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Foreword

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- *do not modify the predefined styles, except for standard "emphasis" effects (i.e. underlined or bold text) – we recommend using the underlined and bold formatting in a consistent and prudent way throughout the document, and on body text exclusively;*
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- *do not remove the instructions (both green and orange ones), and do not remove the auto-generated sections, incl. the annexes;*
- *do not overload the document with uncompressed / excessively large images; a proposal should ideally fit in less than 10 MB.*

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Full Project Proposal Annex

MOS2S

Media Orchestration from Screen to Screen

Edited by: O.A. Niamut (TNO)
Date: 02-02-2018

Apart from the State-of-the-Art-dedicated text (§2.3.1) which is handled by the ITEA Office as public information, unless otherwise specified by the consortium, this document will be treated as strictly confidential.

Project key data

Table of Contents

Project acronyms

ACM	Association for Computing Machinery
ADVP	AudioVisual Description Profile
AFL	Australian Football League
BIFS	BInary Format for Scenes
CAGR	Compound annual growth rate
CSS	Companion Screens and Streams (DVB Term)
CDN	Content Distribution Network
CDVS	Content Descriptors for Visual Search
DASH	Dynamic Adaptive Streaming over HTTP
DSL	Digital Subscriber Line
DVB	Digital Video Broadcasting
EBU	European Broadcast Union
EPTS	Electronic Player Tracking Systems
FIFA	Fédération Internationale de Football Association
GPS	Global Positioning System
GPU	Graphics Processing Unit
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
IBC	International Broadcasting Convention
IEC	International Electrotechnical Commission
IEEE	Institution of Electric & Electronics Engineers
IETF	Internet Engineering Task Force
IIM	Information Interchange Model
IoE	Internet-of-Everything
IPTC	International Press Telecommunications Council
IPTV	Internet Protocol TeleVision
ISO	International Standards Organization
KPI	Key Performance Indicator

MMT	MPEG Media Transport
MOS2S	Media Orchestration from Screen to Screen
MXF	Material eXchange Format
NAB	National Association of Broadcasters
NewsML	News Markup Language
NFL	National Football League
NTP	Network Time Protocol
OECD	Organisation for Economic Cooperation and Development
OTT	Over The Top (video over the Internet)
PTZ	Pan-Tilt-Zoom
RDF	Resource Description Framework
RML	RDF Mapping Language
PON	Passive Optical Network
RSS	Real Simple Syndication
RTP	Real Time Protocol
SIC	Satellite Innovation Centre
SME	Small or Medium-sized Enterprises
SMIL	Synchronized Multimedia Integration Language
SMPTE	Society of Motion Picture and Television Engineers
SotA	State of the Art
SVG	Scalable Vector Graphics
UGC	User Generated Content
UHD	Ultra High Definition
UWV	Ultra Wide View
VNI	Visual Networking Index
VOD	Video On Demand
VR	Virtual Reality
VRML	Virtual Reality Modeling Language
WWS	World Wide Streams

1. Project one-page description

> *(Mandatory length: 1 page)*
>
> *Provide, within one page maximum, a strategic description of your proposed project addressing:*
>
> - *the context and goals of the proposal;*
> - *the business relevance and the targeted market impact;*
> - *the innovative aspects and the major expected technical outcomes;*
> - *the consortium relevance.*

The proliferation of novel consumer-priced audiovisual and environmental sensors, producing huge amount of data and video, represents an important aspect of the Smart City environment. Harvesting this data in an orchestrated fashion enables a variety of attractive applications for citizen information, participation, entertainment, experience, safety and security. However, the successful development, testing and deployment of Smart City solutions with and towards its end-users is highly complex. Most cities are not equipped to deal with the required process of infrastructure development, technology deployment and end-user trialing, or do not provide the advanced underlying infrastructure to test and deploy these innovative ICT solutions.

With the MOS2S project (Media Orchestration from Sensor to Screen), an international consortium of partners will develop and test audiovisual Smart City technologies addressing the needs of its inhabitants, and embed these solutions in a dedicated Smart City Playground. This playground provides for a *venue platform* as stepping stone towards a full Smart City Operating System, and for the support of proof-of-concepts and trials. As such, the playground has the unique potential to accelerate the creation and market introduction of new unique Smart City applications, based on a range of sensors and datasets, to improve profitability, sustainability, safety and customer experience.

The project partners focus on media orchestration platforms and technologies, that allow for orchestrating devices, data and media streams, and resources into a rich and coherent media experience on various end-user devices, including virtual environments. Applications include crowd journalism (citizen information and participation), smart venues, live events (citizen experience and entertainment) and event security (citizen safety and security). These cases build upon advanced sensor, networking and cloud infrastructures, and leverage emerging media and data analysis, analysis, processing and streaming technologies. The international MOS2S consortium comprises large-scale industry partners, small-to-medium enterprise partners and research and technology organizations. Together they provide all necessary technological components: networking and cloud technology, data brokerage, orchestration between video sources and sensor data, video analysis and stitching, broadcast (sports in particular) production and distribution, and a smart venue as a proxy for a smart city.

The combined technologies and experience of these partners enables unique world class innovation, that will allow them to introduce captivating new products and services. The applications that MOS2S provides will impact the global markets of wireless data communications (3G/4G/5G), the market of broadcast production (news and sports production in particular) and audiovisual terminal equipment, including signage. Given the size of each of these markets, the global impact of MOS2S can be very significant.

2. Project overview

2.1. Rationale of the project

2.1.1. Problem statement and market value chain

(Recommended length: 1-2 pages)

Introduce here the problem the project aims to solve. Explain the current issues, limitations or bottlenecks of what currently exists, explain the needs you plan to satisfy or to create.

Describe the societal, economic and/or technological challenges addressed by the proposed project.

Also introduce the market value chain(s). The market value chain is a representation of the various processes involved in producing products or services and delivering them to the market. It indicates where and how value is considered and created, and how the market actors in their respective markets can be profitable. It also describes the actors' strategies and relative positioning: it must show all the actors involved in designing, producing, distributing the products and/or services and the relationships among them. All the peripheral actors who can influence the market(s), through regulations, recommendations, indirect suggestions, etc., must also be included. Describe clearly the interfaces between these actors and define the customer – provider relationship(s) wherever relevant.

This subsection describes the context and background relevant to the project, in terms of technological and market status, not the project itself. It should convince evaluators that the project partners have a good understanding of the context in which they will be evolving, both technology- and business-wise.

Smart Cities and the Internet-of-Everything
The Internet of Everything — the networked connection of people, process, data, and things, is opening up new opportunities and risks, in policy leadership, services and regulation. The success of the Internet of Everything (IoE) is determined by the proper understanding of the relation between advanced network infrastructures, connected sensors and clouds providing storage, processing and distribution. This relation plays a role at different scales, i.e. between continents, countries, and within urban areas, the so-called Smart Cities. Representing autonomous, small-scale IoE instantiations, Smart Cities stand much to gain from connecting people, processes, data and things. Smart City solutions consist of ICT technologies, services and applications for e.g. sensor acquisition, data analysis and information sharing. These technologies operate on an underlying Internet-of-Things infrastructure, consisting of advanced wireless networks offering global connectivity, and cloud storage and computing for real-time sensor, media and data analysis and fusion. As such, Smart Cities can take a role as playground and starting point for IoE technology development and application & service deployment.

Figure 1- The Smart City innovation deal between Amsterdam and the Amsterdam ArenA venue.

Smart Stadium as driver for Smart City solutions

The successful development, testing and deployment of Smart City solutions towards end users is highly complex. It requires a controlled process of infrastructure development, technology deployment and end-user trialing. Most cities are not equipped to deal with such a process, or do not provide the advanced underlying infrastructure to test and deploy these innovative ICT solutions. Recognizing this major bottleneck for Smart City solution development, the city of Amsterdam and the Amsterdam ArenA stadium in The Netherlands, established and positioned the stadium as a driver and accelerator for new smart city solutions. These include the development of a *venue platform* as stepping stone towards a Smart City Operating System, and the support of proof-of-concepts and trials, in which international sets of partners can develop, experiment and test focused Smart City applications, technologies and infrastructure. Therefore, the Amsterdam ArenA Innovation Center (AAIC) has been established as an innovation hub, with the mission to accelerate the creation and market introduction of new unique Smart City applications to improve profitability, sustainability, safety and customer experience. The AAIC builds the Smart Stadium and Smart City playground and Reference Zone. The themes to work on within this partnership and innovation hub include Mobility and Accessibility; Customer Experience of the ArenA area; Energy and Sustainability; Entertainment and Leisure; Safety and Security.

MOS2S – developing Smart City solutions for Smart Citizens

Audiovisual sensors and data in particular, represent an important aspect of the Smart City data set, enabling a variety of applications for citizen information, participation, entertainment, experience, safety and security. Audiovisual media provide citizens with Smart City data readily accessible to human senses. With the MOS2S project (Media Orchestration from Sensor to Screen), an international consortium of partners will develop and test audiovisual Smart City technologies and solutions in the context of citizen needs, and embed these solutions within a Smart City Playground.

MOS2S wants end-users to participate in and influence how they capture and experience everything around them, in the physical and virtual world. With so many capture and display devices, and with applications and services moving towards a more interactive and immersive experience, we need the tools to be able to manage multiple, heterogeneous devices over multiple, heterogeneous networks, to create a single experience. We call this process *Media Orchestration*: orchestrating devices, media streams and resources to create such an experience. We will develop technologies and tools for media orchestration, allowing the merger of many media and sensor feeds into a coherent, interactive experience, in real and virtual environments.

We will enable and validate shared capture and shared rendering to provide new opportunities for consumers and professionals, specifically in crowd journalism (citizen information and participation), smart venues and live events (citizen experience and entertainment) and event

security (citizen safety and security). These cases build upon advanced sensor, networking and cloud infrastructures, and leverage emerging media analysis, processing and streaming technologies. They are built around international collaborations between large-scale industry partners, small-to-medium enterprise partners, supported by research and technology organizations.

Market players and value chain

Three types of market players can be identified to contribute to a commercially viable end-to-end application of MOS2S. The figure below depicts the relations between the market players in a MOS2S market value chain.
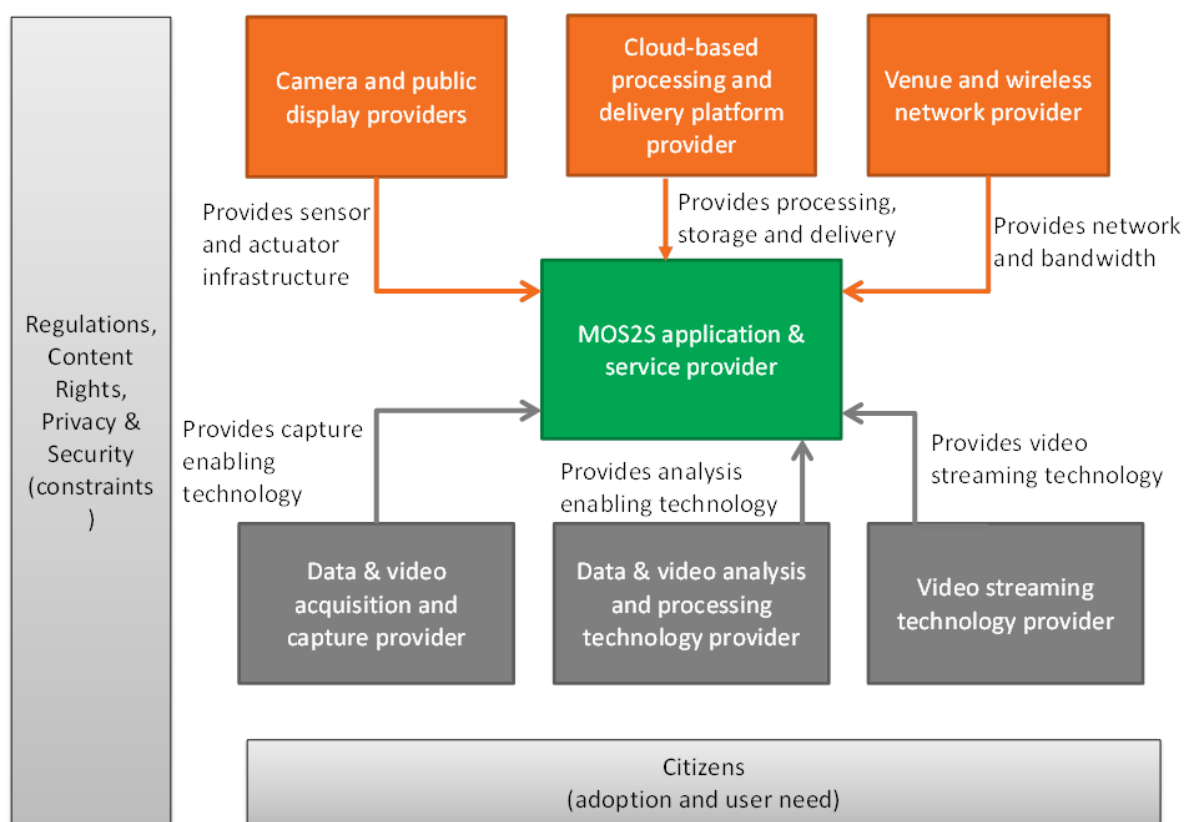
Figure 2 - the MOS2S market value chain, depicting the various partner roles and value exchanges.

1. *Enabling technology providers (dark grey)*: These include data & video acquisition and capture technology providers, data & video analysis and processing technology providers, and video streaming providers. A brokering and orchestration platform will combine the above mentioned data and video streams into quality output products, such as audio and video streams, supplemented with related and synchronous sensor data. The tools should preferably run autonomously but allow for manual intervention by an editor or director. MOS2S partners taking this role are Bor, DIA, ETRI, Nokia Bell Labs, Imec, Kiswe, KPN and TNO.

2. *Application and service providers (green)*

    a. Professional and consumer applications will present the streams to the end user as dashboards or mobile applications, allowing him/her to interactively select a stream, add sensor data or other features, on a plethora of devices.

    b. Developers of acquisition or contribution applications, to run on the cameras or smartphones. These applications combine sensor data, audio and video into a synchronised stream, to ease the import into the brokering and orchestration platforms.

MOS2S partners taking this role are Game On, Imec, Kiswe, TNO, and VRT.

3. *Infrastructure providers (orange)*: such as cloud service solutions providers and network providers, will ensure the scalability and effectiveness of MOS2S solutions in real-time applications and optimize their deployment according to available resources. MOS2S partners taking this role are Amsterdam ArenA, Bor, Bosch, DIA, ETRI, Inmotio, Imec, KoçSistem, KPN, Nokia Bell Labs, Samsung, TNO and VRT.

Problems and challenges

With the MOS2S project and consortium, we aim at addressing the following problems and challenges. These arise from the different smart city use cases, specifically crowd journalism (citizen information and participation), smart venues, live events (citizen experience and entertainment) and event/venue security (citizen safety and security).

▪ *Extending the smart city experience from event-only to pre- and post-event:* live event coverage can be expanded from a stadium-only experience to a door-to-door Smart City experience by offering pre- and post-event content, engaging communities and out-of-stadium businesses, such as surrounding shops and restaurants. We address this challenge through compelling and focussed smart city use cases.

▪ *Data and video capture and monitoring:* a crowd journalism event, and an associated warning of security services, can be initiated by discovery of buzz on social media. This requires continuous monitoring and real time semantic analysis of these media, including the analysis and interpretation of photographs and live video. We address this challenge through development of enabling technology for data and video analysis, and platforms for large-scale real-time monitoring of data and video streams.

▪ *Data and video brokering and orchestration:* smart data and video brokering can make data meaningful and exploitable in multiple Smart City application domains, by exchanging data between apps from different providers in a sensible way. Similarly, media brokering and orchestration could simultaneously serve multiple goals, like citizen journalism, venue information and security. To make the various sources reusable, meaningful and exploitable for multiple applications and domains requires:

    ○ the selection, combination and orchestration of all contributions and smartly putting them into context, taking into account the very divergent characteristics (e.g. clocks, video streaming formats, available metadata, quality, location and position, type of information, ..) of the captured data.

    ○ the discovery and profiling of a wide variety of end-user devices and composing and adapting the multiple output streams to them in an intuitive and efficient way.

    ○ taking care of the reusability and broad applicability of both captured data and video.

We address this challenge through the development of platforms for data and video brokering and orchestration.

▪ *Application design for professionals (dashboards) and end users (mobile apps):* the design of an intuitive orchestration dashboard to enable a well organised and scalable way of combining the various sources into meaningful experiences, and the design of data-enriched mobile video applications. We address this challenge through agile and iterative application design, aligned with yearly demonstrators of MOS2S technologies and applications.

2.1.2. Project innovations and technology value chain

(Recommended length: 1-2 pages)

Present here a brief view of the project innovations you are introducing: focus the description on novelty in terms of the state-of-the-art. Innovation can include both technological, process, usage and business model innovations. Explain what the project brings to the table, how it differs from existing results and previous or current projects, products and services, how partners will be able to differentiate themselves from existing market actors and become competitive (or how they can create or reimagine a market). Remain concise in this section (cf. §2.2 and §0).

Describe in a few words what the project aims to achieve and how it backs the broader goals of the main partners.

Introduce also the technological value chain(s): it is a kind of modular architecture comprising the main functions and building blocks required to create the solution, as well as their interactions.

This subsection should convince evaluators of the novelty of the project proposal.

An increasing range and diversity of digital platforms and devices are emerging that offer unprecedented opportunities to capture, create, deliver and consume new forms of digital media services and products. At the capture side, omnidirectional video cameras, different types of consumer range recording devices (action cams, smartphones, drones, high-end cameras), as well as sensors (wearable, environmental, IoT) bring new opportunities for extensive gathering of all available content, data and scene information useful in many different smart city applications such as information sharing, safety & security, entertainment, interactive community experiences, public powered journalism and more. Combining multiple capture and rendering devices in parallel, in particular a variety of consumer devices, creates revolutionary possibilities. An end-to-end approach to orchestrate such devices from acquisition to rendering allows new forms of user participation and interactivity, and novel creative formats for more informative, immersive and interactive Smart City experiences. It also enables a more coherent and in-depth understanding of what is really happening during events.

The MOS2S project will develop, improve and test novel ICT technologies and tools for media and device orchestration at the capture, productions and consumption sides. MOS2S will deliver both technology and content format demonstrators. The tools are aimed at the *creative industries* (supporting broadcasters, content creators and creative SMEs), the *news media industry* and the *societal safety industry*, enabling the creation of novel types of media experiences that:

- combine multiple acquisition technologies, both classic and emerging, into a coherent media representation;
- combine multiple consumption technologies, both classic and emerging, into a coherent immersive experience;
- through new levels of interactivity and immersion, enable novel storytelling, live event experience and video-based surveillance paradigms.

The data and media streams handled inside the MOS2S can also be channelled towards any other third party application that has appropriate rights to access. Innovation in media orchestration technologies is required throughout the technological value chain, i.e. from sensor to screen. The MOS2S project focuses on the following key technological innovations:

- For acquisition: we will provide tools to perform stitching, synchronization and encoding in real-time of new professional camera setups, and consumer device recordings as well as tools for adding proper metadata to captured content. These tools will provide output that is either merged already or enriched with metadata to allow further processing during production. The tools will have interfaces towards the production tools, to allow production to steer the capture.
- For production: we will develop technologies for the orchestration of devices, intelligent processing and contextual analysis of incoming video and sensor streams into actionable data, intuitive dashboarding for application professionals, managing user contributions both from a quality and target service or application point of view, managing multi-device end-user interactivity and parallel storylines.
- For delivery and rendering: we will enable the orchestrated delivery of new immersive and interactive content formats over the top of the existing infrastructure by enhancing existing standardized tools with descriptions in both temporal and spatial domain as well as through the synchronization of the play-out on a heterogeneous set of devices. These extensions will enable the orchestrated delivery of various timed media assets coming from various sources to a plethora of end user devices. This includes the discovery and identification of the source and rendering devices (e.g. cameras, screens and mobile devices) and their capabilities, through existing or extended device profiles. For example, we may send device properties and profiles as in-band or out-band data along with media streams. Our standardization efforts will allow us to reach industry with these extensions.

