The production and support of enhanced services using the 2IMMERSE platform is a business opportunity that we expect taken up by media producers, including Illuminations themselves.

3.1.4 Customer Analytics

Through object-based broadcasting, 2-IMMERSE brings the ability to orchestrate an experience seamlessly across multiple screens at the same time. This environment also offers the unique opportunity to instrument customers' behaviour synchronously across all the devices participating in the experience.

Today, Pay TV providers and OTT content platforms work with third parties (e.g. Conviva, Looker) to manage the capture, processing, analysis and presentation of rich data related to the performance and usage of their services. This business canvas illustrates how this role could be applied to multi-screen experiences. The opportunity is clearly most relevant to industry segments who are most likely to enhance their traditional broadcast or on-demand content by targeting complementary content at companion screens in order to differentiate their service. These are most likely to be sports broadcasters, PSBs or production company owners of specific high-value content brands.

Customer Analytics				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> Building and supporting large-scale data capture infrastructure Instrumenting software components across all major platforms Behaviour analytics Performance analytics Aggregation Reporting and presentation 	<ul style="list-style-type: none"> Software component vendors Platform providers Device manufacturers 	<p>From an Analytics Provider to a TV Service Provider or Producer: Offer a managed service for the capture, processing, analysis and presentation of customers' behaviour and service performance within a DMAApp.</p> <ul style="list-style-type: none"> Unique insight into multi-screen behaviour Service benchmarking 	<ul style="list-style-type: none"> Account managed Aggregated, anonymized data published to industry. 	<ul style="list-style-type: none"> Pay-TV service providers and OTT content platforms – especially those offering companion apps – e.g. <ul style="list-style-type: none"> Sports broadcasters Public service broadcasters TV Production companies creating companion experiences to support TV brands.
	KEY RESOURCES		CHANNELS	
	<ul style="list-style-type: none"> Software developers Data Scientists Scalable data infrastructure 		<ul style="list-style-type: none"> Direct Public website 	
COST STRUCTURE			REVENUE STREAMS	
<ul style="list-style-type: none"> Software development and maintenance Cloud infrastructure, security and scalability Consultancy and account management Free-to-Industry benchmarking to achieve visibility and credibility 			<ul style="list-style-type: none"> Service usage fees (different models possible) Consultancy fees for specific data insights Bespoke instrumentation development fees Sale of aggregated, anonymised data 	

Figure 5: Business Canvas for "Customer Analytics"

The proposition addresses two main benefits – behaviour insights and performance. The TV service provider will value behaviour insights because these indicate engagement with their content on a fine-grain level and can be used to create a sticky, personalised experience – potentially in near real-time. Behaviour insights can also add significant value to targeted advertising, increasing the value of ad spots sold inside an instrumented, multi-screen experience.

Performance data is equally vital for a TV service provider because it helps them to manage their service while minimising churn and cost to serve. This is especially true of multi-screen experiences which are complex and place additional demands on devices and home infrastructure while raising customer expectations as premium services.

Platform providers should see customer analytics as an essential tool to help service providers optimise performance. Indeed, some of today's analytics providers publish anonymised aggregated data to establish industry-wide service benchmarks and indicate how well a particular service provider is doing in comparison.

Customer Analytics is generally a managed service, based around building strong relationships with TV service providers and use constant feedback to inform requirements and evolve the product.

3.1.5 Dynamic Ad Insertion

Dynamic ad insertion for commercial broadcast services is a hot topic currently. This is not only reflected by the high number of showcases at IBC 2017, but also by a study mission installed by the DVB consortium. For commercial broadcaster advertising is the main source of funding. In 2017 Broadcast advertising hold 50% of the German advertisement market revenue share. Whereas advertisement on Internet and mobile platforms together account for only 12% of the share¹.

¹ <http://www.nielsen.com/de/de/insights/reports/2017/top-ten-trends.html>

Targeted Advertisement				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> Upgrade broadcast infrastructure to include sync points Marketing new features to ad agencies and owners of advertised brands 	<ul style="list-style-type: none"> Broadcast playout provider Ad agencies Brand owners TV manufacturers 	Offer targeted ads, regionalized and personalized, either as <ul style="list-style-type: none"> banner or L-shape side-by-side with broadcast or replacing spots on "free" ad slots 	<ul style="list-style-type: none"> Direct 	<ul style="list-style-type: none"> Ad agencies Advertised brand owners
	KEY RESOURCES <ul style="list-style-type: none"> App developers Broadcast engineers Marketing people 		CHANNELS <ul style="list-style-type: none"> Direct 	
COST STRUCTURE			REVENUE STREAMS	
<ul style="list-style-type: none"> Upgrading and operating broadcast infrastructure to enable targeted ads CDN 			<ul style="list-style-type: none"> Increase revenue per available ad slot Keep revenue share while competing with OTT and VOD provider 	

Figure 6: Business Canvas for Targeted Ad Insertion

Air time for advertisement is rare, as regulation restricts the share of advertisement in the programme. Nevertheless, broadcasters do not achieve top prices for every available ad slot. Broadcasters compete with other broadcasters and also with a growing number of OTT platforms. The ability to regionalize and personalize advertisement can help them to defend their business. Platforms that support object based broadcasting like HbbTV, allow to individually overlay the broadcast signal with personalized ads, implemented as for example:

- Graphical overlays
- Replacing some spots of an ad break to increase the revenue for the individual slot

The first option is already applied by broadcasters in Germany. As it is not strictly synchronised with the broadcast signal there is also no need for changes to the broadcast infrastructure. Also, it can be deployed to TV devices which support version 1 of the HbbTV specification. This option has therefore a large potential market reach as there are already 11.5 million German households that own an HbbTV version 1 device that is connected to the internet. The second option requires some synchronisation of the broadcast service with the playback of the personalized ad. Depending on the requirements for accuracy this means an additional investment to upgrade the broadcast infrastructure allowing for a synchronised transition between broadcast and broadband for an individual viewer.

Information that helps to personalize content can be inferred from different sources, including the usage history (which could be collected per device) or the information associated with the account of a logged in user.

3.1.6 Object protection

The business canvas previously presented in Figure 2 for ‘flexible content packaging’ requires a capability for managing and enforcing the rights to access the different packages by viewers. The ‘Object Protection’ business canvas presented above in Figure 7 summarises the business opportunity for this capability for a Digital Rights Management (DRM) technology or ‘as-a-service’ provider. This can be seen as an evolution of their existing business model, which is typically direct to TV Service Providers.

The value proposition to TV Service Providers (be that traditional Pay-TV Service Providers, or ‘Over-the-top’ (OTT) content platforms), is to offer DRM technology and services that make it simple to manage protection of multiple media objects within a set of content packages i.e. a Distributed Media Application (DMApp). This would include enabling management of access to different content (object) packages, and potentially the re-use of protected objects in multiple DMApps.

In providing this capability, the expectation would be of increased licencing or usage revenues driven by increased numbers of viewers / subscribers, and an overall increase in the number of protected objects per content package (i.e. viewing experience).