Another underlying key technological objective is innovation in how successful cross-domain orchestration scenarios can be setup between a multitude of publishers and subscribers (envisioning that a consumer might use published streams from multiple organisations and a publisher might send data to consumers in multiple organisations), in a way that makes sense to all involved parties (data brokering).

The figure below depicts the technological interfaces between the MOS2S enabling technologies (dark grey), new infrastructure (orange), applications and services (green), all building upon available building blocks and infrastructure (light grey).
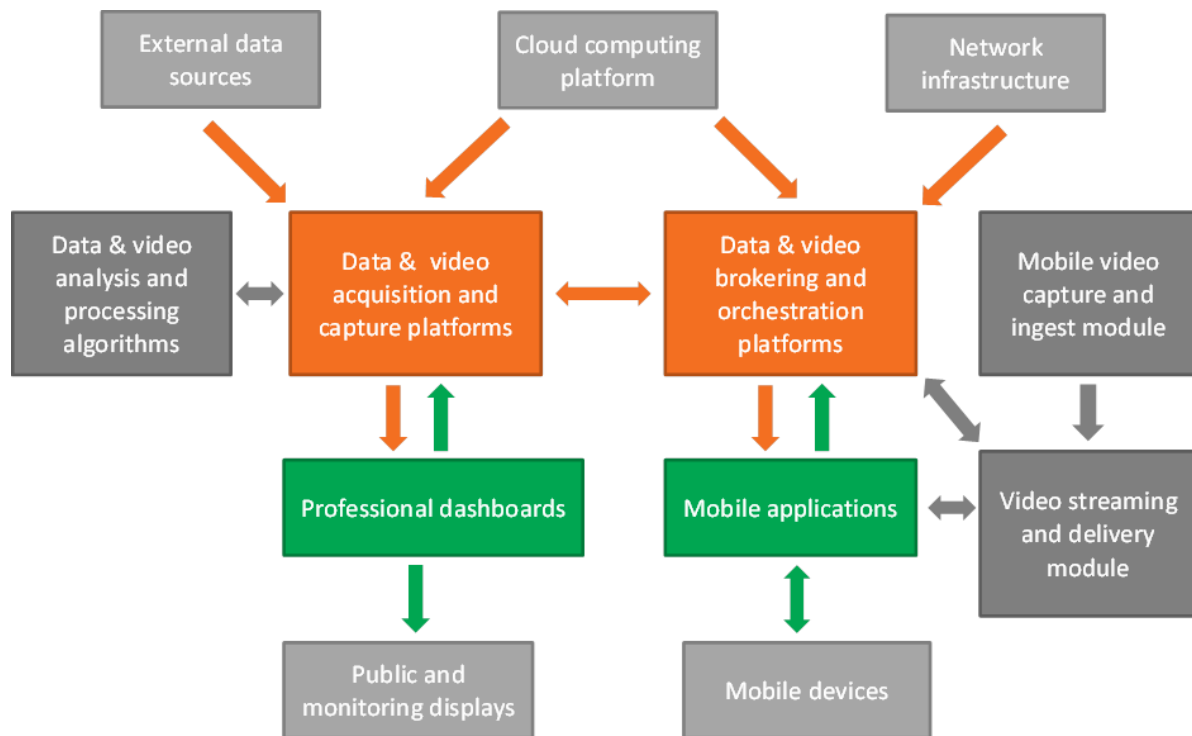
Figure 3 - The MOS2S technology value chain, depicting the various interfaces between existing (light grey) and new (orange) infrastructure and platforms, enabling technologies (dark grey) and applications and services (green).

The contributions of the project partners to the enabling technologies can be summarised as follows:

- Existing technologies and infrastructure comprises the ingest of external data sources (Nokia Bell Labs, through their WorldWide Stream (WWS) analysis platform), a cloud computing platform and networking infrastructure (provided by Amsterdam ArenA, DIA, KPN and Nokia Bell Labs) and public displays (KoçSistem and Samsung).
- New infrastructure consists of data and video acquisition and capture platforms (Bosch, ETRI, Inmotio and TNO), a data analysis, brokering and orchestration platform (Nokia Bell Labs, KPN, Imec) and a video brokering and orchestration platform (Bor, Nokia Bell Labs, TNO).
- Within MOS2S new enabling technologies will be developed, such as video and data analysis, processing, and publishing (Bor, Nokia Bell Labs, Imec and Kiswe), a mobile video capture and streaming module (TNO, Kiswe) and a video streaming and delivery module (DIA, Samsung and KPN).
- Finally, MOS2S will deliver new applications and services, such as professional dashboards (VRT, TNO, Imec) and mobile applications (GameOn, Kiswe).

These technologies -- the platforms and enabling technologies in particular -- will be further described and detailed in sections 2.3.1 and 2.3.2.

2.2. Targeted impact

2.2.1. Market analysis

> *(Recommended length: up to 5 pages)*
>
> *Present here a detailed market analysis that is focused on the actual markets targeted by the project partners. Present market trends (e.g. graphics and figures), main products, describe the landscape in terms of competing or alternative solutions (companies, products…), the situation in Europe vs. US and Asia, etc.; provide figures whenever possible. Use up-to-date data or comment on outdated information (e.g. forecasts of several years ago). Do not rely solely on current market situations but consider also predictions and estimates of future growth from the latest studies.*
>
> *Describe the existing or announced industrial products or services in the project domain. Explain which competitive advantages the market leaders have and how differentiation could be achieved towards them. Detail why smaller actors are restricted to low market share (e.g. targeting niche markets or competitiveness issue) and how volatile the market currently is (are there more and more actors or is it the opposite? In the latter case, does it derive from market consolidation or from competitors dying out?).*
>
> *Present existing and potential and/or forecasted competitors (e.g. Google in the car industry or satellites). Do not hesitate to introduce Porter's five forces model of competition to describe (on top of the current industry competitors) not only suppliers and buyers, but also potential new entrants as well as threat of substitutes.*
>
> *This subsection should convince evaluators that the project partners have a clear and detailed understanding of the market they are targeting, including not only the current situation but also the current trends, forecasted evolutions and potential threats.*

In this section, we provide an overview of the current market situation and expected market trends, both for the global markets for mobile, broadcast and media technology, as well as for the three main MOS2S use cases. Furthermore, we provide an analysis of competition for the MOS2S platforms and infrastructures.

Current market situation and expected market trends

Global markets for mobile, broadcast and media technology
According to the GSM Association, smartphone adoption is already reaching critical mass in developed markets, with the devices now accounting for 60% of connections. In 2014 2.6 billion smartphones were in use worldwide, a number expected to rise to 5.6 billion by 2020. The vast majority of these have mobile broadband connections (3G/4G), making them suitable for contributing video and data. Yet, mobile broadband connections (i.e. 3G and 4G technologies) only accounted for just under 40% of total connections at the end of 2014, but will increase to almost 70% of the total by 2020[1]. The OECD estimates that mobile broadband penetration (i.e. population coverage) has risen to 81.3% in the OECD area, according to data for December 2014,

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[1] GSMA Global Mobile Economy Report 2015.

compared with a penetration rate of 72.03% in December 2013[2]. Consequently it appears that many smartphones are not connected to a public broadband network, leaving much room for growth. Moreover, Europe is lagging the US, as mentioned in Cisco's Visual Networking Index (VNI)[3]. It states that at the end of 2015 North America had 74 percent of its installed base converted to smart devices and connections, followed by Western Europe with 59 percent. By the end of 2020 it is forecast that North America will have a nearly 95 percent penetration, against 86 percent for Europe. MOS2S applications could be an incentive to increase wireless broadband use in Europe. In monetary terms, MarketsandMarkets expects the Global CDN market size to grow from USD 6.05 Billion in 2016 to USD 30.89 Billion by 2022, at a Compound Annual Growth Rate (CAGR) of 32.8%[4]. RnR Market Research[5] predicts a grow from USD 3.71 billion in 2014 to USD 12.16 billion by 2019, at a CAGR of 26.3%.
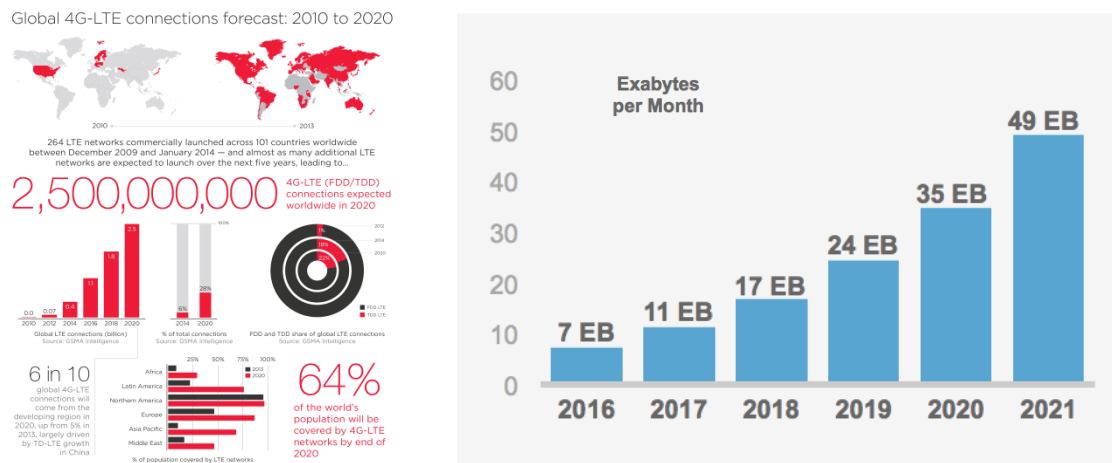
Figure 4 – (left) Global 4G-LTE connections forecast (source: GSMA Intelligence). (right) Cisco Visual Networking Index 2017.

Cisco also points out that in 2014 mobile video accounted for 55 percent of mobile data traffic, and this percentage will rise to 75 percent in 2020. This illustrates the growth opportunity for video applications, such as those explored in MOS2S. Orchestration tools will be part of the global broadcast and media technology market, which is set to grow to USD 44.3 billion (€34.7 billion) by 2017, up from USD 39 billion in 2012, according to research by IABM DC, a joint venture between the International Association of Broadcast Manufacturers and Devoncroft Partners. It found that the broadcast and media tech industry produced a compound annual growth rate of 3.6% over the previous four years[6]. To zoom in on specific market details and opportunities, the MOS2S consortium partners target the markets for smart venues, live event services and mobile news providers and video-based surveillance and security. Below, detailed market analysis for each of these markets is provided.

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[2] OECD broadband statistics update, 23 July 2015
[3] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015–2020 (Feb. 2016)
[4] https://www.marketsandmarkets.com/Market-Reports/content-delivery-networks-cdn-market-657.html
[5] http://www.prnewswire.co.uk/news-releases/content-delivery-networks-cdn-market-2019-forecasts-in-new-research-report-available-with-rnrmarketresearchcom-270023421.html
[6] Global broadcast and media tech market set for growth, Digital TV Europe October 21, 2014
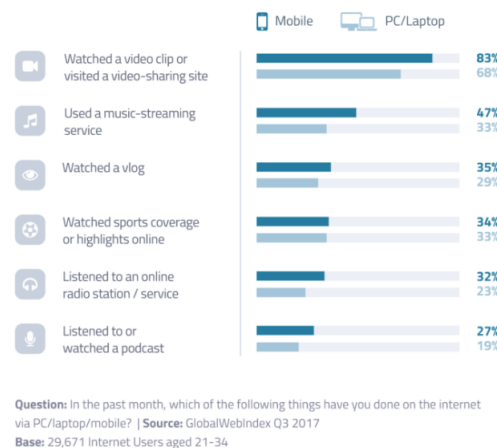
Figure 5 – Online entertainment device usage (source: Global Web Index).

Smart Venues

Perhaps not surprisingly, several major IT companies worldwide are developing technologies and products for Smart Venues or Live Events in some way or the other. Sports venues are increasingly aiming to become "smart stadiums" and are seeking ways to strengthen their relationship with the audience, increase audience participation and monetise (video) content. They are dependent on innovative technologies to achieve these goals. The market potential towards stadiums is large, but the market opportunities for the solutions will reach further than large stadiums. The innovative solutions which are being developed are smart city solutions which are tested in a field lab in a real circumstances and with real end-users. These are proven smart city solutions
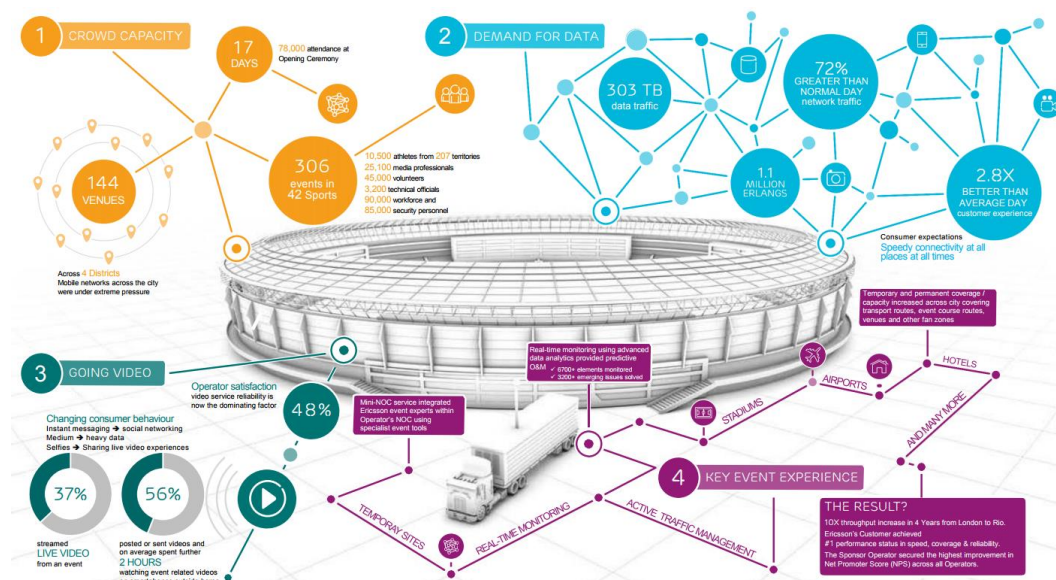
Figure 6 – Connected stadiums: fan experience going beyond stadiums (source: Ericsson)

which are interesting for any city in the world that is looking for provable concepts and solutions. Research done by Frost & Sullivan for IBM leads to the conclusion that the smart city market in 2020 could be as big as 1.565 trillion USD[7]. MarketsAndMarkets estimates that smart stadium

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[7] http://public.dhe.ibm.com/common/ssi/ecm/uv/en/uvw12372usen/UVW12372USEN.PDF

market will grow from USD 4.62 Billion in 2016 to USD 17.32 Billion by 2021, at a Compound Annual Growth Rate (CAGR) of 30.2% during the period 2016–2021[8], with the global event management software market projected to grow from USD 5.88 Billion in 2016 to USD 11.06 Billion by 2022, at a Compound Annual Growth Rate (CAGR) of 11.6% during the period 2016–2022[9]. As mobile networks become more capable of delivering video, media orchestration technology will make an impact in or near the event venue or live act itself, beyond its use in the home, into the emerging market of the "Connected Venue/Stadium".

Live Events Services
Live streaming is hot and has undergone an explosive growth in the past years. Still, this growth has not come to an ending yet, with the lower end of the market not being addressed so far. High end events can afford the required camera equipment and upstream bandwidths to deliver their experience in the cloud for streaming. At the lower end, smartphone manufacturers have recently launched mobiles with decent quality cameras, allowing many people to shoot and contribute to the live streaming of everyday events, like youth sports, small festivals and so forth. The market opportunity in live video streaming is multi-fold, but is certainly driven by advertising values. Marketeers start to value the power of live streaming, and live streams currently dominate ad view growth. The market opportunity at the high end side runs into the billions of euros, and will be complemented by a lower end segment as soon as streaming service providers achieve a level of maturity when it comes to user analytics and profiling.

Figure 7 – Share of internet users in the United States who have watched or created live streaming video on social media as of November 2016, by age group (Source: Statista)

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[8] https://www.marketsandmarkets.com/Market-Reports/smart-stadium-market-137092340.html
[9] https://www.marketsandmarkets.com/Market-Reports/event-management-software-market-136859992.html

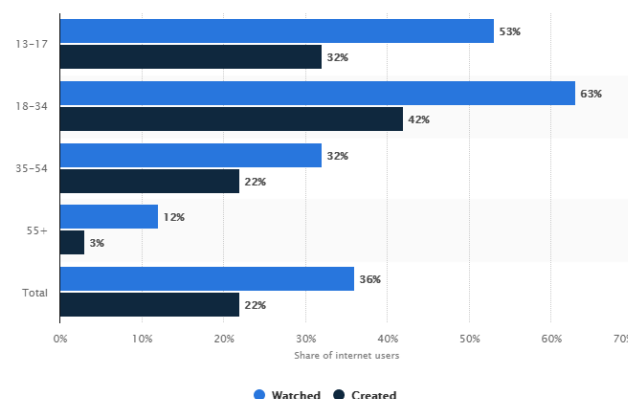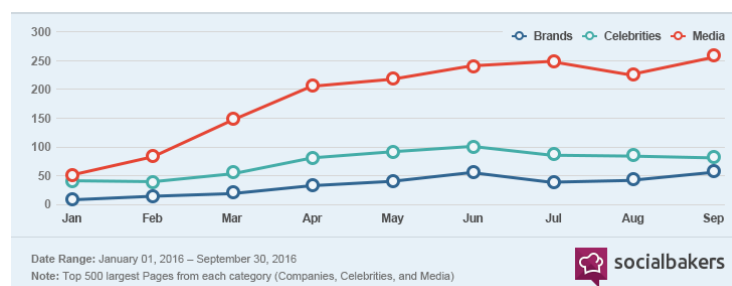*Figure 8 – The number of Pages using Facebook Live for news has steadily increased from January - September, 2016. (Source: SocialBakers)*

Apart from social media that use popularity to select what you want to see, such as Youtube, Facebook, Periscoop, there are less known startups in this area working on streaming to fans such as *YouNow*[10] and *Fancred*[11]. YouNow is a product that fuses the experience of broadcasting, gaming, performing and social networking, giving direct power to the people and enabling them to discover and create new kinds of interactive content in real-time. The viewer can send virtual gifts or tokens of affection/rejection but then will have to pay. Fancred is a sports-centric social network that offers live streaming and gamification features as well as news and scores, making it a one-stop shop for fans. A specific area in this field is *camera auto direct (automatic compositing)*, with currently only off-line applications: the *Graava camera*[12] summarizes an event as a shorter video. It is an action cam that records an entire event and allows you to extract a clip of a certain length automatically. *Muvee*[13] software automatically summarizes videos into a short clip. *Google Auto Awesome*[14] makes clips automatically from a set of videos. We hope to implement similar technologies for live use.