Key activities for the DRM technology or ‘as-a-service’ provider include DRM technology development (both servers and client device ecosystem), ‘as-a-service’ operations and breach management / enforcement, with cost structure and key resources reflecting these activities. Key partners include distribution encoder / packager suppliers, platform provider / CDN and Device manufacturers, each of which requires some level of DRM system integration / support.

Object Protection				
KEY ACTIVITIES	KEY PARTNERS	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
<ul style="list-style-type: none"> • DRM technology development (servers & client device ecosystem) • ‘as-a-service’ operations • Breach management / enforcement 	<ul style="list-style-type: none"> • Distribution encoder / packager suppliers • Platform provider / CDN • Device manufacturers 	Offer DRM technology & services that make it simple to manage protection of multiple media objects within a ‘DMApp’, enabling management of <ul style="list-style-type: none"> • Access to different content (object) packages • Re-use of protected objects in multiple DMApps 	<ul style="list-style-type: none"> • TV service operators 	Traditional Pay-TV Service Operators OTT Content Platforms
	KEY RESOURCES <ul style="list-style-type: none"> • Security expertise • Software developers • ‘as-a-service’ operators 		CHANNELS <ul style="list-style-type: none"> • Direct 	
COST STRUCTURE			REVENUE STREAMS	
<ul style="list-style-type: none"> • Software development and maintenance • Breach management / enforcement 			<ul style="list-style-type: none"> • Increased numbers of viewers/subscribers, and no of protected objects per experience drives as a service / pay per use revenues 	

Figure 7: Business Canvas for "Object Protection"

4 Dissemination

The section revisits 2-IMMERSE dissemination plans and activity to date. In the proposal we listed the target audiences for our dissemination as:

- **General Public** – who require information described in easy to understand language.
- **Academics** – who require rigorous presentation of scientific results.
- **Programme makers and commissioners** – who require exemplars of production practice and object-based experience design and production workflows and tools with which to explore these.
- **Production engineers and suppliers** – who require concise and convincing presentation of exploitation opportunities and potential business models (from ITC suppliers, broadcasters, production houses and public venues).

At this stage of the project we can be more specific about the stakeholders and the broader communities for whom the project will be critical for some and of interest to others. In the broadcast and project value chains implicated by the pilot services are:

1. **Commissioners:** who need to be convinced of the value of experiences to their audiences;
2. **Content Producers** who need to be convinced of the value to and consequence for their art and their craft;
3. **Broadcasters** who need to understand the business value against the challenges of delivering broadcast quality content in new interactive formats;
4. **Venue owners** (such as hospitality chains who own pubs and restaurants) who need to understand the business benefits to their establishments;
5. **Audiences** who need to know why they should try new experiences;
6. **Project partner organisations and the EU Commission** who need to know whether the project's targeted and achieved contributions are worth the resource investment;
7. **Software developers and hardware manufacturers** who need to be able to build on and extend the platform and conform to its specifications to deliver the targeted experiences;
8. **Standards bodies and regulators** who need to monitor the performance of standards specifications and the evolution of new ones to enable industries to thrive;
9. **Academics:** who need to have an understanding of the social and technical science behind the contributions made;

In order to deliver the four service pilots in sport and theatre we will engage with practitioners in categories 2-7. Individuals and companies will be consulted and contribute in the process of designing and delivering the trials but we hope to reach broader audiences within these. We will deliver presentations and workshops at practitioner and industry-driven events such as IBC, ACM TVX, ACM CHI, NEM with the intention of testing our contributions and building a Community of Practice to further explore and experiment with our object-based, multi-screen experience delivery platform beyond the lifetime of the project. By building an extensible platform to support the four service pilots we will test the appropriateness and completeness of standards to support the requirements for delivery.

Only through the delivery of content experiences and audience feedback will commissioners (cat.1) take note. Along the way as results come in we have academics on the project who will generate peer reviewed publications at conferences and journal articles (the latter more likely towards the end of the project) (cat. 9). Attending top conferences since the beginning of the project is thus important, as it provides a good dissemination outlet and good networking opportunities. Highly recognized conferences gather academics, practitioners, and commercial partners: producers, broadcasters, and academics. In particular, the project targets the following academic international conferences, independently of the continent in which they are hosted each year:

- ACM CHI, which it is the premier international technical and UX conference for computer interaction. The conference attracts yearly over 3000 participants from all over the world, including representatives from industry. For example, the course that was run by CWI in 2016 was attended by people working at YouTube, Facebook, and many other relevant companies and universities.
- ACM TVX, which it is the premier international conference on interactive experiences for online video and television. The conference attracts yearly over 100 participants from all over the world, particularly attracting representatives from the broadcast and online video world: Samsung, YouTube, Facebook, Nokia... For example, during TVX2016 CWI attended the TVX in Asia Forum, networking with companies such as NHK, NTT, and Samsung.

The standardisation community (cat 8) is addressed by public presentations at trade fair shows, as 2-IMMERSE makes use and promotes open standards from DVB and HbbTV. However, there are no specific technical contributions planned from 2-IMMERSE, though partners may take advantage of an opportunity arising. For further details please refer to section 6.

4.1 Achievements to date

4.1.1 Web Site, Blogs and Social Media

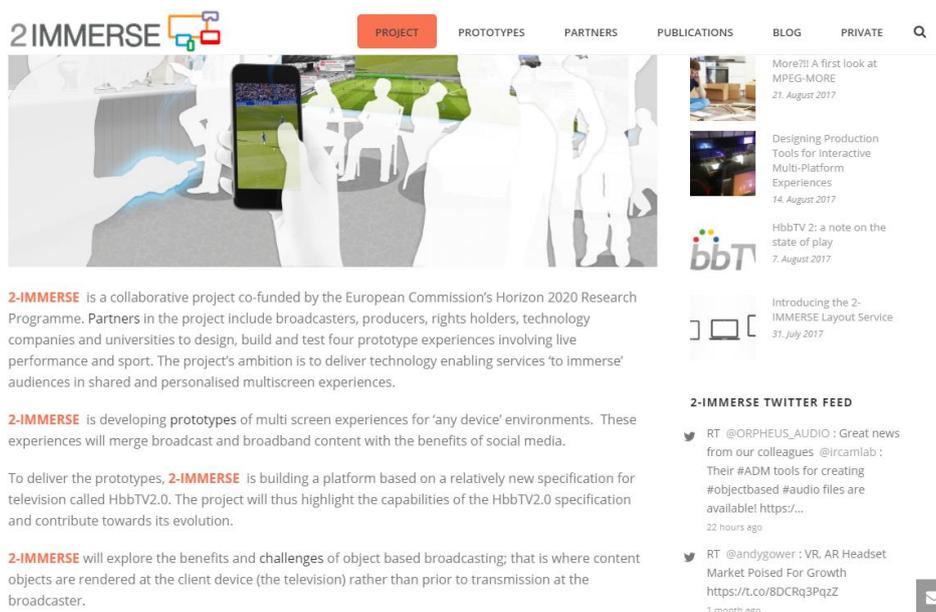


Figure 8: the project web site available at <https://www.2immerse.eu>

Since its first release, significant improvements were made to the project website, including the following changes:

- a re-worked Home page with text highlighting the question of the audiences to which the project as a whole, and the website specifically, is addressed; a re-structured menu of options as well as the inclusion at this level of a link to Blogs, so as to enhance the profile of our contributions; and a more elegant integration of the Twitter feed;
- refinement the slideshows for the four prototypes, to ensure that these are displayed far more effectively;
- a more active and productive publication schedule of blog posts that both report on the progress made by the project and that highlight activities and technologies that relate to the interests and concerns of 2-IMMERSE;
- the inclusion of the first videos produced by and about 2-IMMERSE, which also feature on a new, linked Youtube channel - this will be populated more fully and publicised more widely as the further prototypes become available for dissemination.