Recently the FIFA has acknowledged that the use of Electronic Player Tracking Systems (EPTS) systems in football games will be allowed under certain conditions. Similar developments have occurred last year in the US at the NFL. The real time available data coming from EPTS systems is more comprehensive and more accurate than tracking systems that are based on for instance GPS or video. The data is needed to enhance the TV viewing experience. In the US, sports TV watchers are using second screen apps more and more. New digital media such as Facebook, YouTube, Twitter and so on, are providing platforms to offer sports content in order to engage fans to the game. In addition more and more statistics are required to improve the quality of fantasy games and betting applications. Therefore it is expected that the sports leagues around the globe will look for better ways to generate content, such as statistics. The NFL in the US and the AFL in Australia already started to implement EPTS systems and the soccer leagues are expected to follow this example. This will offer the manufacturers of tracking systems such as Inmotio a great opportunity to enter this relatively new market. There are few companies able to provide real time EPTS solutions that are proven technology.

Mobile News Providers
Crowdsourcing is increasingly used in professional journalism. Journalists retrieve information from the crowd (e.g. via social media), typically fact check the information and then use it in their articles or news items as they see fit. New applications such as Meerkat and Periscope allow citizens to stream video directly to their social media (Twitter) followers, providing both a technological platform and a built-in audience. These apps offer new opportunities and dimensions for live reporting of breaking news or event reporting, potentially bringing it to a much larger audience. Although such live streaming apps make viewers feel like they are in the moment, and increase their participation and engagement, they have a number of shortcomings as well. Typically they lack curation of a professional newsroom and provide less clarifying information than formal news crews do. For instance, video contributions might be too far (no information) or too close (no broader perspective) from the scene. The apps show what's new, but

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[10] https://www.younow.com/
[11] https://fancred.com/
[12] https://getgraava.com/
[13] http://www.muvee.com/home/
[14] https://www.google.com/photos/about/?page=movie

they do not necessarily show the news. However, this might evolve when broadcasters learn to use them. More generally, a lot of emerging tools and solutions for crowd sourced content contribution and production (not necessarily news) become available. Examples of these crowd sourced applications include functionality such as (off-line) collaborative filming, community-based assignments and user-gen contributions, dashboard/map to visualise locations of interest and potential contributors, and more.

<u>Analysis of competition</u>

Data and video acquisition & capture

- Live event services with multiple cameras are currently in trial phase. Fraunhofer HHI already provides the OMNICAM 360, a 360-degree mirror-based omnidirectional camera system. Furthermore, US-based start-ups Jaunt, NextVR and Immersive have organized several 360VR live event tests with systems from capturing to rendering. In terms of quality, only the OMNICAM 360 and ETRI's rig support to capture sufficient quality content, while other 360VR capture tools remain still at a very basis (e.g. HD) level. On the other hand, OMNICAM 360 and ETRI's rig are relatively heavy when comparing to other 360VR tools. ETRI is working on the live stitching service with a mirror-based multiple-camera rig, three-dimensional monitoring and live stitching system. Here, French start-up Videostitch provides a competitive product for live video stitching. ETRI's competitive edge lies in the promotion of the UltraWideView (UWV) format, which provides for a relatively new aspect ratio, particularly suited for large-scale public displays (enabled with projection or multi-screen approaches).

- We consider the recommended solution of fixed cameras with stitching technology to provide a competitor overview. Several competitors are considered, Dallmeier with its Panomera product, and Avigilon with is HD Pro camera family. The Dallmeier Panomera is a so-called multi-focal camera, which combines up to 15 individual (each max 3 MP) cameras into a single enclosure. Within each enclosure, the individual cameras are combined (stitched) and create a single output (hence the product is marketed at a 45 MP camera). Stitching between multiple Panomera units is (as far as known) not possible. Avigilon offers a broad range of high definition cameras – up to 30 MP. However, we only consider the models up to 16 MP as for higher resolutions, the frame rate drops below 10 frames per second, which is considered inappropriate for stadium applications where events can occur at a high speed. The key differentiators in Avigilon's HD Pro camera family are the 1" sensor (which offers higher sensitivity) and the EF lens mount (SLR-style bayonet), which allows for greater flexibility in lens options. Furthermore, these cameras offer an advanced technology for transmitting only the required information to the user (HDSM), hence saving CPU and bandwidth. The Intel TrueVR system provides an end-to-end solution for 3D visual scene capture, but requires significant on-premise processing and storage hardware, tailored to Intel's own camera. MOS2S consortium partner ETRI provides a multi-camera solution consisting of fixed cameras with stitching technology. Their system is able to work with a large variety of common of the shelf cameras providing flexibility.

- For live mobile capture and streaming, competition is diverse and companies like UStream, Youtube, Periscope, Twitch all aim at addressing this market. Periscope, with a user base of 10 million users as of August 2015, is fully integrated with Twitter, but only the initial broadcast is exposed on Twitter. Content remains on disk for 24 hours only, and

it offers analytics on viewers. *Snapchat* is also for live-only content, without saving option. *Blab* allows for conversation, debate, or collaboration, all within the same live-stream. Blabbers can connect with up to 4 other users in the same Blab, allowing for a more interactive live-stream. These are all still in the game of just allowing everyday people to stream in the context of single stream events, with the exception of Youtube. There is no-one however who has yet used the capability of having a multi-stream event to produce a different type of user experience based on synchronised videos and associated metadata such as play-by-plays, stats, merchandising, odds for betting, etcetera. None of the current competitors have a similar strategy in creating different type of interactive user experiences and as such are addressing the potential of introducing mechanisms to enlarge the pool of available, good quality user generated video. Facebook has also rolled out live streaming[15] . Initially they focused on influential people such as celebrities for contributions. They allow this select group of people to stream to the rest of the Facebook users. *Facebook Live Video* users can save videos to their timeline, and those videos can stay there unless users choose to delete them.

All these upcoming tools each have their merits and benefits, but standing on their own do not leverage the full potential of crowd journalism:
- o no known (real-time) aggregators of such diverse sources yet;
- o no existing solutions to match and correlate real-time contributions of diverse sources in terms of timing, location and context (what the content is about);
- o no integrated solutions, platform/editing suite and approach for managing of (near) real-time crowd journalism (breaking news) scenarios;
- o no integrated end-to-end approach to involve the audience in each step of the news creation process (from idea to distribution).

Competitive advantage in the newsroom domain could be achieved when solutions are developed that address these current shortcomings. Such solutions would provide more immersive and in-depth understanding of news events, and what's really happening on location from all different angles. The potential impact of MOS2S technology increases with the number of contributing sources and devices, as such a (smart) city or large sports/music event represent excellent cases for added value experiences.

Data and video analysis, brokering & orchestration

- ▪ Most video streaming back-end systems combine video server capability with easy publish/subscribe capabilities, and provide for integration with social networking platforms. On the client side, some mobile apps do not allow to save the video stream. On the server side, no or only limited video retention over time is offered. The WWS platform used in the MOS2S research prototype will have the capability to store video streams on disk. Streams with metadata analysis and video frame analysis will be saved to a dedicated database. Both video and derived data will be accessible based on time. The WWS platform used in the MOS2S research prototype will livestream data through its built-in message broker that scales to any number of streams required. Historical data will only be available for selected streams by means of a dedicated WWS component that persists data from these streams in a structured way inside a database. This persisted data will at least be accessible based on time.

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[15] http://www.cnet.com/news/facebook-tests-live-video-streaming-for-the-masses/

There are few companies able to provide real time EPTS solutions that are proven technology. Inmotio is such a provider and has a long history in working with elite sports organizations such as football clubs and, Ice hockey clubs and the International Ice hockey Federation, American (college) Football, handball, canoeing, speed skating and so on. There are several companies that focus on live video sport streaming and feedback, such as Myplayxplay, Provispo and Match Analysis. Game On distinguishes itself in terms of video quality (4K), intuitive interface, support for multiple users, live tagging and the possibility to integrate with existing systems.

Smart Venue concept and infrastructure
- Several major IT companies worldwide are developing technologies and products for Smart Venues or Live Events in some way or the other. For instance, top football teams are already beginning to install wireless networks and prepare their arenas for second screen applications, social networks and other interactive internet services. Bayern Munich and Bayer Leverkusen are prominent examples from the German Premier league; the same holds for top teams in other European countries like Ajax Amsterdam in The Netherlands and Arsenal in the UK. In the US similar trends can be observed in the National Football League. Further examples include Miami's Sun Life Stadium hosting IBM's Intelligent Operations Center; SAP's installations at The MetLife Stadium and the Hoffenheim venue; Sony's partnership with the Levi's Stadium; and Cisco partnering with Hamburg to showcase their Smart+Connected City solution portfolio. The Amsterdam ArenA compares favourably to these initiatives, because of its combined Smart Venue – Smart City approach, its partnering with a variety of partners beyond IT companies, its Living Lab facilities, and its concrete exploitation plans and agreements towards Euro2020.

2.2.2. Consortium market access

(Recommended length: up to 10 pages)

Describe how the introduced innovation will help achieve competitive advantage. Explain the expected business impact of the project with respect to the competition (see §2.2.1). Each of the partners (except for the academics and research centres) should clearly identify its markets, opportunities and how it intends to profit from them.

Detail how the partners will exploit the actual project results after the project end (e.g. integration in future products or services, third-party licensed software, published APIs, life-cycle maintenance through an SME, open source software, integration in in-house software tools ...). When possible, briefly discuss a timeline for commercialising the project outcome (keeping in mind that funded projects may not directly develop products or services): indicate the most relevant technology deployment time range, i.e. short-term (less than two years after project closure), mid-term (two to four years) or long-term (five years or more) that can be expected.

NB: while ambition is at the core of competitiveness, it is also important to remain realistic and credible with regards to the partner targets and capabilities.

Detail also in this section the global strategy deployed towards achieving the exploitation goals, for instance (and when relevant) through:

- *Standardisation:*

  Standardisation includes de jure/de facto standards, published APIs, open source repositories and associated communities, etc. Standardisation should be seen as a way to enable exploitation plans, e.g. by enabling a market to take off, by helping integrators to embrace the proposed technology, by counterbalancing proprietary solutions of leading competitors, etc.

  When relevant, define a standardisation strategy consistent with the project and document its implementation. Projects having software- or system-engineering related activities should, whenever applicable, identify the open source strategy or the tools interoperability strategy.

  When Open Source Software is considered, explain how the project intends to build (on) a large, lively and strong community around the open source software and how the impact from the project will be quantified.

- *Dissemination:*

  Consider here dissemination towards customers, communities (industrial, scientific, etc.), incl. communications, seminars, workshops, conferences, papers, courses, etc. Dissemination must be seen as a tool to make potential customers or partners aware of the project achievements and results, within and outside the organisations participating in the project.

  Define and justify a dissemination strategy actually supporting and having impact on the project, i.e. justify the choices made (e.g. why selecting given workshops rather than others). Indicate how the project results will be disseminated in the course and at the end of the project, i.e. by means of (e.g.) which presentations in workshops and conferences, publications, etc.

If fast exploitation is expected, explain what exactly is targeted, and how the consortium intends to achieve these goals.

This subsection should convince evaluators that the consortium is credible, legitimate and relevant to address the market and to exploit the project results (if successful) to generate business (i.e. that it can have an impact on the market). This subsection should be market oriented and should only focus on the long-term goals of the project (i.e. what is expected to be achieved thanks to the project outcomes, i.e. after the project closure).

The MOS2S consortium partners target the markets for smart venues, live event services, mobile news providers and video-based surveillance and security. Below, detailed market access and exploitation plans for the consortium partners is provided, categorized per market.

Smart Venues

Amsterdam ArenA (The Netherlands)

On a yearly basis, Amsterdam receives more than 100 delegations from abroad aiming to learn from the 'smart' solutions which are developed in the Amsterdam region. These visits initiate and facilitate a structured and continuing international cooperation between the Amsterdam Metropolitan Area and other metropolitan regions in the world. Amsterdam also supports companies within the Amsterdam region with their export plans and international ambitions. For instance, by giving them a role in hosting incoming delegations and in international collaborations

with other city regions. In the period from mid-2016 to 2020, in the run-up to the European Football Championship 2020, the Amsterdam ArenA will be extensively refurbished. Joint Projects, such as MOS2S, that have been successfully tested may possibly be applied to the new Amsterdam ArenA development on the basis of delivery terms and conditions to be set at the time. This gives relevant parties the potential of direct commercial spin-off.

The Amsterdam ArenA Innovation model is scalable and may be licensed for use in other locations in the world where initiatives are developed for Smart City and/or Smart Stadium innovations. Cities and/or stadiums can obtain an Amsterdam ArenA Innovation Center license by entering into a Satellite Innovation Center ("SIC") Agreement with AAIC which will allow the local set-up and exploitation of the AAIC Innovation Hub model. This agreement links the SIC with the Amsterdam ArenA Innovation Center and this new location is added to the innovation platform. The aim, in principle, is to have the same basic facilities as in the Amsterdam ArenA Innovation Center with the possibility, by working together with local partners, to extend the basis with specific and/or unique facilities. The foundation is the compatibility in facilities in the Amsterdam ArenA Innovation Center and the SIC in order that PoCs can be tested and demonstrated in both innovation centers. The SIC model gives the Amsterdam ArenA Innovation Center access to international markets, and partners from the SIC's region may be linked up. It also provides Joint Projects with the opportunity to test and demonstrate in SIC locations. Joint Projects may also be included in SIC locations.

Bosch (The Netherlands)
Bosch produces integrated cameras and video solutions, such as video stitching. The Amsterdam ArenA will serve as the showcase for the technology, Bosch is able to support as well on the commercial side. The initial investment of creating a unique solution can be easily replicated to different projects worldwide, as it is based on standard products. Additionally, new business will be generated around sports analysis, fan engagement and such, which will enable further economic growth in adjacent areas. Finally, the concept itself is likely to prove useful in other domains than sport, namely smart city and smart buildings.

KPN (The Netherlands)
KPN is the Dutch incumbent with its own fiber and copper networks in the fixed domain and 2G/3G/4G networks in the mobile domain. Currently, KPN is rolling out the first LoRa network that will have total national coverage. LoRa will act individually and alongside the other mobile networks and is especially suited for IoT and Smart City solutions. KPN is Dutch market leader on both mobile and fixed connections within the business market and consumer market. KPN provides millions of clients with different products and services. KPN takes in an enabling position in the Internet of Things and Smart City marketplaces. With its focus on collaborating with ecosystem parties (from start-ups to corporates) and matching demand and offer in the market, from niche players and specific unique customer demands to general solutions and maturing market opportunities, KPN has a dominant local presence in all customer segments in The Netherlands and therefore is the Dutch go-to party that boosts the Internet of Things and Smart City marketplace in The Netherlands. Within the MOS2S project KPN will contribute the following: Data transport on fiber; data storage via Cloud NL in own data centers; real time data analysis with Hadoop (big data management); interactive video delivery.

KoçSistem, Bor , Dia (Turkey)
KoçSistem is a solution provider of digital signage in Turkey with its product named Pixage and Bor Software is a video middleware developer and solution provider with its product named IVME,

and DIA is a key member of Turkish SaaS market. According to Turkish perspective, Koç is going to bring market opportunities from digital signage customers, Bor is going to scatter results of MOS2S in middleware consumers, and DIA is going to promote results in enclosed business sites. The increase of video related revenues of Koc and Bor also reflects growing demand and opportunities in the Turkish market. Rich media consumption in Turkey in the last decade was highly related to entertainment needs of the Turkish community. However shares of other domains as education, security and surveillance, enterprise communications (telepresence, video conferences) are growing each year.

Live Events Services

GameOn (The Netherlands)
The goal of GameOn is to develop a consumer application for viewing and sharing video content, with the possibility for in-app purchases, in combination with a (web-based) video platform for sports venues that handles storage, metadata management and further remarketing. Commercialisation is possible within one to two years. GameOn will develop software components in the form of reusable libraries with clear APIs and documentation to be shared amongst stakeholders and possibly published online under a specific (commercial) license.

Inmotio (The Netherlands)
Inmotio has the goal of offering live data feeds to media companies, such as broadcasters and sports rights owners etc. The timing of this development is well chosen given the fact that the FIFA is planning to allow and standardize the use of EPTS (Electronic Performance and Tracking System) in football games.

KISWE (Belgium)
Upon successful validation and implementation, the MOS2S developments will be integrated in Kiswe's current live sports & entertainment streaming platform, *Trekker Live*. The timing will depend on the outcome of the results and further developments to be done, but it is anticipated that within 6 months to a year from project ending the results should be integrated and maximally contributing to the success of our Kiswe platform.

ETRI, JDI System(Korea)
ETRI and JDI system are targeting the professional 360VR content venue. ETRI and JDI systemare expecting that, by implementing a high-quality live event content chain in MOS2S, a new content value chain can be developed, sufficient to convince their current and future customers.

Mobile News Providers

Nokia (formerly Alcatel-Lucent) Bell Labs (Belgium)
The World Wide Streams (WWS) research track of Nokia Bell Labs focuses on platform technology to deploy processing graphs of real-time streams in distributed architectures. Nokia anticipates to exploit the MOS2S innovations to its WWS platform into all market segments where enterprise and provider solutions are deployed that blend cloud, mobile and sensors technologies into coherent applications, particularly if the individual parts of the solution are all managed by different players but need to interoperate in complex ways. In particular, Nokia Bell Labs intends to exploit the project results in the following ways:

- use the experience gained by running project demonstrators on the WWS platform to allow us to put WWS as hosted solution in the market to act as a dataflow engine enabled broker between streaming data sources and applications;
- use the context analysis capability of the WWS interest broker to monetise on the value of the data flowing through this platform;
- transfer the interest broker functionality to our customer care product division, so that the device management and self-care products of Nokia gain a competitive edge. The future of customer care is defined by a number of capabilities that are directly linked to the MOS2S results, such as predictive customer experience management and AI assisted self-service based on contextual information and insights.

VRT (Belgium)

VRT will exploit the gained insights in MOS2S to deliver high-quality and novel digital storytelling formats for news and sports to its viewers, and via the Sandbox approach stimulate the creation of spin-offs. VRT's Sandbox[16] offers private companies an on-the-floor accelerator with pitching opportunities within VRT and towards EBU members. Ideation and business model fine-tuning are provided in partnership with iMinds. It offers consumer research using "real people" and collecting information from the web. Through iMinds it offers access to schools, universities, socio-cultural organisations, distributors, etc. The Sandbox provides exposure and helps in recruiting investors or new business partners and, via the EBU, Europe-wide dissemination of results and cross-fertilization with the international broadcast market. The approach often results in the creation of spin-offs. Furthermore, VRT intends to exploit the project results in several ways, i.e. via news and sports delivery to mainstream media (besides VRT), e.g. newspapers and websites; via event feeds and emergency notifications to city screens; and via early warning of emergency services.

Dissemination

The table below provides an overview of dissemination activities that the MOS2S partners plan to engage in. With a mix of large industry, small-to-medium enterprises, research and technology organizations, the consortium is able to cover a wide range of activities.

Pillar	Activity	Community	Approach	Expected results
Scientific dissemination	Publishing (ACM, IEEE)	scientific	Target top-quality venues, such as ACMT TVX	Increased interest in research topics around optimization of panoramic interactive experiences and data/driven video
Commercial presentation	Showcase technology	industrial	Presence with compelling demos at industry events (IBC, NAB)	Early adoption by commercial and industrial counterparts

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[16] http://sandbox.vrt.be an international joint platform for collaborative innovation, put together by VRT, EBU and iMinds.