4.1.1.1 Blogs

John Wyver, from Illumination, writes a blog under the company web site Illuminations <http://www.illuminationmedia.co.uk/blog/> John is a respected and authoritative figure in the broadcasting of Arts TV in the UK. As and when there is a 2-IMMERSE related story or an experience about which it is relevant to write John will use the blog to mention the outputs of this project.

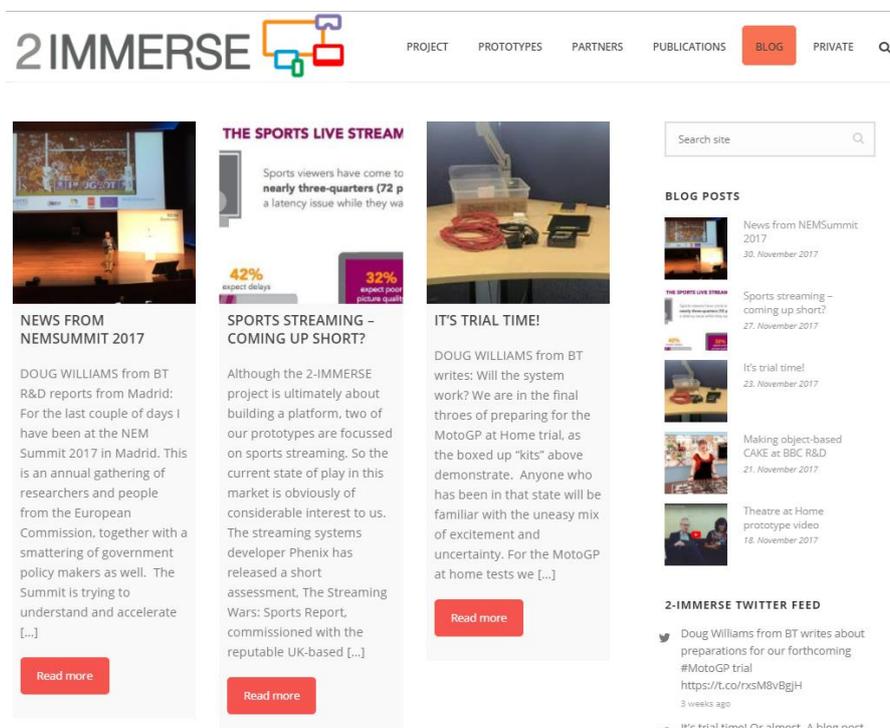


Figure 9: The latest blogs on the website

2-IMMERSE partners are writing blogs on a regular basis, coordinated by John. All blogs are published on the web page: <https://2immerse.eu/category/blog-post/> Since the start of the project following blogs have been published. Posts attempt to be light, short accessible and timely.

- BBC: Beyond the Video Wall – Responsive Content Projection
- BBC: MORE?!! A First Look at MPEG-MORE
- CWI: Designing Production Tools for Interactive Multi-Platform Experiences
- IRT: HBBTV 2: A Note on the State of Play
- CISCO: Introducing the 2-IMMERSE Layout Service
- BT: How we Watch Football in a Pub
- ILLUMINATIONS: 2-IMMERSE at Half Time
- BT: Never Work with Children or Animals
- ILLUMINATIONS: Researching the Landscape of Live-to-Digital Theatre
- BBC: Getting in Sync with Shakespeare
- ILLUMINATIONS: ‘A Great Thing’: Watching Theatre at Home since 1939
- BT: It’s not ‘or’, It’s ‘and’
- BT: KISS: Keep it Simple, Stupid
- BT: Signing on
- BT: FA CUP

4.1.1.2 Social Media

The project has a Twitter feed <https://twitter.com/2Immerse> managed by Illuminations mainly used to announce 2-IMMERSE related events and presentations. Latest tweets are included and referenced on the website.

Project partners use their own Twitter accounts to announce 2-IMMERSE related events. See Figure 10 for a photograph taken during the IFA Berlin 2017 where IRT presented HbbTV 2 prototypes, that were implemented using technology shared with 2-IMMERSE. The photograph shows Miss IFA wearing the Hololens device that is used as a companion screen adding additional video feeds next to the TV screen.



Figure 10: Miss IFA with IRT’s HbbTV 2 demo

4.1.1.3 Videos

2-IMMERSE has completed and posted online its first video, which is a narrated demonstration of the Theatre at Home prototype. In production is a similar video demonstrating the **Sport in the Home: MotoGP** prototype which will be completed during the imminent trials. Other videos will be produced for the two other prototypes, as well as at least two further videos outlining the 2-Immerse platform and the benefits of the project as a whole.

These videos will appear on the project’s Youtube channel which will be made public as soon as the MotoGP video is completed. This channel will also feature, where permission has been given, additional short video extracts showcasing the dissemination activities of 2-IMMERSE. In the meantime the Theatre at Home video is available on Youtube and as an embedded video in a blog post on the 2-Immerse website, and this presentation will be replicated for future videos. The videos will also be linked to from relevant points elsewhere in the website, as we have begun to do with a link to Theatre at Home from the text of the home page Introduction.