Pillar	Activity	Community	Approach	Expected results
Industry Fora	Integration of existing standards (IETF, ISO/MPEG, W3C, SMPTE)	industrial	Incorporation of project results within distribution and presentation standards	Increased adoptability and acceptance of the technology
Community building	Design of low-cost content creation tools	End- users	Availability of low-cost content production tools to grassroots community	Allow experimentation with content creation to facilitate early adoption
	Project branding	End-users, scientific, industrial	Definition of project logo and website, promotion through social media	Increase awareness of project activities and results in all communities.

Standardization

The table below provides an overview of focused standardization activities that several MOS2S partners plan to undertake. The focus lies on standardization of media orchestration technology in ISO/MPEG, but other groups and bodies will be approached and influenced as well.

Partner	Standards body	Main Focus
KPN / TNO	ISO/IEC MPEG	KPN and TNO jointly contribute to MPEG activities. TNO is the initiator and lead of the recently started MPEG activity on media orchestration (MORE), and active contributor to MPEG's unified timeline activity. TNO will contribute MOS2S concepts to these activities. TNO also leads the efforts on Spatial Relationship Description in MPEG DASH, a form of media orchestration what will certainly be used in MOS2S.
VRT	W3C, ISO/IEC MPEG, IPTC	W3C SMIL (Synchronized Multimedia Integration Language); MPEG-7 ADVP (AudioVisual Description Profile) - modelling of metadata taking into account timing and location information of captured content; MPEG CDVS (Content Descriptors for Visual Search) - descriptors for visual content, facilitating matching of different video sources; MPEG4-11 (Scene description and application engine). A number of IPTC standards can be involved: • IIM Multimedia News Exchange

Partner	Standards body	Main Focus
Imec		- NewsML-G2 for exchanging text, images, video, audio news and event or sports data. - EventsML-G2 for collecting and distributing event information - SportsML-G2 data model and format for sports - RightsML Rights expression language
	W3C	W3C-CSV Working Group : RML = RDF Mapping Language. The RDF Mapping language is a generic scalable mapping language defined to express rules that map data in heterogeneous structures and serializations to the RDF data model. RML deals with the mapping definitions in a uniform, modular, interoperable and extensible fashion. RML is defined as a superset of the W3C-recommended mapping language, R2RML, that maps data in relational databases to RDF.
ETRI	ISO/IEC MPEG	ETRI contributes to MPEG activities regarding content streaming and orchestration. In particular, ETRI is contributing to MPEG-DASH, and to Media Orchestration (MORE) activities for panoramic video composition and streaming.
Samsung	ISO/IEC MPEG	Samsung is a dominant industrial global player in MPEG standardization, with a focus on next-generation video transport with Modern Media Transport and 360/VR video streaming with the Omnidirectional Media Application Format.

2.2.3. Impact on quality of life

(Recommended length: up to 1 page)

Describe here the expected impact on the quality of life (e.g. improved wellbeing, enhanced healthcare, increased crowd security, extended social connection, better working conditions with less physical burden and fatigue, more reliable products, broader access to knowledge, etc.).This subsection should only mention the (potential) societal relevance of / added-value or benefit from the project.

There are several impacts through MOS2S results on quality of life of citizens. Currently, some professional rich media publishers take time to process and enhance information before delivering it. However with the results of MOS2S, amateur video shooters are going to reach respectable quality of standards and let others consume new orchestrated rich media in real time. This property increases societal transparency and fosters open data initiatives.

MOS2S is going to bring more joy to sports competitions. It is going to increase the interaction between the audience, fans and sports professionals (athletes, coaches, content providers) and may lead to a more engaging viewing experience and a more active user participation. It is also going to bring fans-to-fans interactions which is going to increase the communication level.

MOS2S will enable real-time participation and engagement of citizens in live events or breaking news situation with a more in-depth and holistic understanding of what's going on, by journalists and citizens. It will bring more benefits especially when multiple locations are impacted. MOS2S is going to bring timely delivery of news and notifications of important events on city displays or video walls, which can also be used in the mainstream media.

Enhanced and more interactive rich media applications are something especially youth are looking for. The youth population of Europe is going to get access to live events, breaking news reports, and sport events on multiple devices in an enhanced and interactive way.

2.3. Technology

2.3.1. State-of-the-Art (SotA) analysis

(Recommended length: 5 pages)

Describe the current technological situation in the project domain with a detailed technical state-of-the-art, with regard to current products, prototypes and research results and trends, both on the industrial and academic sides.

For the research state-of-the-art (SotA), also document how your proposed project relates to, and/or builds on results of, and differentiates from, other (past or running) cooperative (e.g. IST, ITEA, ARTEMIS or national) projects or national ICT clusters tackling related issues: we recommend filling in, for each of such projects or national ICT clusters, a short description thereof in the suggested table below, focusing on the aspects related to the proposed project and a short description of how the proposed project relates to, and/or builds on and differentiates from it. Please note that in this table below, the last column, "Relationship", should explain:

- *which input modules will be reused from the mentioned project;*
- *and/or what will be transferred from this proposal to the mentioned project;*
- *or the reasons why the consortium does not intend to reuse/transfer results from/to the mentioned project (i.e. why the results already achieved are not useful for this proposal).*

NB1: The ITEA Living Roadmap (accessible through the ITEA Community website) provides a rich source of information with regard to the existing SotA. Use it but go also beyond its content to extend the known SotA (e.g. with the very latest products, achievements, publications, etc.).

NB2: For each past or running ITEA project, a two-page description ("Leaflet") is available on the ITEA public website.

The state-of-the-art described in the project proposal will have to be updated / extended in the course of the project and integrated in a public deliverable. Except for specific cases, the state-of-

the-art section *of the project proposals* *will be considered by the ITEA Office as a public document* *which could be added to the Living Roadmap.*

This subsection should convince evaluators that the project partners have detailed knowledge of the technological background (and evolution) in the targeted field. ITEA considers the State-of-the-Art analysis as a key tool to clearly understand and steer innovation all along the project lifespan.

The MOS2S project will make significant contributions in several areas and on multiple topics. For these topics (listed below, see also the Technology Value Chain), we provide a detailed state-of-the-art analysis.

Use cases	Crowd-sourced journalism in news production
	Data-driven and immersive fan experiences for live events
Enabling technologies	Data and video acquisition & capture
	Data analysis, brokering and orchestration
	Video analysis and processing algorithms
	Video brokering and orchestration
	Video streaming and delivery

Use case - Crowdsourced journalism in news production

More and more news organizations are trying to fit citizen journalism into their coverage of local and world events. Crowdsourcing has an increasing impact at every stage of the news or broader content production process: real-time fact-checking and curation of breaking news, story ideation and community-based story assignments, device-agnostic information gathering and interactive event visualisation, location-based audience engagement platform, etc.. Emerging crowd-sourced video collaboration apps and platforms allow organisations to co-create news and content stories with their customers, viewers, fans or experts. One of the main challenges is to make this workable and scalable in real-time production scenarios, enabling real-time guiding of user generated event coverage and providing intuitive editorial suites and dashboards to select, filter and process suitable and quality-proof content based on careful annotation and video synchronisation. At the consumption side, interactive and multi-device experiences should give the viewer a better understanding of what's actually happening and how the scene really looks like. The above mentioned applications such as Meerkat and Periscope allow citizens to stream video directly to their social media (Twitter) followers, providing both a technological platform and a built-in audience. Other players such as UStream and Twitch are still mainly offering services in the context of single stream events, with the exception of YouTube. Cameraad[17], an application trialled in the summer 2015 by the Dutch news site NU.nl and TNO, adds curation by a central

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[17] Cameraad: livestreams van ooggetuigen in het nieuws SVdJ 2015-05-07 (in Dutch)

news room. Apps for Android and iOS are available[18]. Around the same time, the Dutch public broadcaster NOS did a similar live streaming trial at the start of the Tour de France in Utrecht, with Amsterdam based Ubideo[19].

Use case – Data-driven and immersive fan experiences for live events
VRT is participating in the ICOSOLE[20] project, where different cost-effective ways of capturing spatially outspread events are investigated. All the content, both professional and user generated, is synchronised in time and space to create an immersive experience for people who cannot attend the event. Methods for fusing audiovisual and sensor information into a coherent data representation have been developed. A prototype networked platform for streaming live content from mobile capture devices to content processing and editing services has been built, including tools for media production professionals to select, configure and review the content sources being used. At the consumption side, VRT has developed the *Wall of Moments[21]* prototype, an interactive and immersive app that shows the latest and most interesting Moments of an event in a highly personalized mosaic, creating a near-to-real experience. In ICOSOLE, a Quality Analysis app was also developed for Android for technical quality assurance of UGC. The app automatically measures Noise Level, Luminance variations and Blurriness. MOS2S will build further upon ICOSOLE tools and insights, improving synchronisation capabilities, increasing orchestration flexibility and adding real-time communication.

SELVIE[22] (Scalable, Efficient, and Low-delay Video Interaction during Events), a collaborative Flemish research project, investigates how the audience engagement in large-scale events can be increased by deploying scalable and reliable networks with massive amounts of connections and by incorporating a high-quality video streaming workflow combining professionally captured video content and UGC. The Selvie framework comes with a director component, which interfaces with the human event director and provides a way of deciding which visitor-made videos and pictures to show on the event's screens and merge it with other professionally captured content. A UGC collector component matches the requests of the director with the metadata of the available streams to decide on which content to collect and forward to the director. Although Selvie shares some interesting functionalities and principles with MOS2S, it does not deal with the orchestration and synchronisation challenges, the real-time streaming capability and the live dashboard and director's cockpit. It also lacks the real-time feedback to end users while they are capturing.

S.M. Entertainment, one of the largest entertainment companies in Korea, recently introduced a new business model for consuming music concerts, "Surround Viewing". Surround Viewing requires a multiple camera system to capture wide field of views which are concatenated and a display technique in a theater for providing viewers with a vivid, live feeling to concerts projected onto three massive widescreens surrounding the audience. ETRI supports this concept with a multi-camera rig and monitoring system, to provide ultra-high quality. This new immersive content technique brings fascinating experiences but at this moment only supports three HD views with considerable bezels between screens.

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[18] NU.nl laat lezers het nieuws livestreamen met smartphone-app. Numrush 2016-02-03 (in Dutch)
[19] NOS en Ubideo laten toeschouwers Tour de France live verslag doen Numrush 2015-07-03 (Dutch)
[20] http://icosole.eu/
[21] Bauwens R. e.a.: *The Wall Of Moments: An Immersive Event Experience At Home* IBC 2015
[22] http://www.iminds.be/en/projects/2014/11/28/selvie

Enabling technology - Data and video acquisition & capture
In terms of stadium video surveillance, we can distinguish between two solutions, i.e. using moving (PTZ) cameras or using fixed cameras. Typically a combination of both solutions is used. The most typical solution is using moving cameras where cameras are strategically placed, often high up, and offer the possibility to have an overview (when zoomed out) and details with up to 36x zoom. PTZ is controlled by the operator using a mouse or CCTV keyboard/joystick. With different fixed lenses options (wide to short angle), stadiums can be fully covered with fixed cameras. This has now been facilitated by multi-megapixel technologies, so that full coverage with high resolution can be achieved with a reasonable amount of cameras. Clearly the trend is towards a fixed installation of multi-megapixel cameras, enriched with some PTZ cameras for full flexibility. This is applicable to every stadium type, from smaller to bigger with cost proportional to its size. Even with the highest resolution cameras, there are still dozens - if not hundreds - of cameras deployed in a single stadium. To overcome this and ease operation, "stitching" technologies have been introduced. Stitching allows images from multiple cameras to be combined in real-time and create a single image (which could be for example of a stand). Stitching software has been developed for the broadcast industry and is now becoming available for the security market.

Data acquisition and capture or multisensory perception implies new dimensions to capture the reality that will provide a higher immersivity or better understanding of the scene. Audiovisual capturing system are enriched with sensor information such as GPS, compass, inertial sensors, thermographic imaging, torque sensors, etc.[23]. Moreover, user comments that are becoming so popular on media that include social-network services, can be considered as a new type of (semantic) sensor information that can have a strong impact in the management of media content. Video will be captured with traditional cameras (supplied by partner Bosch) , supplemented with the Ultra Wide View (UWV) capture system, a 360° Virtual Reality camera platform in Ultra-High Definition (8Kx4K@60fps) for professional users and real-time 360VR generation, supplied by partner ETRI (KR).

InMotio (NL) will provide a real-time and wearable sensor data acquisition system, focussed on player tracking, while TNO (NL) will develop a mobile video capture module.

Enabling technology - Data analysis, brokering and orchestration
Context analysis depends on additional metadata that is available about a particular stream. Dublin Core Application Profiles (DCAP) specifies at a minimum which metadata terms are used within a particular application[24]. A notable example is semantic technology for multimedia production[25]. A framework called Semantic Streams[26] allows users to pose declarative queries over semantic interpretations of sensor data. According to Nilsson[27], in order to promote metadata

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[23] Bailer W., Pike C., Bauwens R.,Grandl R., Matton M., Thaler M.: *Multi-sensor concert recording dataset including professional and user-generated content.* Proceedings of the 6th ACM Multimedia Systems Conference, pp 201-206, ACM, March 2015.
[24] CEN: *Guidelines for machine-processable representation of dublin core application profiles*, ftp://ftp.cenorm.be/PUBLIC/CWAs/e-Europe/MMI-DC/cwa15248-00-2005-Apr.pdf.
[25] Nack F., Van Ossenbruggen, Hardman L. J.: *That obscure object of desire: multimedia metadata on the web, part 2*, IEEE Multimedia 12 (1) 54-63.
[26] Whitehouse K., Zhao F. , Liu J.: *Semantic streams: a framework for composable semantic interpretation of sensor data*, in Proceedings of the Third European conference on Wireless Sensor Networks, 2006, pp. 5-20.
[27] Nilsson M.: *From interoperability to harmonization in metadata standardization*, http://kmr.nada.kth.se/papers/SemanticWeb/FromInteropToHarm-MikaelsThesis.pdf.

harmonisation, metadata models (semantics) are much more important than metadata syntax or metadata application profiles. Classifying metadata by means of ontologies or tag clouds is not sufficient though - some entailment or reasoning capability is required to match publishers and subscribers based on the context of the streams. For MOS2S, the relevance of the data is dependent on the context in which the data was created. In particular, it is in many cases necessary to keep track of the spatial and temporal context, i.e. where and when the data was created, in order to decide where, to whom and for how long this data is relevant and to prioritise the most relevant data.

MOS2S both considers multimedia, sensor and data streams as input. For sensor and data streams, a wide range of broker solutions are available that all have made specific trade-offs between the requirements they have to implement. For multimedia streams, the typical solutions are split between servers that handle live streams and servers that handle stored streams. The data broker platform considered for MOS2S as back-end for the demonstrators is the WWS (World Wide Streams) platform[28] provided by Nokia Bell Labs. It has a broker architecture that is geared towards real-time, high bandwidth data streams. Its video capabilities will include webrtc[29] for live stream publishing and subscribing and HTTP for stored stream playout. The broker has built-in analysis and processing capabilities; this includes an interest broker that can select data streams based on relevant metadata information and can also report on trending metadata. MOS2S will use available state-of-the-art data analytics techniques and available social media APIs such as twitter trendsmap[30] and Google trends[31] to derive trending concepts and topics and possibly trending stories and their context, and feed this context into the interest broker.

Media sensor orchestration is about correlating sensor streams by adding high quality metadata to recordings, including those from on consumer devices. In a professional recording, cameras are gen-locked and calibrated. Using consumer devices for capture, adding good metadata is key to creating this same functionality here. Current timing mechanisms are either not very accurate (NTP), not accessible on many consumer devices (GPS)[32] or not available everywhere (beacons). Much work has been done to improve clock synchronisation, e.g. by Ridoux[33], and some work has been done in combining NTP and probing[34,35] to increase accuracy and lower convergence time. For location, GPS may not be accurate enough, agricultural GPS is very accurate relatively but not absolute, and works with a special beacon[36]. For connectivity, it is important to have a view on available network bandwidth for real-time use cases, and encoding needs to be adapted for this,

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[28] Weldon M. K.: *The Future X Network: A Bell Labs Perspective,* CRC Press, 2015; p. 309
[29] http://www.webrtc.org/
[30] http://trendsmap.com/
[31] https://www.google.com/trends/
[32] Kooij W.J., Stokking H.M., Van Brandenburg R., De Boer P.T.: *Playout delay of TV signals: measurement system design, validation and results.* Proceedings of the 2014 ACM International Conference on Interactive Experiences for TV and online video, pp.23-30, ACM, June 2014.
[33] Ridoux J., Veitch D.: *Principles of robust timing over the Internet.* Queue, Vol 8(4), pp. 30, 2010.
[34] Tsuru M., Takine T., Oie Y.: *Estimation of clock offset from one-way delay measurement on asymmetric paths.* Proceedings of the 2002 Symposium on Applications and the Internet (SAINT), pp.126-133, IEEE, 2002.
[35] Gotoh T., Imamura K., Kaneko A.: *Improvement of NTP time offset under the asymmetric network with double packets method.* Conference on Precision Electromagnetic Measurements, 2002, Conference Digest, pp.448-449, IEEE, June 2002.
[36] Hofmann-Wellenhof B., Lichtenegger H., Collins J.: *Global positioning system: theory and practice.* Springer Science & Business Media, 2012.

e.g. using tiling mechanisms. Various probing mechanisms for this exist. Finally, metadata is added to media streams, e.g. timing data[37],[38] and other metadata as well[39].

Enabling technology - Video analysis and processing algorithms

Video stitching has been around for some time now. Recently, efforts have been made to improve this to real-time[40]. Recent solutions to capture 360° content exist with using low cost video cameras (gopros, 360Heros). Software from Bosch and ETRI uses high-powered graphics cards designed for advanced video gaming to stitch thousands of frames per minute (GPU processing). Tools for stitching videos for camera clusters typically require a fixed setup of the camera cluster, with normally equal camera types. The tools are based either on templates (e.g. VideoStitch) or work with a feature based approach combined with templates (e.g. Autostitch[41]). The templates can be generated with a sample scene and a feature based approach, e.g. with Hugin[42]. Nearer objects can only be stitched with a feature-based approach, but for a much higher computational cost incompatible with real-time constraints, as opposed to fixed templates. The output is one linear video showing the surround view. This works only for static cameras that are all (near) the same position and highly symmetrically placed. For arbitrary input, algorithms similar to that coded in Photosynth[43] are necessary. This is a tool from Microsoft, which merges still images that are taken with cameras from different point-of-views. It is based on interest point detection and matching. The output is a surrounding image mosaic; the images are placed on billboards in a 3D scene around the viewer. This scene is static in its geometry (it does not change during time) and static in its texture (the images on the billboards are still, they are no videos).

On the computer vision side there are two important fields we want to address. The first is image quality assessment, where the goal is to automatically evaluate the quality of images in agreement with human quality judgments[44],[45],[46]. This is a well-researched field to qualify images with the purpose to automatically improve them in image processing applications. These techniques start from a learning set of human judged images to build a model for image quality analysis. They do not address the complexity of live video stream however. A second field we would research can be supported by abstracts and papers describing how to use publicly available images and videos on the internet to abstract data from the scene such as the camera

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[37] Veenhuizen A.: *frame accurate media synchronisation of heterogeneous media sources in an HBB context.* Proceedings of the Media Synchronisation Workshop, January 2012.

[38] Le Feuvre J., Singer D.: *Proposed Exploration of Uniform signalling for timeline alignment,* MPEG contribution, December 2013.