4.1.2 Publications

This section lists all publications based on work performed in 2-IMMERSE. Publications that are available freely can be downloaded via <https://2immerse.eu>

4.1.2.1 Book Chapters

Applications and Usability of Interactive TV

Title	<i>“From Secondary Screens to Socially-Aware and Immersive Experiences”</i>	
What is the publication about?	Several years ago, first conceptualizations of the usages of the secondary screen in the television environment were proposed. At the time, the real challenge was to convince stakeholders that interactivity was not a threat, but an opportunity. Ten years later, the mass adoption of smaller devices has reshaped the media landscape, truly enabling interactivity while consuming media content at home. What was perceived as hindering the user experience - the second screen - has resulted into an essential companion to the television. Paradoxically, even though key players are investing on secondary screen applications, there are very few successful examples. In this talk we provide an overview of the present state of the art through representative examples and discuss future possibilities and challenges. In particular, we will focus on the importance of immersion, taking into account the surrounding of the users, and of sociability, involving her social network. The talk will conclude by highlighting the importance of storytelling for crafting experiences that take advantage of the new media landscape, and the still relevant work of professionals that master such a craft.	
When was its content created?	This paper summarizes the keynote talk of Pablo Cesar at the Interactive Digital TV Congress, which took place in Palma de Mallorca (Spain) from 14th to 16th October 2015. The full talk is freely available here: https://www.youtube.com/watch?v=hCGYdg1qbPI	
How was its content derived?	The talk already included inputs from 2-IMMERSE (project proposal), which was accepted by that time. The book chapter was updated with further information from the project in 2017.	
Bibliographic information	Authors	Pablo Cesar
	Organisation	CWI
	Publisher	Springer
	Webpage	http://www.springer.com/us/book/9783319226552
	Book Title	Applications and Usability of Interactive TV
	ISBN	978-3-319-22656-9
	Publication type	Book Chapter
	Date of publication	2016

MediaSync: Handbook on Multimedia Synchronization

Title	<i>“Media synchronisation for television services through HbbTV”</i>
What is the publication about?	The paper presents use-cases for media synchronisation in the context of interactive TV experiences and overviews technical solutions provided by HbbTV version 1 and version 2 as well as the relevant referenced standards including DVB-CSS, MPEG TEMI and DIAL.
When was its content created?	We got the invitation to contribute to the book at the beginning of the project. Research that led to the presented results, was conducted in the first six months of the project. The first draft was submitted to the book’s reviewers on 1st of June 2016 We received a provisional acceptance of the chapter on 12th of

	March 2017. A major revision had to be implemented for final acceptance by the reviewers. The camera-ready paper was submitted on 9th of May 2017.	
How was its content derived?	The results were derived from a survey of standards HbbTV version 1 and 2, DVB-CSS and MPEG TEMI and hands-on experience gathered during implementation of client API's for media synchronisation, application discovery and launch and the TEMI timeline inserter.	
Bibliographic information	Authors	Oskar van Deventer, Michael Probst, Christoph Ziegler
	Affiliations	IRT and TNO
	Publisher	Springer
	Webpage	http://www.springer.com/us/book/9783319658391
	Book Title	MediaSync
	ISBN	978-3-319-65840-7
	Publication type	Book Chapter
	Date of publication	2018

4.1.2.2 Conferences

ACM CHI Conference on Human Factors in Computing Systems: ACM CHI

Title	<i>“Interaction Design for Online Video and Television”</i>	
What is the publication about?	This course will teach attendees how to design and evaluate interaction with online video and television. It provides attendees a pragmatic toolset, including techniques and guidelines, which can be directly applied in practice. The different tools will be contextualized based on current developments, giving participants a complete overview of the state of the art and industry.	
When was its content created?	This is a tutorial at the prestigious ACM CHI conference that happened in an annual basis (2011, 2012, 2014, 2015, 2016). It provides newcomers to the field insights about interaction design for online video and television. It is linked to the ACM TVX conference.	
How was its content derived?	The course organisers update the topics and slide set of the course on a yearly basis. For 2016, (delivered in May 2016) we incorporated the principles and use cases of 2-IMMERSE (Pablo) and further information about multi-sensory experiences (Marianna)	
Bibliographic information	Authors	David Geerts, Pablo Cesar, Marianna Obrist
	Affiliations	KU Leuven, CWI, University of Sussex
	Publisher	ACM
	Publication type	Course
	Conference	ACM CHI
	Year	2016
	Link	https://dl.acm.org/citation.cfm?doid=2851581.2856684

ACM International Conference on Interactive Experiences for TV and Online Video: ACM TVX

Title	<i>“On Time or Not on Time: A User Study on Delays in a Synchronised Companion-Screen Experience”</i>	
What is the publication about?	The paper presents results of a user study. The study evaluated the potential influence of different delays, between the TV and the companion screen, on how users experience watching a Shakespearean play on the TV, using a synchronised, interactive textbook application on the companion screen.	
When was its content created?	Literature review around how delays in media synchronisation influence media experiences started in the beginning of the project. Work on the study design started in month 4 of the project. Implementation of the lab trial experience started in month 6. User studies were conducted in month 8 and 9. The paper was submitted in month 13 (27 th of January 2017) for review. The camera-ready version was submitted in month 17 (13 th of June 2017).	
How was its content derived?	A prototype experience was created and tested in a user study in the framework of WP3. Study and its results are also documented in D3.2.	
Special note	<p>The paper was awarded the TVX '17 conference's BEST PAPER AWARD.</p>  <p>See social media coverage of TVX conference here https://twitter.com/What2DoNext/status/875655443665768448</p>	
Bibliographic information	Authors	Christoph Ziegler, Christian Keimel, Rajiv Ramdhany, Vinoba Vinayagamoorthy
	Organisation	IRT, BBC
	Publisher	ACM
	Publication type	Conference proceedings
	Conference	ACM TVX
	Year	2017
	Link	https://dl.acm.org/citation.cfm?id=3077557

Title	<i>“Multi-Screen Director: a New Role in the TV Production Workflow?”</i>
What is the publication about?	Multi-screen applications have been a research topic for the last 10 years. Recent technical advances make authoring and broadcasting of interactive multi-platform experiences possible. However, most of the efforts have been dedicated to the delivery and transmission technology (e.g., HbbTV2.0), but not to the production process. The hypothesis of this paper is that studio and

	<p>outside broadcast production requires radical changes in the production workflow, in order to allow for an efficient management of interactive multi-platform experiences. This paper explores such changes, investigating workflows and roles, and identifying key requirements for supporting these. The final objective is to create a new set of tools, which are extending current processes, that allow broadcasters to curate new types of experiences. We conducted a set of interviews with broadcast producers and directors that allowed us to identify two major (sub-)workflows, one for pre-recorded and one for live experiences. We could then assign roles to the different stages of the workflows and derive a number of requirements for the next generation of production tools.</p>	
When was its content created?	2017	
How was its content derived?	The paper reports the results of the user-centred design process followed to identify the requirements of the 2-IMMERSE production tools	
Bibliographic information	Authors	Britta Meixner, Maxine Glancy, Matt Rogers, Caroline Ward, Thomas Röggl, Pablo Cesar
	Organisation	CWI, BBC
	Publisher	ACM
	Publication type	Adjunct proceedings
	Conference	ACM TVX
	Date of publication	2017
	Link	https://dl.acm.org/citation.cfm?id=3089924