[39] ISO/IEC 15938-1:2014: *Information Technology -- Multimedia content description interface -- Part 1: Systems.* ISO/IEC, Genève, 2014.

[40] El-Saban M. A., Ezz M., Kaheel A.: *Fast stitching of videos captured from freely moving devices by exploiting temporal redundancy*. ICIP, pp. 1193-1196, 2010.

[41] http://www.cs.bath.ac.uk/brown/autostitch/autostitch.html

[42] Hugin - Panorama photo stitcher. http://hugin.sourceforge.net/

[43] Uricchio W.: *The algorithmic turn: Photosynth, augmented reality and the changing implications of the image.* Visual Studies, vol. 26(1), pp. 25-35, 2011.

[44] Mohammadi P., Ebrahimi-Moghadam A., Shahram S.: *Subjective and Objective Quality Assessment of Image: A Survey*, arxiv 2014

[45] Ye P. , Doermann D.: *Active Sampling for Subjective Image Quality Assessment*, CVPR 2014

[46] Ye P., Kumar J., Doermann D.: *Beyond Human Opinion Scores: Blind Image Quality Assessment based on Synthetic Scores*, CVPR 2014

positions[47], 3D model of the scene[48] or even material properties[49]. These algorithms work offline and are therefore not interesting for live events where such analysis is to run in real-time.

Enabling technology - Video brokering and orchestration

Several tools for media orchestration (data models, protocols, frameworks, object models, APIs) are already available from standardisation organisations. MPEG has designed a number of media composition technologies (MPEG-4 BIFS, LASeR, MMT-CI). Such technologies are perfectly suited for complex compositions of media streams at the consumption side, on a single device. MPEG transport technologies usually allow for the declaration of associated resources through hyperlinking, addressing part of the media announcement issues. However, all these technologies are used to communicate a list of known locations and will probably not be adequate for media discovery. MPEG TEMI is able to deliver a timeline for external data in a main transport stream. DVB Companion Screens and Streams (CSS) has defined many protocols, some of which could be relevant to MOS2S, e.g. *DVB-CSS-WC (*wall-clock synchronisation between TV Device and CSA, a quickly-converging NTP variant), and *DVB-CSS-TS (*timeline synchronisation, timestamping of video frames at the TV Device with the wall-clock).

Orchestrated citizen information and participation scenarios requires in-depth understanding of one or multiple scenes or locations where the action takes place, and their relation with contributed user gen footage. There are several standards that have been designed with the focus on configuring and specifying the composition of a multimedia scene and its low level components. Some of most important efforts are: (1) W3C-SMIL (Synchronized Multimedia Integration Language)[50], an XML-compliant W3C standard focused on the composition of a media scene and its interactivity, mainly video and 2D content; (2) MPEG-4 Part 11[51] (Scene description and application engine) encompassing BInary Format for Scenes (BIFS, defines the content, composition and compression of a scene) and the XMT Framework, comprising substantial portions of SMIL, W3C Scalable Vector Graphics (SVG) and X3D (the new name of VRML); and (3) MPEG-7 (ADVP and CDVS), where specific metadata could be applied to scene configuration and composition. Visual authoring tools have been developed over these standards (e.g. in FP7 TOSCA-MP for ADVP), but more as sample tools and proof of concept than real production tools, let alone for live use cases.

Within the FP7 project STEER, a video orchestration and brokering platform was developed by TNO to synchronize video streams originating from both professional broadcast cameras as well as mobile phones. The orchestration involved timestamping of video streams at different ingest points, and temporal alignment based network clocks such as NTP. The platform was further developed together with Dutch online news provider Nu.nl, enabling the selection of incoming video streams from mobile devices.

Enabling technology - Video streaming and delivery

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[47] Frey N., Antone M.: *Grouping Crowd-Sourced Mobile Videos for Cross-Camera Tracking*, Computer Vision and Pattern Recognition Workshops (CVPRW), 2013

[48] Agarwal S., Furukawa Y., Snavely N., Simon I., Curless B., Seitz S.M., Szeliski R.: *Building Rome in a Day*, Communications of the ACM 2011

[49] Haber T., Fuchs Ch., Bekaert Ph., Seidel H.-P., Goesele M., Lensch H.P.A.: *Relighting Objects from Image Collections*, CVPR 2009

[50] Bulterman D., et al., *Synchronized Multimedia Integration Language (SMIL) 3.0.* W3C Recommendations, 2008.

[51] ISO/IEC14496-11

MPEG-DASH, enabling smooth over the top streaming of multimedia content, is available as international standard, and a first versions of the new standards enabling spatial relationship descriptors[52] and the signalling for timeline alignment are becoming available[53]. Additionally, synchronization efforts at the client mainly focus on RTP-based streaming with only preliminary results (early prototypes) for DASH-based delivery. New immersive and interactive content formats are currently not subject to discussion or standardization in the context of MPEG-DASH. Initial work is being conducted within the ICoSOLE project and MPEG has started an exploration activity related to media orchestration, both with active participation of MOS2S partners, specifically TNO.

Link to previous and/or current collaborative research projects:

Project Name	Cooperative Programme	Time period (approx.)	Technical Focus	Relationship
ICOSOLE (VRT)	FP7	2013-2015	Allows users immersively experience live events (spatially spread out, such as festivals) by combining quality spatial video, audio and user generated content.	Like MOS2S, it has multiple contributing sources and a mobile capture app, content tagging and filtering, selection and production tools in a live broadcast context.
TOSCA-MP (VRT)	FP7	2010-2012	Scalable and distributed content processing and annotation methods with advanced multimodal information extraction and semantic enrichment.	MOS2S will build upon diverse video analysis and feature extraction tools for live and non-live production scenarios.
FASCINATE (ALU, TNO)	FP7	2010-2013	Immersive interactive broadcast experience, with a special tiling approach for interactive delivery of very high resolution content.	Common partners with MOS2S will re-use the interactive tiling approach and build on this for interactive delivery to VR equipment.
HBB-NEXT (TNO)	FP7	2012-2014	User-centred technologies for enriching the TV-viewing experience, with (o.a.) multi-device synchronisation for media play out.	MOS2S re-uses the synchronisation solution and extends this to multi-sensory synchronisation.

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[52] ISO/IEC 23009-1:2014/FD AM 2, *Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 1: Media presentation description and segment formats, AMENDMENT 2: Spatial Relationship Description, Generalized URL parameters and other extensions*
[53] ISO/IEC 13818-1/FD *Amd 2, Delivery of timeline for external data*.

Project Name	Cooperative Programme	Time period (approx.)	Technical Focus	Relationship
STEER (TNO)	FP7	2012-2014	Experimentally exploring the dynamic relationship between social information and networked media STEER developed a solution for synchronisation amongst multiple capture devices.	Common partners with MOS2S will build upon the synchronisation approach to meet more stringent requirements, such as frame-accurate synchronisation.
OpenTransportNet (iMinds)	EU-CIP	2014-2017	Open Data tooling & publishing in a European Open Data Transport Network.	MOS2S will extend TheDataTank framework with real-time (sensor) data characteristics
Apps4EU (iMinds)	EU-CIP	2013-2014	Publication of Linked Open Data concerning the different European Apps Competitions	MOS2S will extend RML-processor with real-time (sensor) data characteristics
Flander's Open Data Publishing (iMinds)	EWI	2013 - 2014	Awareness creation and deployment of Open Data in Academic Publishing, Data Journalism and Governmental Data re-use.	MOS2S will extend TheDataTank framework & RML-processor with real-time (sensor) data characteristics & visualisation libraries
TheDataTank	iMinds Open Source Framework	2011-ongoing	"15 minutes" Linked Open Data Publishing framework (v5 deployed)	MOS2S will extend TheDataTank framework with real-time (sensor) data characteristics & visualisation libraries
SELVIE (iMinds)	iMinds IWT	2014-2016	Stream visitor-made smartphone videos in real-time to the event screens	Knowledge on how to build an interactive user-gen video-platform will be taken into account
USENET (NOK)	ITEA	2012-2014	M2M service platform.	Large scale platform to reach out to sensors and actuators. Produced lots of ETSI standardisation.
WTEPlus (NOK)	iMinds	2008-2010	Study and enhance new paradigms for	Demonstrated a platform and marketplace for composable M2M services

Project Name	Cooperative Programme	Time period (approx.)	Technical Focus	Relationship
			composition and deployment of applications. Our first dataflow engine.	based on a dataflow concept.
DIYSE (NOK)	ITEA	2009-2011	Support for creating aware, interactive and flowing experiences in an Internet-of-Things world.	A follow-up project of WTEPlus, with more attention to prosumer creation of services.
M2MGRIDS (NOK)	ITEA	2014-2018	Creating real-time enablers for a dynamic cyber-physical information business ecosystem.	Combines reasoning and M2M sensor / actuator interaction in the energy domain, based on the WWS platform.
iCore (NOK, TNO)	FP7	2011-2014	Demonstrator and platform for urban security (with Thales)	One of the demonstrators showed narrow Artificial Intelligence features coupled to a director component for video streams.
SmartIP (NOK)	EU CIP	2010-2014	Platform for large-scale Zwerm trial in Ghent https://vimeo.com/65648085	Zwerm was a large-scale city game running on the WTEPLUS/DIYSE platform, which later evolved into ALU's current WWS platform.
Care4Balance (NOK)	EU AAL	2013-2016	Demonstrator and platform supporting quality of life improvement for the older adult.	Another long-time running demonstrator on the WTEPLUS/DIYSE/WWS platform.
ImmersiaTV (iMinds, VRT)	H2020	2015-2017	An end-to-end toolset covering the entire audiovisual broadcast value chain and associated demonstrators.	Focuses on an immersive video distribution chain, see http://www.immersiatv.eu

Table 1: Related collaborative research projects.

2.3.2.   Proposed technological innovation and novelty in relation to the SotA

(Recommended length: 4 pages)

Clearly explain the progress and technological innovation proposed by your project, with reference to the current technology state-of-the-art. Explain what differentiates the project from other R&D efforts, how it builds on the SotA and which novelty it brings from a technological standpoint.

This subsection should convince evaluators that the consortium has sufficient insight into the technological challenges and proposes significant breakthroughs to bring technological innovation and novelty.

Data & video acquisition: multi-stream capture
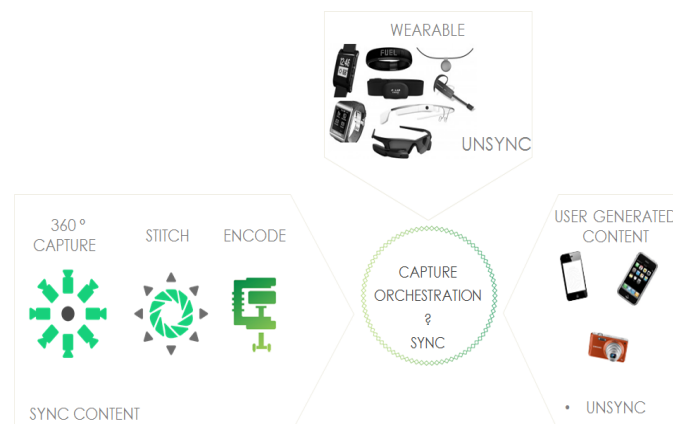
Figure 9 - MOS2S challenges in capturing.

The main challenges in capture are to provide good output in real-time, to orchestrate across all different capture devices and to enable production to steer capture. A first challenge is for the professional capture using new types of cameras, such as 360° cameras. The challenge is how to provide good output, based on calibration, stitching and encoding, even if the geometry or illumination of the captured scene evolves through time or if the camera is in motion. The latter constraints imply to constantly analyse the input scene to adapt the distance of the artefact-free stitching planes, compensate the different colour and exposure responses of the various cameras to varying illuminations and lights, and efficiently stabilize the assembled 360° video to prevent motion sickness for the viewers using immersive VR headsets. In addition, it may be necessary to be able to record the input videos during stitching for offline higher-quality stitching in post-production, putting more load on the stitching station. The second challenge is for the capture on consumer devices. Here the challenge is how to calibrate these, by providing good metadata on timing, location, orientation and characteristics. For both professional and consumer acquisition, the challenge is how to make production control the capture, in what is captured and how it is captured, and what output is delivered in which quality.

MOS2S will provide tools to perform stitching and encoding of new professional camera setups in real-time as well as tools for adding good metadata to captured content. These tools will have interfaces towards the production tools, to allow production to steer the acquisition. For adding good metadata, we will determine the metadata first. This means extending upon existing mechanisms to determine timing (e.g. extend NTP), location (e.g. combine GPS and Wi-Fi location mechanisms) and orientation (e.g. using built-in sensors or compare the captured pictures to Google Street View), to achieve the MOS2S requirements. This metadata will then be added to the captured stream, which will be partly session information and partly metadata directly matched to the streaming output. Adjustable camera settings will be made available to the production tools by creating new interfaces. Advanced onboard camera analytics provide object classification and crowd density analysis. 4D stitching will be explored for projecting the stitched video on 3D models, making operation even further intuitive. In addition, advanced bandwidth management will be developed to transmit only the required data, saving network and computational power. The real-time stitching performance is supposed to be 8K-grade with more than six HD cameras. Also, the 360VR solution will be applied to the 2nd use case event to show the matureness and feasibility of the 8K-grade 360VR broadcasting service.

Partners involved: VRT, Kiswe, Nokia (B), ETRI, Samsung (KR), InMotio, GameOn, Bosch (NL).

Outcome: Output from capture devices that is either merged already or with supplied metadata to allow further processing during production. It would also be possible to derive additional metadata such as localisation/orientation from image analysis from user generated content contributions.

Data & video analysis
The challenge is a data fusion finely and accurately managed to benefit from all sources based on the video ingest time and location (i.e. geo-location of the four corners of the different camera scenes). The idea is to implement technology, eventually supporting its evolutions as requested, for dynamically combining video streams, dynamic metadata in general and results of video analytics in particular. Advances requested are in an accurate geo-location and time stamp of each produced video frame and a seamless infrastructure managing consistently all information as streams, each fitted with the necessary synchronization data. The other challenge is proper insertion of alternative videos in the regular displays with a smooth rendering. Furthermore, proper storing of the combined content to the cloud respecting to the 3D scene reconstruction requirements, and video histogram equalization for heterogeneous sources in online debate application are the other subjects which we can mention as innovations. Furthermore, in an industry-first proof-of-concept application, the KPN IPTV service and associated set-top box will be further enriched with a coach-on-the-couch application; this application, running on the KPN STB, includes a newly developed interface between the data server hosting data from the Inmotio Electronic Player Tracking System and a visualisation overlay. The overlay can show real-time player positions, and real-time individual player features, such as current speed, distance travelled and even heart rate.

Partners involved: Amsterdam Arena, TNO, GameOn, InMotio (NL), Nokia, VRT (B).

Outcome: multi-stream visualisation of action scenes, giving the event and security operator a better and more immersive view on all available data.

Data & video analysis, brokering & orchestration: Crowd journalism and live event coverage

New production tools

A professional cockpit for crowd journalism and live event coverage will be developed and tested. The cockpit allows the professional content creator to steer the crowdsourced capturing effort, making sure the UGC feeds optimally match the creative story needs, both in duration, number of contributions, level of detail and quality. Filtered contributions taking into account the director's needs are presented in an intuitive dashboard. Information from scene images as well as camera locations and view coverage will be extracted, to create a clear view on what's happening on the event. and provide feedback as to how the current production can be improved by motivating certain contributors to change perspective and/or location. The live coaching aspect will be explored to determine which type of feedback can help the contribute to improve their contribution by changing perspective and/or location, without compromising their attention and focus on the subject and ongoing event. The complexity of the research here is mainly driven by the real-time and video quality requirements. A novel live hangout feature that is tightly integrated with the editorial redaction tools and end user app will be developed. This new feature will allow people to call in live via the app to report on ongoing actions at any action location across the country. Before possibly going live on antenna, the radio journalist can communicate with incoming callers, prepare them for the live broadcast and put them in a waiting queue. Radio journalists will get a clear overview of all incoming callers to manage their live contributions. The resulting experience can be published on social media or on television. Live hangout will generate additional content from a motivated crowd, that could not be acquired with the traditional professional capturing processes.

New metadata flows

Another important innovation aspect is the metadata handling throughout this new type of production process. Metadata will be captured and added at an early stage, wherever possible via linked open data. There should also be an easy way to annotate or appreciate the captured content for user gen contributions. All the gathered metadata will play an important role in the semi-automatic visualization and interlinking of content sources and in the composition of the multi-device experience. In practice, an own developed data model for a coherent data flow during orchestrated news event coverage will be delivered.

New data flows

New real-time data flows should be easily (read: within 15 minutes) incorporated in the workflow at hand. Therefore, our State-Of-The-Art Linked Open Data publishing suite (TheDataTank + RML processor) will be extended to be able to cope with real-time (sensor) data & crowd-sourced data (with possible feedback loop), which means the incorporation of provenance metadata will be essential. This means the interactive visualizations & story flows will be able to make a distinction between versioned stories (and how they further develop over time).

Partners involved: Nokia Bell Labs (BE), Imec (BE), KPN (NL), Kiswe (BE), TNO (NL), VRT (BE)

Outcome: tools for professionals that enable real-time steering of live event capturing (content and quality)

Data analysis, brokering & orchestration

The data brokering platform that will be developed and tested in MOS2S, will have the following distinctive features:

1. real-time distributed publishing engine and broker giving applications full access to data and metadata of physical streams (sensors, multimedia, data)

2. interest broker functionality that has the capability to funnel and match a limitless amount of real-time inputs (provided the necessary scaling infrastructure is provided) to applications based on an interest description (location, metadata, context, values)
3. real-time data analytics pipeline that can turn streaming data from a wide range of sources (sensors, blogs, social networking apps, ...) into knowledge
4. turn data into context, using ontology and folksonomy driven methods that can handle noise, errors and uncertainty, preferably via a standardised mapping/cleansing language, i.e., RML.
5. extract trending topics and stories augmented with context out of this analysed data

Partners involved: Nokia Bell Labs (BE), Imec (BE)*,* KPN (NL)

Outcome: high-performant and real-time broker platform that can be leveraged as back-end for MOS2S application.

Data & video analysis, brokering & orchestration: Media orchestration standardisation
MOS2S will actively contribute to the media orchestration standard and be the first to implement it. MOS2S will help refine the media orchestration standard architecture and its elements, lead the writing of the specification and help with validation by implementation.

Partners involved: ETRI, Samsung (KR), KPN , TNO (NL).

Outcome: Contributions to ongoing standardization efforts within MPEG.

Video streaming & delivery: Multi-stream consumption
The enhanced and immersive content requires scalable and hybrid content distribution through heterogeneous delivery environments (broadcast, broadband, Web, social), and combining end-user devices for seamless rendering of an immersive experience. This includes the following challenges:

- Orchestrated delivery of immersive media content from multiple inputs to multiple outputs allowing for synchronized playback and rendering on the end-user devices;
- Real-time delivery of enhanced, immersive, and interactive media content within heterogeneous delivery environments, specifically in live scenarios;
- Inclusion of additional timed data including context information to be delivered within a heterogeneous environment and allowing for synchronized playback and rendering on the end-user devices;
- Discovery of various end-user terminals, including legacy devices with fall-back presentation, and identification of their capabilities.