Title	<i>“2-IMMERSE: A Platform for Orchestrated Multi-Screen Entertainment”</i>	
What is the publication about?	<p>This demonstration will showcase a new approach to the production and delivery of multi-screen entertainment enabled by an innovative, standards-based platform developed by the EU-funded project 2-IMMERSE. Object-based production enables engaging and interactive experiences which make optimal use of the devices available, while maintaining the look and feel of a single application. The ‘Theatre at Home’ prototype offers an enhanced social experience for users watching a live or ‘as live’ broadcast of a theatre performance, allowing them to discuss it with others who are watching at the same time, either in a different room or in a different home.</p>	
When was its content created?	2017	
How was its content derived?	The paper describes and showcase the technical infrastructure of 2-IMMERSE that makes possible the trials	
Bibliographic information	Authors	I. Kegel, J. Walker, M.Lomas, J. Jansen, J.Wyver
	Organisation	BT, CISCO, BBC, CWI, Illuminations
	Publisher	ACM
	Publication type	Adjunct proceedings
	Conference	ACM TVX
	Year	2017
	Link	https://dl.acm.org/citation.cfm?id=3089909

New European Media Initiative: NEM Summit

Title	<i>Evaluating the potential benefits of object based broadcasting</i>	
What is the publication about?	About 15% of the TV hours watched in UK homes is brought into people's homes using Internet protocols and about 85% of the data carried by the Internet to people's homes is video. As the worlds of the Internet and video and television continue to converge this paper explores the impact of treating TV content more like web content. In particular it examines, through a use case based on the delivery of filmed theatre, the proposed benefits to end users of adopting an object-oriented approach to broadcasting.	
When was its content created?	2016	
How was its content derived?	The paper describes the approach and methods chosen for evaluating the concepts of object based broadcasting and the claimed benefits for the users as planned for the Theatre-at-Home prototype	
Bibliographic information	Authors	Doug Williams, John Wyver, Maxine Glancy
	Affiliations	BT, Illuminations, BBC
	Publisher	NEM
	Publication type	Conference Proceedings
	Conference	NEM Summit
	Year	2016
	Link	https://nem-initiative.org/nem-summit-2016/

Title	<i>"Multi Screen Football Assessment"</i>	
What is the publication about?	An evaluation of the subjective enjoyment levels reported by judges of school age in response to different presentations of televised football is described. Four different presentations of football are evaluated including two presentations using multiple screens carrying synchronized views taken from isolated camera feeds recorded from the 2016 FA Cup Final in the UK. Student's t-test evaluations suggest that the only subjectively assessed difference that has less than 5% probability of being caused by chance is that the three screen presentations are preferred to single screen presentations.	
When was its content created?	This experiment was designed and built between January and March 2017	
How was its content derived?	The content reports the results of a set of subjective tests used to assess the perceptions young people had of different presentations of football.	
Bibliographic information	Authors	Doug Williams, Martin Trimby and Jonathan Rennison
	Affiliations	BT
	Publisher	NEM
	Publication type	Conference Proceedings
	Conference	NEM Summit
	Year	2017
	Link	https://nem-initiative.org/nem-summit-2017/

Title	<i>“Theatre at Home evaluation”</i>	
What is the publication about?	This paper describes an evaluation of a flexible and personalised Theatre At Home Experience. It presents details of a home theatre service pilot constructed using an extensible platform. The platform is being created to support tailored configuration of devices and content across a number of experience genres including drama and sport.	
When was its content created?	This work was created between project start and February 2017	
How was its content derived?	The work reports the evaluation that took place of the Theatre At Home Experience	
Bibliographic information	Authors	Maxine Glancy, Matt Rogers, John Wyver, Phil Stenton, Jimmy Lee, Doug Williams
	Affiliations	BBC, Illuminations, BT
	Publisher	NEM
	Publication type	Conference Proceedings
	Conference	NEM Summit
	Year	2017
	Link	https://nem-initiative.org/nem-summit-2017/

4.1.2.3 Journals and Magazines

Title	<i>“BT Sport gears up for MotoGP trial”</i>	
What is the publication about?	<p>This paper explores whether object based broadcasting in combination with IP delivery can create a genre of entertainment experiences that are more immersive and compelling than current TV. This question is being probed through a collaborative project called 2-IMMERSE which uses skills from the BBC, BT and Cisco (among others).</p> <p>2-IMMERSE adopts a use case driven approach to develop multi-screen experiences using content based on sport and live theatre. The project is developing prototypes for an 'any device' environment that merge broadcast and broadband content with the benefits of social media. We recognise a number of challenges, with the primary one being conceiving personalised multi-screen experiences that hold the promise of promoting deeper engagement.</p> <p>Object based content distribution with client based composition is central to our vision.</p>	
When was its content created?	This paper summarizes the keynote talk of Pablo Cesar at the Interactive Digital TV Congress, which took place in Palma de Mallorca (Spain) from 14th to 16th October 2015. The full talk is freely available here: https://www.youtube.com/watch?v=hCGYdg1qbPI	
How was its content derived?	The talk already included inputs from 2-IMMERSE (project proposal), which was accepted by that time. The book chapter was updated with further information from the project in 2017.	
Bibliographic information	Authors	Andy Gower
	Organisation	BT

	Publisher	Broadcast
	Webpage	https://www.broadcastnow.co.uk/bt-sport-gears-up-for-motogp-trial/5100158.article
	Journal/Magazine	Broadcast Now magazine
	Publication type	Journal/Magazine
	Date of publication	2016

4.1.3 Training and Courses

Training is an important dissemination activity of the project, aiming at instructing others with the knowledge gained during the project. 2-IMMERSE particularly targets audiences outside the consortium institutions.

1. CWI has delivered a course at the prestigious ACM CHI conference: D. Geerts, P. Cesar, and M. Obrist, "Interaction Design for Online Video and Television," in the ACM CHI Conference on Human Factors in Computing Systems (CHI 2016) [May 10, 2016, San Jose (CA), USA].
2. BT gave a masterclass to undergraduates and post graduates in Theatre Film Television and Computer Science at York University. The talk showed examples of the work carried out at BT, including reconfigurable love stories in Finnish, flexible documentaries of the Renaissance in England, social games played through telepresence, live production of The Tempest in Cornwall from two separate theatres, new multi-screen productions of MotoGP, and offer some reflections on this work and its likely progression.

4.1.4 Demonstrations, workshops and meetings with practitioners

Workshops and meetings will be held with Creative Industry practitioners during the project to canvas their views and experience and inform our experience designs and technology implementations. As the project progresses discussions will include a broader group of Sports and Drama commissioners and producers. Illuminations, as a skilled and experienced media production SME, will help to ensure highest-quality dissemination and communication activities appropriate for a media innovation project, e.g. by preparing short promo clips. Supported by excellent links to the Royal Shakespeare Company, Illuminations will be instrumental in communicating innovations toward the creative industry. As a commissioner of content BBC is the hub of a network of creative companies and through its Creative Studios and On-line Taster platform has the means to engage and communicate media innovation to broad section of the community. Naturally, Illuminations also has a high commercial interest in the project itself and will seek exploitation opportunities also for different customers.



Figure 11: 2-IMMERSE demo at BT innovation week in June 2017

The following is an updated list of meetings with practitioners held since the start of the project.