The targeted solution will provide tools – integrated within state-of-the-art OTT solutions based on the MPEG-DASH standard – enabling the orchestrated delivery and consumption of new immersive and interactive content formats to a set of heterogeneous and interconnected devices. MOS2S will enable the orchestrated delivery of new immersive and interactive content formats over the top of the existing infrastructure by enhancing the existing MPEG-DASH standard with tools enabling the description in both temporal and spatial domain as well as its synchronization of the play-out on a heterogeneous set of devices. These extensions will enable the orchestrated delivery of various timed media assets coming from various sources to a plethora of end user devices. Additionally, MOS2S will further enable the delivery of new immersive and interactive

content formats by optimizing the delivery function with respect to network, device, and user capabilities. This requires a tighter integration of delivery and rendering functions with enhanced interactivity features based on the user's context.

Partners involved: VRT, Kiswe (B), KPN , TNO (NL), ETRI, JDIsystem, Samsung (K)

Outcome: Existing over the top (OTT) solutions will support use cases for new immersive and interactive content formats both within delivery/streaming and consumption functions.

2.3.3. Expected project outputs

(Recommended length: 1 page)

Detail the concrete final results of the project: give a clear description of what will be its actual set of outputs (novel algorithms, standards, open source libraries, implemented collaborative framework, demonstrator, product prototype, new service based on some software, wearable device, etc.). The description should be detailed enough to give a clear picture of what will be generated, including the core functionalities and levels of maturity.

At the end of the project, the results will be confronted with the content of this subsection (potentially updated through Change Requests). A poor description will be considered as a lack of expected results, or as significant uncertainty about what will be delivered: clarity is therefore highly recommended here.

The requested description must focus on tangible, realistic and credible outputs that will be developed within the project (if the project extends existing solutions, then clearly clarify the specific contributions of the project) and available at project closure, i.e. demonstrated at the final project review. Post-closure results, like exploitation plans and prospects, have to be indicated in §2.2.2.

This subsection should convince evaluators that the project will deliver tangible results of interest that will support the business goals of the project partners.

Technology
MOS2S will provide novel tools and technology to the creative and news media industry and societal security industry that enable them to create and explore new forms of immersive and interactive content. This includes:

- a user-friendly app for orchestrated co-creative video capturing to share crowd-sourced video content;
- a 360/VR capture system and application for fan experience, with a real-time video stitching and improved encoding tool, assisted by metadata on timing, location and orientation, and video analysis;
- a real-time cloud-based data and video broker with collection, analysis and processing capability giving applications full access to a limitless amount of (selectable) data and metadata of streams turning data into knowledge and context. This includes an interest broker that can select data streams based on relevant metadata information and can report on trending topics or incidents.

- real-time video and sensor data analytics tools assisting in content matching, contextualisation and quality control;
- an online debate application for crowd journalism. Online debate will allow people to talk publicly about arguable events such as a live sports game, a political issue, economy etc. The debate format includes one anchor, four debaters and interactive viewers who can participate via surveys, emotions buttons and text comments;
- a live hangout feature for crowd journalism Live hangout feature for crowd journalism;
- a set of creative production tools for MOS2S applications and services in multiple domains (news, live events,) providing
  - an orchestration interface to steer capturing and quality over a large, unpredictable number of crowd generated streams;
  - a creative dashboard for professionals: novel cross-device experiences and intuitive wide angle vision of complex scenes based on filtered and contextualized data and streams;
  - a video streaming and orchestration module: MPEG-DASH based delivery tools enabling orchestrated delivery and consumption to a set of heterogeneous and interconnected devices.

Business

The aim is to research, develop, integrate and validate novel media orchestration tools and to develop and validate novel Smart City solutions and apps for crowd contributions in the domain of media journalism, live sports and events, and security.

Global project gains

The MOS2S platform and tools enable added value orchestration scenarios in multiple domains: citizen information, participation, entertainment, experience, safety and security in smart city context. While having maximal potential impact and benefit in a fully deployed Smart City context, MOS2S applications will also deliver significant added value in other environments and scenarios that are relevant to citizen needs. In particular, MOS2S will create added value for combined cross-domain use case scenarios, e.g. reuse of orchestrated data (both raw or already processed by a MOS2S application) in different use cases, e.g. event experience in and outside the stadium including pre- and post-event experiences, breaking news coverage and event/venue security, crowd journalism and local news services. Finally, the project leverages a Smart Venue as a Smart City Playground, thereby accelerating the development and testing of Smart City platforms, technologies and applications, in a unique manner. We will showcase these novel capabilities of the obtained results by means of a set of concepts and use-case demonstrators.

tools for audience engagement and media production optimization (leading country: Belgium)

This involves end-users using their smartphones to contribute to news creation, initiated by the user community or broker discovery. The combination of metadata, video analysis, localisation and contextualisation will provide the professional journalists at the newsroom with a detailed situation overview (dashboard). They will also be able to interact with and direct the capturers in real time through a cockpit. This orchestrated effort results in informed news streams back to the crowd, to security and emergency agents, to displays or hyperlocal district information sites throughout the smart city and -- if relevant -- to the mainstream media.

Description: Change redaction process for interactive radio production and creating (new) formats. Potentially license to other broadcasting companies through a spin-off.
Main contributors: VRT, Kiswe (B)

Market/competitors: The market features a number of tools that address a part of the desired solution. Many tools for communication with users (Phonebox, Tweetdeck, Arctic Palm) exist but are not merged into the radio production processes. Some radio redaction systems (e.g. Pluxbox RadioManager) already offer some integration for social media channels, without good support for deploying and adding new and/or custom services. The application we develop is merged into the radio making workflow and covers the entire chain from information acquisition to broadcasting.

Compelling TV, companion screen and venue applications for live event experience (leading country: Netherlands)
Live sport and music events attract a huge amount of city and venue visitors. This use case involves both professional dashboards as well as end-user applications for enhanced citizen entertainment and experiences. Through the venue-based integration of ultra-high resolution cameras, interactive video streaming and real-time data tracking technologies, this use case will drive application development for professional sports coaches and sports and music fans. They will be able to enjoy augmented data overlays and interact with video to provide a more enriched and personalized experience.

Description: Consortium partners have developed first versions of a coach-on-the-couch application, where viewers at home can now share the joy and feel the frustrations of being the coach using augmented reality layers in an in-stadium smartphone app. They can determine their team's game tactics, follow a specific player, and get more information about the players and the game in real time. All this is made possible by a data-integrated interactive video system and mobile application combining tracking data and ultrahigh definition video images. At home, too, tracking and UHD video data streams shown via an app on an IPTV set-top box allow the couch potato to become the coach supremo and enjoy an innovative TV experience of a live sports or music event. These applications allow an (IP)TV and/or online video service provider to reduce churn and attract new customers.
Main contributors: Bosch, GameOn, ArenA, TNO, InMotio, KPN (NL)
Market/competitors: Entertainment market, sport broadcasting market. Ericssson Piero[54] / Deltatre DIVA[55] / EVS C-CAST[56]. Our main differentiator is access to professional EPTS and we have an efficient streaming technology (tiled streaming).

An efficient video capture and delivery system for UHD and 360/VR content (leading country: Korea)
Description: ETRI provides an 360VR broadcasting solution using high quality and wide field of view videos to deliver an immersive experience to the home environment. Consortium partners have improved upon video delivery systems, that employ tiled streaming. Tiled streaming enables distribution of UHD and 360/VR video at extremely high quality, using standard encoding / decoding systems, for both on-demand and live content and in a way that is massively scalable to millions of users simultaneously over any CDN, using standard http streaming technology at bitrates comparable to normal video. Tiled streaming works by dividing the video into tiles, and only sending the tiles that are in view. Compared to alternative, server-based approaches, tiled streaming is much more scalable and requires much less encoding and server resources. In particular, a bandwidth reduction of a factor 5 can be realized. The tiled streaming technology has

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[54] http://www.ericsson.com/broadcastandmedia/what-we-do/piero/
[55] http://www.deltatre.com/online-solutions/diva/
[56] https://evs.com/en/product/c-cast

been patented and standardized via MPEG. Our main differentiator is an strong IP position (TNO/KPN) and MPEG SRD standard-compliant implementation.

Main contributors: ETRI, JDIsystem (KR), TNO, ArenA, KPN (NL)

Market/competitors: Fraunhofer HHI[57], GPAC[58], Intel[59], Voysys[60]

2.3.4. Quantified objectives and quantification criteria

(Recommended length: 2 pages)

Consider the expected project results (cf. §2.3.3), and for each one of them define appropriate quantification criteria (Key Performance Indicators - KPIs) that will be used to measure the objective achievements, i.e. what will enable the consortium and evaluators to measure during the course of the project the progress achieved towards the goals. The KPIs should not cover the steering & management of the project, but cover actual exploitation oriented project results.

Example 1: for the detection of ships on coastal borders, the ship detection and recognition rates as well as the required processing time could be considered, and confronted with a target defined by the end users (e.g. 90% detection rate, not more than ten false alarms per hour on the typical traffic of a given area, and at least 5 images per second analysed in a continuous stream with a single workstation).

Example 2: for an HPC framework applied on quantum physics simulation, considered KPIs can include the coverage of accelerated code (how much code is now "HPC-ready"), the processing time reduction (normalised by the hardware cost and/or by the power consumption), the impact on the implementation time (for experienced as well as for new developers), and/or the performance gain for the simulation tool itself, from a user point of view (e.g. latency between request and results, real-time visualisation, etc.).

Example 3: for a standardised model-based framework for the transportation industry, KPIs can cover the percentage of models that can be simulated (on predefined industrial use-cases with existing code), the performance impact (e.g. with an objective of having that impact below 1%), the requirements and specifications coverage of the current implementation, the number of active members in the open source community and the number of industrial end-users that have adopted the framework (or that are at least experimenting with it). The KPIs can also include a set of binary goals to be achieved (e.g. full UML integration, real-time debugging and on-the-fly code recompilation within a simulation, etc.).

This subsection should convince reviewers that the clear analysis and quantification of project progress will be possible during the project lifetime.

Target KPIs - Crowd journalism

A live demonstrator validating the technological and business case innovation objectives for crowd journalism in a living lab context with 50-100 volunteers will provide learnings and best

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[57] https://www.hhi.fraunhofer.de/en/departments/vca/research-groups/multimedia-communications/research-topics/tile-based-hevc-video-for-virtual-reality.html
[58] https://github.com/gpac/gpac/wiki/Tiled-Streaming
[59] https://www.intel.com/content/www/us/en/virtual-reality/true-vr-technology-overview.html
[60] http://voysys.se/

practices in how to optimize communication with and steering of crowd contributors in real-time. A very important KPI for the crowd-journalism case is the size of the contributing and consuming community. The larger the contributing community, the greater the chances are that one of the participants stumbles on a newsworthy event, and the more news value the community achieves. At the consuming side, a bigger news consuming community indicates growing interest in the news offer, and is indicative of the value of the end result. As this is a totally novel way of news gathering, it is currently impossible to state any numerical targets that should be met to call the initiative a success or a failure. **The target is to grow from 1 broadcasting format making use of user-generated content to 3 formats,** with incoming crowd-based images of usable quality. However, this goal is highly dependent on the complexity of the chosen event and environment, and the availability of people with proper smartphone or cameras and sufficient bandwidth.

Target KPIs - Live sports events
Through live demonstrators we plan to validate both technological and business case innovations. The objective is to integrate the enabling technologies within the venue infrastructure and test integrated solutions on performance, scalability, quality and latency. Depending on the end-user application (professional coach, in-venue fan, outside-venue fan), different trade-offs between these KPIs may be sought, e.g. low-latency (<1s), non-scalable for profession coaches vs. higher-latency, highly scalable (>100.00 viewers) for fans. The development of streaming solutions will focus on bandwidth (ranging from 10-100 Mbps) and latency (1-10s), whereas media orchestration will target quality and performance. For TNO and KPN, contributed platforms and technologies focus reducing latency and bandwidth requirements (1s and ~10 Mbps), and to allow for distributed and automated deployment. With regards to media orchestration, focus lies on near-real-time processing (<5s) on low-power devices such as mobile phones.

For Bosch, **higher resolution cameras (8K) and stronger magnification lenses for further detail are expected.** One of the key KPIs for the proposed live event service is the quality of content from sensors to screens. ETRI's goal for this aspect is to capture at least **8Kx2K at 60 frames per second** for 360 omnidirectional view. For GameOn, real-time video stitching resolution on end-user application needs to be improved **from HD to 4K resolution**. For TNO and KPN, a
bandwidth reduction for streaming UHD content to screens with lower resolution needs to be achieved **from 20 Mbits for 4K video, to 10 Mbits for sending a region-of-interest from a 4K video to a HD screen.**

MOS2S will allow Kiswe to run an event where a relevant sample of camera holders will be motivated to contribute and live stream. Kiswe will evaluate the quality of the incoming streams in realtime and advise as to which issues are responsible in driving the stream below the quality threshold. Kiswe will then provide live feedback and coaching via the streaming recorder app software to improve the below threshold video streams. Kiswe's goal with regards to obtaining a larger set of quality streams for this event will be to bring on average at least **25% of the below-threshold streams** above the threshold in the course of the event. This goal is largely impacted by the complexity of the chosen event and environment, and the availability of people with proper smartphone/camera's and sufficient bandwidth willing to cooperate. It is hard to estimate what the exact impact of the project will be on Kiswe's *Trekker Live* in numbers, but it is certain that a successful completion of this project will lead to more people being able to participate and contribute to streaming live events. The availability of more quality video streams for mass and lower level events will allow Kiswe to further enhance its unique interactive and personal user experience and support the growth in overall live content consumption.

In case of event security, for live ingest of mobile video, the objective is to aggregate all such video sources in a consistent way, providing live, near-real-time or post event, the picture of a given action scene, seen from as many angles as possible in an editor, operator, or end-user friendly manner. For event and venue security, this applies to the supervision rooms, but also ideally, if feasible, to field staff fitted with hand held or wearable terminals providing a multi-sensorial rendering preventing any efficiency loss in their missions. Minimum objective would be to be able to smoothly and synchronously insert videos from a limited number of mobile devices (e.g. 10, typically for emergency calls) in the traditional displays based on video-surveillance streams, providing the security staff with a close insider's view of a security incident, all this being available near-live, near-real-time (with delay ranging between 1-5s) and post-event for forensics investigations.

2.4. Consortium overview

For many Public Authorities, it is crucial to already have at the PO stage a clear national consortium as well as clear costs & effort figures: indeed, many countries need to decide on national budgets before the FPP deadline, which means significant changes between POs and FPPs at the consortium and cost levels should be limited to clearly needed updates (in particular, based on the PO evaluation feedback from reviewers and Public Authorities).

2.4.1.   Cooperation added value: business level

(Recommended length: 2 pages)

Position the consortium partners in the market value chains as described in §2.1.1. Explain the business rationale behind the consortium composition, providing convincing elements regarding the consortium legitimacy in terms of the business:

- *describe the core idea motivating the partners to collaborate and explain how this consortium helps them achieve their business goals;*
- *describe how the cooperation is adding value;*
- *explain why the international collaboration (and in particular the ITEA frame) is the best way to reach the targets;*
- *in the event that the consortium does not cover the whole value chains for the respective markets, explain why this is not an issue for the project, and how the consortium intends to overcome this missing link.*

For the software engineering focused projects, highlight the participation of the software tool vendors or, otherwise, justify why such partners are missing.

In any case, it is strongly recommended to involve (directly or indirectly) end-users and potential future costumers in the project, and to set up (whenever possible with these end-users) strong business cases which will derive in business-oriented demonstrations.

This subsection should convince the evaluators that the consortium has enough business power to have an impact on the market.

Dutch Perspective

The Dutch consortium partners find a common business interest in the field of live sport and music events. Most of the partners (ArenA, Bosch, Inmotio, KPN, TNO) already collaborate in the context of the Amsterdam ArenA Innovation Centre, the innovation hub where innovative concepts can be successfully and quickly tested and demonstrated and prepared for the introduction on to local and global markets. ArenA offers the Smart City Playground, and exploits the Smart Venue concept; Bosch provides advanced visual sensors, Inmotio offers an advanced EPTS for data-driven sports, GameOn provides an advanced video-based training application, KPN is active in wireless networking for field trials and TNO enables technology innovations throughout the MOS2S value chain. As such, the Dutch partners are in an excellent position to benefit from international cooperation with the MOS2S partners. ArenA is interested in hosting multiple pilots and trials for all MOS2S use cases; Bosch can naturally extend their product portfolio and R&D from the video-based security domain to the live event experience domain, where they already collaborate with use-case lead Amsterdam ArenA. Inmotio and GameOn are interested in assessing market opportunities with Kiswe; KPN sees opportunities in the Nokia platform innovations. Finally, TNO sees the potential of leveraging its technological innovations in other uses than live events only. Note that for end-user participation, we have conversations with content and service provider Endemol.

Belgian Perspective

The Belgian national consortium consists of VRT as content producer and distributor (with a public mandate), Nokia Bell Labs as IT software provider, device manufacturer (DSL, PON, IP routing infrastructure) and system integrator, Kiswe as SME active in interactive video experiences for sports and music events and Imec as research partner focusing on data knowledge (a.o. linked data cleansing, mapping, and publishing) and prototype design and validation. With actors covering the ecosystem, we bring a strong complementary and unique technological value chain to the MOS2S proposal, which can provide significant innovations in collaborative journalism and in personalised live event experiences (and in smart cities in general). This can lead post project to joined cross-platform productions for news, sports and other events, and as such yield an attractive new ecosystem in which other Flemish media players can join and generate value. KISWE sees opportunities in Nokia Bell Labs becoming a service provider to Kiswe, bringing sensor data broker functionality at the ingest side of generic sensor streams, and eventually at the processing side offering specific video (meta)data services in support of Kiswe's ambition to develop a unique and different type of user experience. The MOS2S developments will upon successful validation and implementation be integrated in Kiswe's current live sports & entertainment streaming platform, Trekker Live. A successful integration will lead to a substantial growth of active users on the platform and as such require Kiswe to further invest in scaling the platform and hiring more development and operational resources at Kiswe Mobile Europe. Vice versa, MOS2S brings a strong international consortium, covering complementary technology areas such as A/V analysis, A/V orchestration and IoT HW and SW components. The international collaboration also brings the possibility for demonstration of (and feedback on) components in actual smart city environments. Furthermore, Nokia Bell Labs has interest in exploring opportunities of its WWS platform in event security as well. Imec's Data Science cluster sees opportunities to align one of its three strategic research ambitions in the smart city domain and validate its semantic research results in real-life IoT use cases.

Turkish Perspective

As Turkish consortium members we have business in different but related fields. Koc Sistem has digital signage products and services, Bor has video middleware solutions and services, and DIA

provides SaaS for enterprises as well. MOS2S is a perfect opportunity for us to bring together our knowledge as a national consortium and gain business knowledge and opportunities from the European consortium to come up with well-defined and well organized applications. With respect to international collaboration, Bor is eager to get information about rich media usage in journalism from Belgian partners, Koc is eager to bear joint knowledge with the Dutch partners about sports arena applications. Finally DIA is willing to enrich its SaaS and IaaS to support rich media orchestration and delivery.

South Korean Perspective

Korea has been the first testbed for the novel IT technologies such as high-speed Internet, 5G network and even realistic media applications. Regarding the MOS2S project, in Korea, there has been several 360VR online stores to provide various 360VR content. From this project, the Korean consortium partners expect to develop the high-quality 360VR platform and attractive content which expands the 360VR market revenue of Korea. JDIsystem is interested in developing a 360/VR player for the virtualized set-top box platform. Samsung focusses on promoting their MPEG standardized solutions, and is interested in collaborating with NL partners from smart venue developments.

2.4.2. Cooperation added value: technology level

(Recommended length: 2 pages)

Describe who among the partners will achieve the technological innovations and detail the technological added value of the consortium collaboration. Focus on unique selling propositions that generate value.

Explain the interactions between the key technology-oriented players. Refer to the targeted technological architecture (cf. §2.1.2), and position the partners in that architecture while underlying their specific role, added value and relevance here.

Explain the technological rationale behind the consortium composition:

- *describe the core idea motivating the partners to collaborate and explain how this consortium helps them achieve their technological goals;*
- *describe what the key partners bring in, how their expertise is complementary, i.e. what makes them relevant partners.*

This subsection should convince the evaluators that there is enough R&D competence in the consortium, that the consortium is appropriate and that value will be created from a technological point of view.

Both business and technological sleeping partners must be avoided.

Dutch Perspective

The Dutch partners offer an advanced and rich set of infrastructure and technologies. ArenA is offering the Smart Playground and its underlying venue infrastructure, and through the support of use case-based trials, will be able to improve the venue infrastructure. The Bosch contribution is aligned with this infrastructure, by adding advanced visual sensors, which can be improved by video stitching and intelligent media synchronization. Inmotio will be focused on the development and delivery of ground-breaking features based on tracking data that are to be used in live video.

The features could be used by consumers in a second screen type of application that will enhance the experience of the sports TV watcher around the globe. The EPTS will be enriched with interactive video features and video analysis. For live sports events, Game On will primarily provide client-side applications and components needed to view, enhance and share (crowd-sourced) video content. Game On will assist in developing the server-client integration layer and any server-side components (or middleware) that are needed to ensure a reliable and performing server-client communication. They will be able to learn from cloud-based technology partners and mobile video app developers. Within the MOS2S project KPN will contribute data transport on fibre; data storage via Cloud NL in own data centres, real-time data analysis with Hadoop (big data management). As such, they will gain technological knowledge about brokering platforms. TNO provides enabling technologies for mobile video streaming and interactive UHD video streaming; they will learn from standardized approaches and integrate with visual sensors and video analysis.

Belgian Perspective
VRT and Kiswe offer applications and test environments and facilities for two main use cases of MOS2S, viz. crowd-sourced news and sports coverage. Nokia Bell Labs has technology (WWS) and experience in deploying data discovery and brokerage between various technological platforms, an essential component to succeed with the project. Imec brings in its TheDataTank technology, an already validated open source platform for processing, publishing and consuming linked (open) data, as well as its accompanying data cleansing and mapping tool set, comprising the open source RML-processor. On the other hand it is obvious that essential technological parts are missing from the Belgian consortium (media and sensor orchestration, video analysis, video stitching…), so that international cooperation is necessary. The city of Ghent has expressed their interest in the MOS2S platform and application developments through a signed LoI, and considers to host and trial relevant parts without becoming a full project partner.

Turkish Perspective
We are going to bring our technological knowledge to the table and try to solve a jigsaw by gaining knowledge of others to the table. Bor is going to bring its expertise in streaming, software encoding, and middleware development and gain technological information about synchronizations of different media, delivery of streaming media in different types of networks, and different tuning techniques in multi-video-audio environment. Koc is going to bring its expertise in digital signage and gain technological information about middleware integrations, time based scheduling of media and also gain domain information from journalism, and urban security. DIA will provide SaaS and IaaS expertise even though he is good at storing and delivering data. In the world of rich media, DİA gain technical knowledge for CDNs as they are providing distributed SaaS and IaaS.

South Korean Perspective
In this project, ETRI is going to design the 360VR camera system and the related software. ETRI contributes a high-quality 360VR live content capture system with a multiple-camera system. Through this contribution, the Korean consortium partners will help the consortium partners to deal with professional-level content and massive video traffic. Especially the transport and delivery of 6Kx3K at 60fps contents brings new challenges on ROI-based streaming techniques, e.g. when using HMDs for 360VR views. Also, ETRI's UWV (Ultra-Wide Vision) system can support the capture of a 180 degree wide field of view at the Amsterdam Arena for a use case and technology demonstration in MOS2S. JDIsystem can further extend its offering with 360/VR

virtual players. Samsung focusses on leveraging MOS2S outcomes for standardisation and dissemination.

International cooperation perspective.
Several cases of cross-border collaboration are envisaged. For example, the live sports streaming, first showcased in the Amsterdam ArenA can be ported and expanded to a live event streaming or crowd journalism case in the city of Ghent, using either CityWifi (if available in time) or 4G. Amsterdam and Ghent are two cities at different stages of "smartness". It will be interesting to compare the feasibility of door-to-door or pre- and post-event experiences in both. Another area of intense collaboration will be the matching and cooperation the complementary platforms for data brokering (Nokia) and video brokering (TNO). Expertise in 360° panoramic capture, video stitching and video analysis is present in several countries (Korea, Netherlands, Belgium) with various levels of maturity. It will be necessary to carefully select the ideal technology for every application. As a final example Kiswe (sports capture, Belgium) and Inmotio (sports metadata, the Netherlands) can cross-fertilize each other's offering.

Business management| Data and Information

gent: zoveel stad

To VRT – MOS2S   MGMT
Auguste Reyerslaan 52
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Belgium

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Letter of interest for project proposal MOS2S (ITEA3)

Dear country coordinator (Belgium),

Thank you for introducing me to your European research project proposal MOS2S in the ITEA 3
Call 2, and specifically its research objectives. The city of Ghent, having read the full project
proposal, takes great interest in the project. We can confirm that the envisioned MOS2S platform,
applications and concepts are closely aligned with the Smart City-related ambitions of the city of
Ghent. In particular in the context of citizen information, where our aim is to digitally bridge city
government and citizen initiatives, we see interesting opportunities to collaborate with the
MOS2S consortium.
The city of Ghent agrees to host relevant parts of it, to cooperate with the partners and to
consider with sincere interest to trial the proposed Smart City aspects, without becoming a full
project partner.

With kind regards,

Bart Rosseau

Figure 10 – Letter of Intent from City of Ghent.

3. Work description

3.1. Project structure

(Recommended length: up to 3 pages)

Provide a global overview of the technical work to be performed and of the Work Breakdown Structure (work packages) envisaged towards it. Use diagrams where possible and do not hesitate to separate the hierarchical view (organisation of WPs and tasks in a tree) from the process view (e.g. interdependency between WPs, yearly processes, etc.).

Explain the interfaces and interactions between work packages, and between consortium members.

Justify how the project structure supports the project objectives.

This section should convince the reviewers that the project structure helps the consortium achieve its goals.

The project plan is divided into a four technical work-packages WP1-WP4, supplemented by the Project Management WP5, to allow focusing on a set of specific innovative aspects in each of the work-packages. In WP1, partners will further detail the use cases and derive related technical and business requirements, with a wide orientation to market trends and technological developments. In WP2, a reference system architecture for the generic MOS2S platform is set up, and technological development of its constituent components is initiated. For each use case, specific applications are developed in WP3, and targeted demonstrations will enable related tests and field trials. Finally, WP4 focuses on the exploitation and dissemination of project results,

The objective of **WP1** is to lay the foundations for the project activities, to ensure the smooth interworking of the individual parts later on in the project and align the project with the needs of the market. To achieve this, we will describe the use cases for MOS2S and extract requirements from them.

In **WP2**, partners define the architecture resulting from addressing these requirements. Based on that detailed architecture, the individual elements are developed and their interfaces are defined.

The aim of **WP3** is to combine individual components into demonstrators and applications, and to showcase during targeted events and field trials. In the work package, we design, test, demonstrate and use the applications to validate that MOS2S serves the needs of the respective markets, in line with requirements determined in WP1.

In **WP4**, we set up a strategic roadmap for the medium and long term exploitation of the MOS2S tools and technologies, we reach out to potential stakeholders, we contribute to relevant standardisation bodies, focussing on MPEG; we disseminate project results via scientific and industry fora.

WP5 is in charge of the project management. Management will cover overall coordination and collaboration of all project participants to ensure proper work package activities. It will organize project resource distribution in order to deal with identified problems or risks in an effective manner. As control instance of the project, WP5 takes care on quality related activities to ensure consistent project output. Legal, contractual, ethical, financial and administrative issues will be also part of the management work package.

In short, the individual WPs and WP leads are:

- WP1: Use cases and requirements (led by yearly use case lead (TNO / ETRI / VRT));
- WP2: Reference architecture and component development (led by Nokia);
- WP3: Applications and demonstrations (led by VRT);
- WP4: Dissemination and exploitation (led by Amsterdam ArenA);
- WP5: Project management and sustainability (led by TNO).

The figure below depicts the work package interrelations; it is clear that the project starts with a wide orientation, then zooms into development of a generic platform and application components, and the widens scope again for dissemination and exploitation.
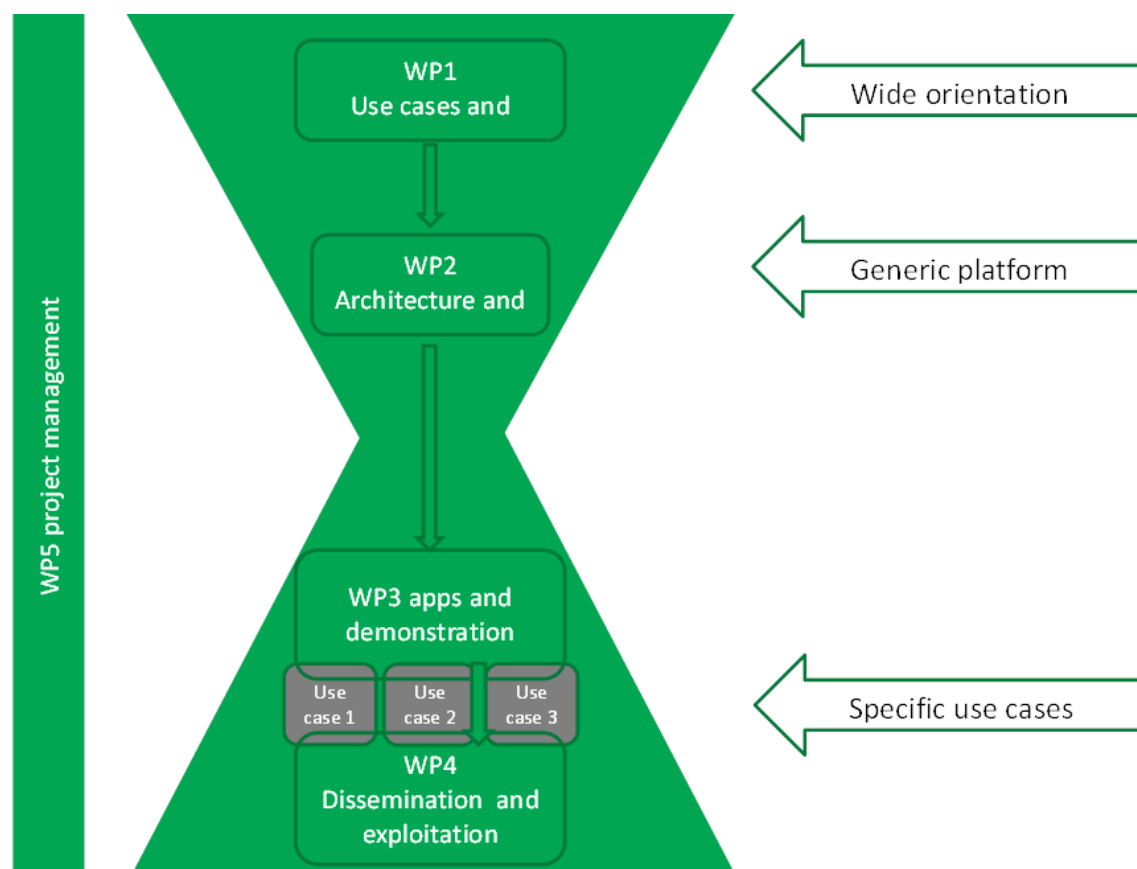

Figure 11 - MOS2S WP structure.

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MOS2S – GANTT Chart for a period of 36 months (note: starting from 2017)

MOS2S work package descriptions	DURATION																																	
	2017												2018												2019									
	jan	feb	mrt	apr	mei	jun	jul	aug	sep	okt	nov	dec	jan	feb	mrt	apr	mei	jun	jul	aug	sep	okt	nov	dec	jan	feb	mrt	apr	mei	jun	jul	aug	sep	
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	262	27	28	29	30	31	32	33	34	35	36	
WP1: Use cases and requirements (TNO/ETRI/VRT)																																		
T1.1: Use cases and demonstrator definitions		D1.1												D1.1												D1.1								
T1.2: Platform, component and interface requirements						D1.2											D1.2												D1.2					
T1.3: Application requirements						D1.3											D1.3												D1.3					
WP2: Reference architecture and component development (NOKIA)																																		
T2.1: Reference architecture														D2.1							D2.1													
T2.2: Platform design and generic component development																	D2.2					D2.2.												
WP3: Applications and demonstrations (VRT)																																		
T3.1: Application Development						D3.1												D3.1											D3.1					
T3.2: Platform integration									D3.2													D3.2												
T3.3: Demonstrator design								D3.3													D3.3												D3.3	
WP4: Dissemination and exploitation (Amsterdam Arena)																																		
T4.1: Innovation potential evaluation and business modelling														D4.1																			D4,1	
T4.2: Exploitation and market exploration														D4.2																			D4.2	
T4.3: Dissemination (academic and industry)								D4.3													D4.3												D4.3	
WP5: Project management and sustainability (TNO)																																		
T5.1: Project Management																																		
T5.2: Reporting									D5.1						D5.1						D5.1								D5.1				D5.1	
T5.3: Change management and work plan updating				D5.2										D5.2													D5.2							
T5.4: Internal communication																																		
Project Milestones							M01		M02						M03						M04					M05							M06	

Figure 12 – MOS2S GANTT chart.

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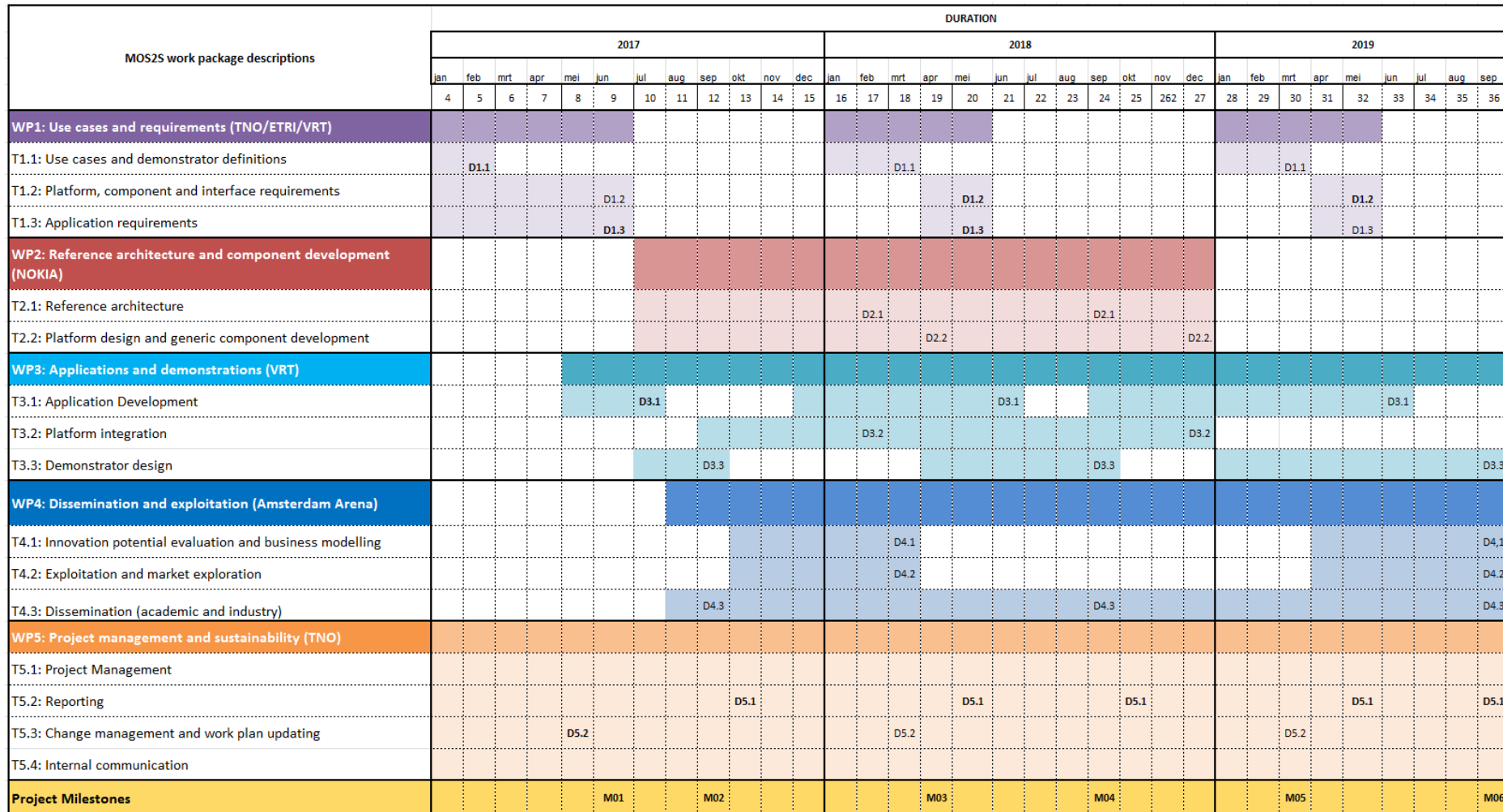
3.2. Main milestones

Present the project milestones in the following table. A milestone should represent a significant intermediate achievement, a date by which major results form the basis for a subsequent phase of work (e.g. finalisation of the data processing algorithms, integration of the semantic modules in the common framework, finalisation of the first version of the prototype, compliance with end-user requirements in terms of performances, etc.), or by which decisions are needed (for example, concerning which of several technologies will be adopted as the basis for a subsequent phase of the project). Major demonstrations should also be considered as project milestones.

It is recommended to consider no more than 6 milestones in a project (i.e. on average not more than a milestone every 6 months).

Milestone titles (descriptions) should be self-explanatory. For each milestone, indicate the Key Performance Indicator (KPI) that will be used to state its achievement, as well as its completion date.

This subsection should give a good overview of the different phases of the project.

Exhaustive list of project milestones:

ID	Description	KPI	Completion month
M01	Specification of requirements MOS2S	Definitions of requirements according to needs of platform, and pilots. Covering 100% of defined needs is expected. First versions of D1.1, D1.2 and D1.3.	M9
M02	First demonstrator ready	First use case ready for demonstration, through mock-ups and based on existing components and platforms. Implementation will cover 35% of defined requirements. First use case demo: Live Sport Event. First versions of D3.1 and D3.3.	M12
M03	Detailed design of architecture and platform	Definition of Reference Architecture and Platform Design through M01. 50% of defined requirements have to be covered through architecture. First versions of D2.1 and D2.2. First version of D4.1 and D4.2	M19
M04	Second demonstrator ready; first implementation	Implementation of applications and components, establishing orchestration mechanisms. Implementation will cover	M24

ID	Description	KPI	Completion month
	of pilot applications and components	70% of defined requirements. Second use case demo: Smart Stadium. (to be defined). Second versions of D1.1, D1.2 and D1.3, second versions of D3.1 and D3.3. Second version of D4.3	
M05	Platform and component developments completed	Final versions Reference Architecture and Platform and Component Design. 100% of defined requirements have to be covered through architecture. Second versions of D2.1 and D2.2 .	M30
M06	Integration and validation of pilot applications and components in real environment	Implementation of applications and components, establishing orchestration mechanisms. Implementation will cover 100% of defined requirements. Third use case demo: Smart City crowd-journalism. Third and final versions of D1.1, D1.2 and D1.3. Third and final versions of D3.1 and D3.3. Final versions of D4.1, D4.2 and D4.3	M36

3.3. Work package descriptions

(Recommended length: up to 28 pages)

For each Work Package (WP), describe:

- *the timeline;*
- *the starting point, objectives and expected results;*
- *the WP tasks;*
- *the detailed contributions of the partners involved in the WP;*
- *the type, content, confidentiality and planned delivery date of deliverables.*

Deliverables can be:

- *either textual deliverables, i.e. documents (pdf, docx, etc.) (cf. "Doc." in the second column of the deliverable tables);*
- *or software deliverables (executables, packages, libraries, compiled or source code, etc.) (cf. "SW" in the deliverables tables); software deliverables do not have to be uploaded to the ITEA Community website and remain in the hands of the consortium.*

Make sure deliverable titles (descriptions) are self-explanatory.