1. **Sept 2016:** BT have met with the production team delivering the RSC's current Theatre At School Experience; they expressed interest in the opportunities of object based broadcasting that would be embodied in the 2-IMMERSE pilots.
2. **October 2017:** BT have met with Dorna team delivering the MotoGP. This has resulted in little side experiments around some responsive design approaches to visual layout carried out between BT and Dorna. This acts as a very early introduction to the characteristics and potential benefits of object based production.
3. **March 2017:** IRT - Workshop on joint HbbTV 2 developments/showcases with Samsung – The workshop is used to discuss joint efforts in developing HbbTV prototypes and their promotion. IRT took the opportunity to present the 2-IMMERSE project, its ambition, esp. the 4 trials and the plan to prepare a test/demo on 'real' HbbTV 2 devices/prototypes. It was decided to continue cooperation including a 2-IMMERSE showcase
4. **May 2017:** CISCO – Knowledge Share Call „Microservices - a Cisco research perspective“ – Cisco, BT Research & Innovation and invited guests (researchers and TV architects) joined a call where Cisco gave an overview of the 2-IMMERSE microservice platform architecture, with some lessons learned, plus insights into the use of microservices and containers in Cisco's service provider applications team
5. **June 2017:** The concepts for the MotoGP and Football trials were presented during the BT innovation week in June 2017 at Adastral Park/Ipswich to Industry visitors and BT employees. Demonstrations were available all time during the week to interested visitors and specially promoted in interviews and video presentations on stage hosted by professional BT presenters.
6. **September/October 2017:** The MotoGP at Home experience was demonstrated by BT at the “New Scientist Live” event in London. It is a four day event with some approximately 20000 visitors. **October 2017:** Cisco gave a project overview within a broader presentation to invited Cisco customers in Oct 2017 at the “2nd Annual Sport Summit” at Cisco HQ in New York. Within a 90 minute CTO presentation on Industry & Cisco developments in media

production, there were 3 slides giving a brief introduction to the 2-IMMERSE project and highlighting the scope and showing a few select wireframes for the MotoGP service prototype. This was presented in the context of new media formats, as an example that would benefit from the flexibility offered by software defined media production workflows running on generic data centre infrastructure.

7. October 2017: BT and BBC had presented 2-IMMERSE at Brussels: “2-IMMERSE Delivering the right content, to the right screen, at the right time.”
8. November 2017: The MotoGP service prototype was presented to BT attendees at a 2 days Showcase Event at the Aadastral Park by Cisco and BT.
9. December 2017: BT gave a presentation of the project as well as a hands-on demo of the MotoGP trial to BT Sport employees during the BT Sport All Hands day on December 13th 2017.



Figure 12: BT stand at New Scientist Live 2017

Though the project decided not to rely on the availability of HbbTV 2 devices in the market, it follows this path up to now in a side track, but it is planned to show in 2018 the capabilities of the 2-IMMERSE platform with available devices. IRT has worked with several manufacturers on prototype services for HbbTV 2, including multiscreen and media synchronisation. The outcome of this work was shown in 2016 and an updated version in 2017 at the IFA Berlin and IBC Amsterdam, both in September, and a local show in Munich the “Münchener Medientage”, which is an important show for the German media and broadcast industry. The presentation were well received especially by IRT’s shareholders (German speaking public broadcasters) and created some opportunities to work on further HbbTV 2 trials in 2018.



Figure 13: IRT's HbbTV 2 demonstration at Münchener Medientage

5 Standardization

As an innovation project 2-IMMERSE strives to evaluate emerging technologies and standards, to employ them where possible and thus foster their market relevance. An obvious use case is with the HbbTV association’s adoption of specific profiles of the TM-CSS specification from DVB to which HbbTV adds further protocols for device discovery and communication between applications running on multiple devices. The latest version of the specification, namely HbbTV 2, already covers some of the use cases and requirements envisioned by 2-IMMERSE. Rather than producing contributions to new standards, we see our role in assessing whether existing specifications fulfil the needs and the requirements of the industry. 2-IMMERSE feedback its observation to the relevant standardisation bodies, if lacks are spotted.

The project evaluates first implementations (prototypes) of HbbTV 2 and assess its suitability for the use cases envisioned. The project discovers use-cases that the current specifications and standards do not support. The project alerts the relevant associations and standards bodies to these deficiencies and if appropriate to share with them the methods we have adopted to overcome the shortcoming. However, it should be noted that contributions to standards will only be successful if there is sufficient interest also outside the project for new proposals and include all players along the value chain from content and service providers to TV manufacturers.

2-IMMERSE partners will follow on-going relevant activities and discuss potential contributions. Currently, there are a number of working groups either forming or progressing in W3C which target TVs and user devices acting as TV companions.

Many of the project partners have active roles in a number of standards organisations. Partners can work with their colleagues who are members of the different standards groups to ensure relevant findings of 2-IMMERSE are represented appropriately.

	BBC	BT	CISCO	IRT	CWI
W3C			Member	Member	Member
HbbTV		Member	Member	Founding member	
DASH industry forum			Member		
DVB	Member – Chair of DVB TM CSS group	Member	Active, TM-AVC and TM	Member	
IETF		Member	Active		
DTG		Member			
ETSI			Member		
SMPTE		Member	Member		

5.1 Relevant standards

5.1.1 HbbTV2/DVB-CSS – companion streams and screens

2-IMMERSE decided to adopt and evaluate the DVB-CSS specification as it is profiled and extended by HbbTV 2. The specification provides the mechanisms for accurate synchronisation of A/V content within the home network, but also the means for device discovery and application communication across the home network.

The requirements derived from the use cases envisioned in 2-IMMERSE are higher of what is supported by a minimum implementation of HbbTV 2. One example is, with HbbTV 2 TVs are only required to support one video decoder. This makes it unlikely to see wide support for a second or even more decoders at least on the HbbTV platform.

2-IMMERSE will evaluate its platform on HbbTV 2 implementations in beginning of 2018, by a dedicated HbbTV 2 showcase of its platform. While its intention is also to validate the technical 2-IMMERSE platform against one of the important broadcast eco systems in Europe, it will also generate a great example use case of HbbTV 2, which will help to promote it to both broadcasters and manufacturers. As another result of the showcase, a gap analysis will identify the delta between the requirements of a “high-end” 2-IMMERSE TVset and an HbbTV 2 implementation. 2-IMMERSE will look into an opportunity to present these results to standards bodies, ideally to the HbbTV requirements group.

Beside companion screen APIs and media synchronisation, HbbTV 2 brings other improvements that could be of interest by 2-IMMERSE. One example is the updated browser profile, now supporting HTML5 and related APIs. These are required by professional tools like Adobe Animate that can be used to produce on-screen graphics composed with video on the client side rather than in the studio. Tests shall show if the HbbTV 2 profile is sufficient in terms of functionality and performance. If sensible results will be included in the feedback to HbbTV.

At IBC 2017 Eutelsat, arte and Samsung have shown 360 content making use of HbbTV 2 features like device discovery and app to app communication. The use case is quite close to 2-IMMERSE sports trials, it is envisioned to include this feature in the 2-IMMERSE HbbTV 2 showcase. IRT started a discussion with partners from the HbbTV consortium whether there is sufficient support to standardize delivery of 360 content in HbbTV. A related activity will be the work on commercial requirements (CR) by DVB in the CM VR group on delivery of 360 video in DVB broadcast and broadband networks.

5.1.2 DVB CM VR

DVB started to look into VR and AR for any commercially viable applications that require standardisation. The report of a study mission proposes to start working on a technical specification which for DVB means to compile a set of commercial requirements.

2-IMMERSE partners will monitor this DVB activity, especially as part of their HbbTV ambitions.

5.1.3 MPEG DASH

The DVB profile of MPEG DASH - DVB DASH - which is included in HbbTV 2, was created with substantial contributions from BBC and CISCO. DASH is used as the transport protocol for audio-visual content by the current implementation of the 2-IMMERSE platform.

The streaming community currently looks into low-latency (<http://biblio.telecom-paristech.fr/cgi-bin/download.cgi?id=14719>) and tiled streaming (<http://ieeexplore.ieee.org/document/7888522/?reload=true>) that are two aspects to optimize the DASH protocol in terms of end-to-end delay and bandwidth usage for VR/360 applications. These

activities are monitored by the companies of the project, not necessarily by the colleagues working in 2-IMMERSE.

Though, such optimization would make much sense in combination with 2-IMMERSE applications, media streaming technology is not part of the innovation that is planned to be created by the project. Hence it is not planned to make any contributions based on project results to either MPEG-DASH or DVB-DASH groups.

5.1.4 MPEG MORE

MPEG media orchestration is a current work item within the MPEG-B specification suite. Requirements as well as the latest committee draft are available online. The work item came to attention of 2-IMMERSE after defining the initial architecture and starting the work for the first trial.

Recently 2-IMMERSE has analysed the committee draft in its version from the end of March 2017. The status of the specification is not mature enough to consider an early adoption of individual aspects for 2-IMMERSE at this stage, except that both 2-IMMERSE and MPEG-MORE use the concepts of DVB CSS for media synchronisation. Nevertheless, there are useful aspects in MPEG MORE that may be considered in 2-IMMERSE once the specification reaches a stable draft.

The internal analysis report is attached to this document as Appendix I.

5.1.5 W3C

Activities around the former Web and TV Interest Group within W3C, which will be re-chartered as the Media and Entertainment IG, will be monitored by 2-IMMERSE partners. There are no contributions related to 2-IMMERSE planned yet. However, partners see potential for contributions, e.g. in improving the community draft of Web Timing objects (<http://webtiming.github.io/timingobject/>) such that it can be integrated with the protocols defined in the DVB CSS specification.

6 Conclusion

This deliverable outlines plans for exploitation, dissemination and standardisation of the project results. The revised version updates the plans for dissemination and standardisation, and adds a first draft set of business models.

The four envisioned pilots of 2-IMMERSE are a perfect basis for exploitation and dissemination. From the beginning of the project practitioners the project partners have been involved in the project to gather their requirements and views on novel multiscreen services but also to introduce them the potential of new technology that may change their work in future.

The document identified the assets from 2-IMMERSE that will be made available to the (broadcast) community reaching from new ways of story-telling, to user interaction design to the architecture specification and prototype implementation which is planned to be open source. It also lists the mechanisms and channel through which results will be published.

In the final year of the project 2-IMMERSE partners will continue to use their strong relationship to practitioners throughout the value chain to show and discuss project results along with demonstrations at trade fair shows and in dedicated workshops. Participation is planned in a few conferences like ACM TVX2018 and ACM CHI2018, also 2-IMMERSE made a request to IBC for presenting the project in the Future Zone of IBC 2018.

The business models and exploitation plans will be revisited and refined. A release of the 2-IMMERSE platform or at least parts of it with an open source license are under discussion. Formal contributions to standardization bodies are not planned. 2-IMMERSE promotes HbbTV 2 as a basis for object based broadcasting and multi screen services, and hence contributes to the evolution of this eco system. It is planned to showcase a 2-IMMERSE service (football or MotoGP) with existing HbbTV 2 implementations (TVs).

Appendix I Analysis of the MPEG MORE draft specification

I.1 Brief Overview

MPEG-MORE provides an object model and set of control protocols for supporting complex orchestration scenarios in a network independent way to achieve scale.

The MPEG-MORE object model describes a media-processing graph that runs across a number of devices. Control messages are sent using a variety of network transport protocols to discover objects, configure communication channels and drive orchestration.

Considerable attention is given to media synchronisation in the MPEG-MORE specification, where the DVB-CSS Inter-device Media Synchronisation Standard has been adopted.

MPEG-MORE describes many different types of timed-metadata but most importantly, it describes each media stream as having a complementary temporal/spatial “Region of Interest” (ROI) stream comprised of timed-metadata for orchestrating media playback and processing. It also specifies how this timed orchestration data and timed metadata is delivered in transport formats such as ISOBMFF, MPEG2_TS and MPEG-DASH.

I.2 Status

As of 29th March 2017, the MPEG-MORE specification is at the committee draft stage (CD), but the CD hasn’t been published to the MPEG website. See the MPEG-MORE timetable below from the *Second Call for Proposals Document* (<http://mpeg.chiariglione.org/standards/mpeg-b/media-orchestration/second-call-proposals-media-orchestration-technologies>):

MPEG meeting	Date	Milestone
114	February 2016	Publication of First Call for Proposals (CfP)
	28& 29May 2016	Start of evaluation of proposals in Ad Hoc Group Meeting (Geneva, Switzerland)
115	30 May -3 June 2016	<ul style="list-style-type: none"> · Evaluation of Proposals during MPEG meeting (Geneva, Switzerland), · Publication of First Working Draft · Publication of Second CfP
	10 October 2016	Deadline submissions for Second CfP
Pre-116	15 and 16 October 2016	Start of evaluation of proposals in Ad Hoc Group Meeting (Chengdu, China)
116	17-21 October 2016	<ul style="list-style-type: none"> · Further evaluation of responses to Second CfP during MPEG meeting in Chengdu, China; · Publication of second Working Draft
117	January 2017	Committee Draft
118	April 2017	Draft International Standard
120	October 2017	Final Draft International Standard
121	2018	International Standard

The latest Committee Draft is available from the ISO content server

<http://isotc.iso.org/livelink/livelink?func=ll&objId=18714925&objAction=Open&vernum=7>

I.3 2-IMMERSE Time Frame

Work on 2-IMMERSE D2.1 started in January 2016 and was completed by May 2016, before the MPEG MORE v4 requirements were published (as evidenced by the BSCW document revision history). It was therefore absent from the list of candidate technologies enumerated in the D2.1 deliverable.

MPEG MORE hadn't reached the level of maturity required for inclusion in our original list of candidate technologies when D2.1 was being prepared in early 2016.

The 2-IMMERSE consortium has kept abreast of MPEG-MORE development but it's too early for anything to be leveraged directly with the exception of the DVB-CSS Inter-device Media Synchronisation standards on which both MPEG-MORE and 2-IMMERSE are based.

I.4 Relevance of MPEG-MORE in 2-IMMERSE Architecture

MPEG-MORE is relevant to 2-IMMERSE because it is concerned with media orchestration and it scopes the end-to-end requirements of media capture, processing and presentation. This is important for trials such as MototGP. More specifically:

1. The network independent and distributed nature of MPEG-MORE could be useful for modeling 2-IMMERSE cloud-based and client-based composition scenarios, especially where synchronisation is concerned.
2. Some 2-IMMERSE functions can be viewed as domain specific implementations of abstract objects within MPEG-MORE. There may be merit in adopting a more abstract set of orchestration concepts to simplify integration of new services into the 2-IMMERSE platform, such as those authored by 3rd parties.
3. At the moment, the 2-IMMERSE architecture is predominantly focused on delivery and playback, but MPEG-MORE also scopes media capture and production tooling. As we turn our attention to production requirements, we may find that the architecture evolves towards MPEG-MORE, or leverages it directly.
4. MPEG-MORE uses a general formulation of DVB-CSS synchronisation allowing MSAS to be cloud hosted. This is relevant because 2-IMMERSE's synchronisation service is equivalent.

I.4.1 Relevance of the MPEG-MORE Object Model

The 2-IMMERSE Layout service fulfills the role of a 'Controller', as defined by the MPEG-MORE object model. The client-server messages defined by the layout service could be considered examples of MORE Communication Channel Messages running over a websocket.

In future, other such 'controllers' may be added to the 2-IMMERSE platform to support cloud-based composition and data playback, at which point it might useful to generalise the 2-IMMERSE architecture to incorporate a 'controller'-like concept to allow other services to act as orchestrators and promote platform extensibility.

I.4.2 Relevance of the MPEG-MORE Communication Model

MPEG-MORE's communication is modelled on MPEG-SAND control messages. See "Enhancing MPEG DASH performance via server and network assistance":

<http://digital-library.theiet.org/deliver/fulltext/conference/ibc2015/20150014.pdf?itemId=/content/conferences/10.1049/ibc.2015.0014&mimeType=pdf&isFastTrackArticle=>

This makes MPEG-SAND of interest to 2-IMMERSE too. MPEG-SAND describes ‘DASH Aware Network Elements’ (DANEs) that process Quality of Service (QoS) information to arrange for the optimal delivery of DASH content.

MPEG-SAND control messages are generated and sent between sources, sinks and processing nodes. MPEG-SAND can be considered as an MPEG-MORE use case. A related example is cited as a use case in the MPEG-MORE specification. It uses the exchange of Mean Opinion Score (MOS) timed meta-data via control messages to orchestrate playback of different video feeds.

The server-assisted adaptation defined by MPEG-SAND is related to the problem of adapting experiences for playback in arbitrary multiple-device ecosystems; an area that needs more work in 2-IMMERSE.

Many of the use cases highlighted in MPEG-SAND apply to 2-IMMERSE, such as:

- *“Multiple DASH clients compete for the same bandwidth, leading to unwanted mutual interactions and possibly oscillations.”*
- *“Where a DASH client lets the delivery node know beforehand what it will request in the near future to prime the cache”*
- *“Network mobility, e.g., when the user physically moves, which makes the device switch from one network to another, but must maintain QoE”*
- *“Inter-device media synchronization, e.g., when one or more DASH clients playback content in a synchronised manner”*

A finding from our early pilot of Theatre-At-Home was that multiple devices compete with each other for available network bandwidth. This is a result of the ‘greedy’ nature of DASH players and the absence of a central coordination mechanism for throttling bandwidth within the 2-IMMERSE architecture (based on QoS and bandwidth metrics or control messages from clients or the network).

The MPEG-SAND DANEs used to assist the delivery of DASH content, can be represented using the MPEG-MORE object model and its communication channel scheme.

Available network bandwidth is an additional type of constraint that needs to be processed by the 2-IMMERSE layout service when computing layout. This may involve some sort of ‘fair share’ bandwidth policy and bandwidth budgeting scheme to safeguard quality of service and quality of experience.

A future version of the 2-IMMERSE layout service could be considered to be an MPEG-SAND DANE service describing bidirectional hinting between servers, clients and the network. As this is somewhat of a different responsibility to spatial layout, it might be useful to consider the MPEG-SAND-like mechanism as a separate responsibility, worthy of one or more separate services or layers within the 2-IMMERSE architecture; particularly gathering, communicating and acting on QoS/QoE measurements and exchanging parameters for enhanced reception and delivery (PERs & PEDs).

Additionally, 2-IMMERSE server and network assisted content delivery could be generalised beyond DASH to include conventional HTTP traffic, WebRTC comms and websocket datagrams.

I.4.3 Relevance of MPEG-MORE Synchronisation

MPEG-MORE's timed data synchronisation design is very similar to the DVB-CSS derivative adopted by 2-IMMERSE.

Notes:

- HbbTV2.0 and MPEG-MORE use the same "timed content" model introduced by DVB-CSS, see TS 103 286-1, clause 5.2.1.
- 2-IMMERSE and MPEG-MORE both use the timed content model to synchronise timed metadata to timed media.
- 2-IMMERSE doesn't explicitly model MPEG-MORE's [timed] orchestration data concept, although it implicitly uses correlation timestamps, which are one type of MPEG-MORE orchestration data cited by the committee draft.
- 2-IMMERSE and MPEG-MORE have both hoisted DVB-CSS WCS and MSAS functions out of the TV and into a separate server, which is the basis of 2-IMMERSE inter-home synchronization and multiple network support.

The knowledge that both groups have independently adopted similar approaches should give mutual confidence in their technical designs. The 2-IMMERSE implementation also lends support to the committee draft by providing an early working demonstration of some of the concepts in action (e.g. inter-home synchronisation). Through our open source efforts, MPEG-MORE might even be able to leverage source code such as 2-IMMERSE's cloud-based MSAS.

I.5 Conclusion

- 2-IMMERSE could make contributions to the MPEG-MORE specification.
- 2-IMMERSE is using a simplified subset of MPEG-MORE synchronisation that's already available in consumer devices (through HbbTV2's use of DVB-CSS).
- The media timing and orchestration choices of 2-IMMERSE are in excellent alignment, providing a possible migration path to MPEG-MORE in the future.
- The completion of MPEG-MORE is outside the 2-IMMERSE project time frame.
- MPEG-MORE demonstrates abstractions, which if adopted, could help improve the extensibility of the 2-IMMERSE platform and inform the design of cloud-based compositing functionality.
- MPEG-MORE concepts are applicable to production and they represent one potential direction in which 2-IMMERSE production capabilities could evolve
- MPEG-SAND is relevant to 2-IMMERSE in the context of maintaining QoS and QoE