Refrain from planning too many deliverables and look for quality and relevance rather than for quantity: avoid duplicating the textual deliverables with different versions and report in this proposal only deliverables that are relevant at the overall project level. It is thus recommended to

avoid defining more than 20 textual deliverables (except when it is highly pertinent and properly justified) and to <u>focus on a reasonable and limited set of deliverables</u>.

NB: no textual deliverable needs to be attached to software deliverables: code documentation (e.g. Doxygen) and how-to documents are considered as part of software deliverables.

It is highly recommended to provide during or at the end of the project a public deliverable consisting of an update/extension of the State-of-the-Art described in the project proposal.

This section should convince the reviewers that the planned work is precisely known and that the roles and contributions of each and every partner are clearly defined.

3.3.1. WP 1: Use Cases and Requirements

Describe here the leadership, timeframe, as well as the overall WP objectives and expected results.

Detail also in the appropriate tables the task descriptions, the contributions per partner (every partner that indicates costs and effort on a given WP should have a proper description of its contribution in the related table) as well as the WP deliverables.

Please add lines to each table by selecting an existing line and by using the built- in Word functionality "insert new lines": it will guarantee that the formatting of the table follows the predefined rules (e.g. with the automatic switching between light grey and white background for odd and even lines). You should never have to adjust the table formatting yourself.

Leadership	year 1 - TNO: Omar Niamut	
	Year 2 – ETRI: Seong Yong	
	Year 3 - VRT: Luk Overmeire	
Timeframe	Start: M01	End: M32

Objectives and expected results

WP1 will explore relevant use cases and usage scenarios for MOS2S from the point of platform functionality and valorisation potential, so that from these use cases the design requirements can be distilled for the design tasks listed under WP2. Initially the envisaged use cases are Crowd Journalism, Live Events (e.g. sports, music) and Smart Venues. Special attention will be devoted to commonalities and synergies between use-cases, such as the reuse of images and data from crowd journalism or events for security. The process used in WP1 should ensure that all stakeholders have a clear view of the usage scenarios for the MOS2S platform, and come to a common understanding of the requested functionality, and the requirements should clearly map to individual architectural blocks or interfaces, capturing both what needs to be designed and how this should be tested.

Task descriptions	
Task	**Description**
T1.1	Use cases and demonstrator definitions; this tasks will explore said use cases and scenarios with the MOS2S platform, with special attention to smart city related scenarios. This includes a detailed breakdown analysis of these scenarios into use cases, and functional and non-functional requirements. From these use cases, user requirements will be investigated both from a professional and an end user perspective. As a means to drive the design and integration and also as a way to report progress, the project will strive to have a demonstrator available at each yearly review. The definition of these demonstrators will follow after studying the use cases. Year 1 - Task led by TNO: Omar Niamut Year 2 - Task led by ETRI: Seong Yong Lim Year 3 - Task led by VRT: Luk Overmeire
T1.2	Platform, component and interface requirements; MOS2S functionality is typically delivered by means of a hosted platform. Platforms under consideration are the WWS platform from Bell Labs, the TNO video platform and the platform supporting the KISWE applications. This task will analyse the use cases and scenarios studied in T1.1 and derive requirements for the added functionality required for MOS2S that needs to go in the platforms. Envisioned common functionality includes real-time stitching and encoding, real-time or time-shifted video streaming and orchestrations, near real-time video and data analytics, video quality control, real-time communication with and steering of citizens, contextualisation and creative production tools. This task will further analyse the use cases and scenarios studied in T1.1 and derive requirements for the added functionality required for MOS2S that needs to go in the external interfaces to the platforms. Obvious requirement candidates would be derived from the need to interoperate with existing third party products, platforms or services (encoding requirements, messaging protocol requirements, ...). Year 1 - Task led by TNO: Omar Niamut Year 2 - Task led by DIA: Özer Aydemir Year 3 - Task led by VRT: Luk Overmeire
T1.3	Application requirements For a number of the use cases and demonstrators that we consider today, the available platform and generic component functionality will need to be complemented with dedicated applications running on top of the platforms supporting the demonstrators.

Task	Description
	Year 1 - Task led by TNO: Omar Niamut Year 2 - Task led by ETRI: Seong Yong Lim Year 3 - Task led by VRT: Luk Overmeire

Contributions per partner

Partner	Contribution
VRT	VRT will focus its use cases on crowd supported news and event reporting and near real-time orchestration of multiple data and multimedia streams into output formats that are suitable for consumption on multiple devices (TV, tablet, computer, mobile phone). From a public broadcaster perspective, contextualisation and interpretation of a wide variety of incoming sources are essential aspects for reliable quality reporting on journalistic events. VRT will study how crowd sourced contribution scenarios can extend existing news creation workflows, and how it can augment current news related content offerings into novel story experiences. Special attention will go to the redaction tool, a key component in the envisioned use case scenarios. Ideally, use cases should include planned (e.g. a report of an election, live event coverage, a planned current affairs programme item) as well as breaking news events (e.g. a natural disaster) but the last type can obviously not be predicted so we will need some flexibility here. VRT will gather both professional and end user requirements in the mentioned cases.
Nokia-Bell Labs	Bell Labs will expand its WWS platform with functionality that will turn the platform into an interest broker, with some kind of indexing support that will allow fast index management *and* fast topic query execution. We also foresee the need to create a set of adaptors between external sources of information and the platform (currently under consideration: MOS2S partner Inmotio, news agencies, generic RSS/atom feeds, generic HTML scraper, Twitter, Facebook, Pinterest, Instagram, Youtube). On top of WSS we will investigate the creation of apps to allow crowdsourcing of sensor data and multimedia in the scope of the VRT use cases (both at the mobile client side and at the platform side), and to orchestrate these crowdsourced streams into a single experience that can be distributed to consumers.
KISWE	KISWE will focus on the live (sports) event use case, taking the following aspects into account while selecting the use case scenarios: - type of live event/venue (linear event such as a cycling race, fixed location event such as a soccer or hockey match, non-sport event) - focus on content that is normally not broadcast or where no professional fixed or mobile cameras are available - explore opportunities for cooperation with the venue organiser in MOS2S (Amsterdam ArenA)

Partner	Contribution
	- explore how KISWE technology can play a role in professional productions (crowdsourcing with quality support, content that is not easily or economically coverable by mass media such as VRT) For KISWE, the user feedback functionality will likewise require adaptations to the clients used. In addition to the multimedia stream generated by the clients, KISWE might be interested in additional sensor feeds (e.g. GPS tracker data)
Imec	Imec will investigate how their current TheDataTank platform can be extended to address the identified requirements from the different MOS2S use cases, in particular crowd journalism & possibly openly available real-time sensor-data. On top of that they will investigate how their accompanying RML-processor handles the cleansing & mapping of (possibly) vast real-time data streams.
BOR	In T1.1 Bor is going to contact at least 10 of its clients to collect user needs through questionnaires. It will contribute the consolidated questionnaires to the use case scenarios. In T1.2 Bor has a knowledge on video middleware and would like to contribute on platform requirements between streaming and viewing. In T1.3 Bor is going to work on requirements for rich media orchestration in the use cases. Bor also would like to contribute on crowd journalism via its past experiences in education and press domains, with an online debating functionality.
KoçSistem	KoçSistem is providing solutions for needs of different sectors and is developing projects both in Turkey and in the world. In MOS2S project, KoçSistem aims to share its professional and personal experience on digital signage and to gain experience of digital signage contents management. It will contribute its Pixage Product Family, an application with centrally managed content, where the players at the end-point retrieve the contents from the center and publish the same. Using the internet infrastructure, Pixage allows dynamic content broadcast, contrary to the traditional information screens. In WP1, KoçSistem will contribute to analyse ● the use cases and scenarios and derive requirements, ● required components for the Turkish use case (RMOSH), ● requirements for a digital signage infrastructure, ● requirements for a video on demand (VOD) system.
DIA	Dia will contribute to user scenario definitions and requirements definitions for MOS2S platform based on the RMOSH use case. Dia, with the help of its expertise on SaaS and PaaS, will also contribute to analyse and derive the requirements about the cloud service platform and security concerns.
TNO	TNO will investigate how to expand its video ingest platform with functionality that will turn the platform into a video orchestration and broker platform, to provision temporal and spatial alignment of video streams, and process stream metadata. We also foresee the need to create a set of adaptors between

Partner	Contribution
	external sources of information and the platform (currently under consideration: MOS2S partner Inmotio, generic HTML scraper, Twitter, Youtube). TNO will further set requirements for real-time spatio-temporal processing of media streams. On top of these platform we will investigate the creation of apps to allow crowdsourcing of mobile video data and multimedia in the scope of the MOS2S use cases (both at the mobile client side and at the platform side), and to orchestrate these crowdsourced streams into a single experience that can be distributed to consumers.
KPN	KPN will provide service provider requirements, and will support the detailing of use cases towards demonstrations. KPN will further provide the constrains of the available networking and cloud infrastructure.
A.Arena	Amsterdam ArenA will provide the Smart City requirements, contribute to and provide use cases & requirements for smart venues and smart events, and will further provide the constrains of the available networking and local hardware infrastructure.
Inmotio	Inmotio will provide external data and processing requirements, and detail their role in the MOS2S use cases.
Bosch	Bosch will investigate fixed multi-camera systems, and requirements for stitching.
Game On	Game On will set application design constraints and requirements, and detail the application platforms to focus development on.
ETRI	ETRI is going to investigate the current quality of 360VR contents and technological bottlenecks for live event services. This activity will help to make the expected requirements more tangible. Also, ETRI will compare the supposed live event streaming system with legacy broadcasting systems.

Deliverables				
ID	**Type**	**Description**	**Access**	**Due month**
D1.1	Doc.	Use cases and demonstrator definitions (y1,y2,y3);	Public	M5, M18, M30
D1.2	Doc.	Platform, component and interface requirements (y1,y2,y3);	Confidential	M9, M20, M32

ID	Type	Description	Access	Due month
D1.3	Doc.	Application requirements (y1,y2,y3);	Confidential	M9, M20, M32

3.3.2. WP 2: Reference Architecture and Component Development

Instructions are the same as for WP1. Copy the template content of WP1 as many times as you have Work Packages in your project

Leadership	NOKIA: Philippe Dobbelaere	
Timeframe	Start: M10	End: M36

Objectives and expected results

Based on the requirements from WP1, the respective platforms will be augmented to support MOS2S specific features. To that end, a Reference Architecture will be defined. Additionally, component code running on top of the platforms will need to be designed, tested and subsequently integrated into a research prototype that can be used for the MOS2S demonstrators.

Task descriptions

Task	Description
T2.1	Reference architecture; this task will start from on the one side the available legacy platform architectures and on the other side the requirements produced in WP1 to come to a unified architecture that at the same time allows interoperability with the legacy platforms and is a solid basis to define and implement the applications and new platform components required in WP3. Task led by TNO: Omar Niamut
T2.2	Platform design and component development; this task will take the requirements from T1.2 and implement this functionality in MOS2S platform components (WWS, KISWE/TNO platform components) . Unit testing will be done here, integration testing in WP3. For more algorithmically oriented functions such as text and video interpretation, the design will start with a thorough survey of the available state of the art. This task will further consider

Task	Description
	component development; in this task, the missing components for the MOS2S platform will be developed and tested. Missing features for the Nokia-Bell Labs WWS, KISWE and TNO platforms, and required components for the use case scenarios from T1.3 are commented in more detail below under contribution per partner. Task led by NOK: Philippe Dobbelaere

Contributions per partner

Partner	Contribution
Nokia-Bell Labs	Currently missing features in the WWS platform under consideration for MOS2S use cases include ● a stream catalogue that supports fast querying of sensor and multimedia streams ● starting from the dynamic changes to the stream catalogue, create a service that can alert subscribers about trending topics or stories in the incoming sensor / multimedia streams. The stream catalogue will also contain provenance related information, such as which original data feeds were used in the generation of derived data by components of the platform or external services. ● a service that allows users to query the stream catalogue based on keywords, concepts, values, time or place of streaming or multimedia information ● text interpretation pipelines (disambiguation, context analysis, turning words into meaning, turning words into stories, includes an (existing) Part of Speech parser for Dutch and possibly English) ● video interpretation pipelines (typically using previously trained neural nets to annotate still images captured from these video streams with descriptive text cfr. NeuralTalk2[61] for a standalone proof of concept) ● data ingestion adaptors to couple existing sources of data that matter to MOS2S into WWS (see T1.3 for preliminary list)
KISWE	Currently missing features in the Kiswe platform under consideration for MOS2S use cases include: ● The module that takes in a set of synchronized UGC videos and feedback from the end-user, analyze them and give them metrics to define its level of quality; ● A user feedback module in the client app that hints and stimulates the contributor to improve the quality of its content; ● The ability to record addition sensor (eg GPS) or computer vision based tracking data in the client app.

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[61] https://github.com/karpathy/neuraltalk2

Partner	Contribution
Imec	Imec will contribute to the reference architecture study of the MOS2S platform by extending their current TheDataTank platform to cope with real-time sensor-data. On top of that they extend their accompanying RML-processor to cope with the cleansing & mapping of (possibly) vast real-time data streams.
VRT	VRT will contribute to the MOS2S reference architecture design based on the scenarios and requirements defined on work package 1. In particular, VRT will contribute to the design and testing of a crowd communication and feedback module and a quality module as basic components for both the crowd journalism and live event use case. VRT will put particular focus in maximal reusability of the designed MOS2S components across different use cases, such that MOS2S modules can be flexibly applied and customized in a wide range of use case scenarios.
BOR	According to Bor's perspective, the MOS2S Platform which serves as a base to rich media orchestration needs to support: ● Live streams through IP Cameras, smart devices and encoders, ● VoD streams from common streaming servers (wowza, fms, red5 ..etc), ● IPTV sources, ● Submedia integration through common standards (Vpaid, vast ...etc) ● Strong remote management ● Visual stabilization of different sources ● Real-time processes (subtitling, commenting, voting ...etc) Bor would like to contribute to reference architecture, platform design and component development while taking into account aspects stated above.
KoçSistem	T2.1 Reference architecture: KoçSistem will contribute to design architecture. The existing architecture of the digital signage product family of KoçSistem can be accepted as a starting point. KoçSistem will derive the requirements in order to implement the use cases. T2.2 Platform design In order to provide the requirements derived in WP1 and T2.1, KoçSistem will develop the required middleware and applications and integrate them with the existing architecture. T2.3 Component development KoçSistem will develop the required components for the applications and integrate them with the existing architecture.
DIA	On T2.1, Dia will contribute to the MOS2S reference architecture design based on the scenarios and requirements defined in work package 1. In partnership with the other Turkish partners, Dia will work on designing the platform, developing the middleware, components and cloud services to feed applications and provide interfaces for external components (T2.2)

Partner	Contribution
TNO	TNO will contribute to the MOS2S reference architecture design based on the scenarios and requirements defined in WP1. TNO will further work work on a mobile video capture module; on real-time spatial segmentation of UHD/UWV video; and on a platform for video brokering and orchestration (e.g. synchronization) for mobile live video
KPN	KPN will contribute to the MOS2S reference architecture design based on the scenarios and requirements defined in WP1. KPN will further contribute an Hadoop-based data analysis platform (existing infrastructure). KPN will further support the deployment of MPEG-DASH SRD / HLS-based interactive streaming for UHD/UWV video.
Inmotio	Inmotio will be focused on the development and delivery of new features based on tracking data that are to be used in live video.
Bosch	Bosch will contribute to the MOS2S reference architecture design based on the scenarios and requirements defined in WP1, with focus on capture infrastructure and video stitching.
GameOn	Game On will primarily provide client-side applications and components needed to view, enhance and share (crowd-sourced) video content. Game On will assist in developing the server-client integration layer and any server-side components (or middleware) that are needed to ensure a reliable and performing server-client communication.
ETRI	ETRI is going to focus on the capturing tools and generation process for 360VR contents as a component for the live event use case of the MOS2S.

Deliverables				
ID	Type	Description	Access	Due month
D2.1	Doc.	Reference architecture (y2, y3)	Public	M17, M24
D2.2	Doc.	Platform design and component development (y2, y3)	Confidential	M19, M27

3.3.3. WP 3: Applications and Demonstrations

Instructions are the same as for WP1. Copy the template content of WP1 as many times as you have Work Packages in your project

Leadership	VRT: Luk Overmeire	
Timeframe	Start: M07	End: M36

## Objectives and expected results

The platform functionality and generic components researched and prototyped in WP2 need to be combined with applications and use case specific functionality that will be designed and integrated in this WP. The resulting applications and the underlying platforms will be used to drive the MOS2S demonstrators in the respective domains.

Task descriptions

Task	Description

Based on the ITEA 3 FPP Template v2.0 (June 2015)

T3.1	Application design
	This task will focus on the development of applications based on T1.3. The following applications are to be developed:

Crowd-sourcing application design

The implementation of crowd-sourcing will be done on separate platforms (WWS, KISWE), so this task will allow sharing insights between the two environments. The WWS implementation will consist of a crowdsourcing client that has the capability to upload multimedia streams on the WWS platform, largely based on legacy functionality available in the WWS instadash app. This is a client for a broker that would invite mobile publishers and stream video feeds to interested subscribers, triggered by a location based interest. For MOS2S, this app will be extended with feedback capabilities towards the client with the intent to either change the capture setting to a more interesting one (angle, zoom, position,...) or change the multimedia quality for the better (resolution, capture sensitivity, image stability…). This feedback loop will be controlled by an application at the platform side that needs to be specifically designed for MOS2S from scratch. Feedback could also include pre-event logistics such as where the event is going to happen and what event phases or camera angles would be of particular interest.

The application should be able to handle the invitation/dismissal of potential crowd journalists in the scope of a production. One way to give sufficient incentive to potential crowd reporters is to introduce an element of gamification (we could e.g. publish a ranking of crowd journalists with their impact on currently streaming or past news offerings). Similarly, KISWE will augment its clients and platform to include a control loop that enables the generation and distribution of quality feedback from the platform to the clients. The clients will be augmented with additional feedback possibly as an overlay to stimulate the contributor to improve the quality of its UGC.

Crowd redactor application design

While making a news production, inputs such as data feeds and multimedia feeds need to be synchronised in time (e.g. to allow switching in between multimedia feeds), location and context (e.g. to allow switching in between multiple viewing angles of an event). This application will serve as a cockpit that presents the available feeds, allows to query the platform for additional data in a user friendly way and will research ways to use the metadata available on the different streams while orchestrating the final output. Interesting metadata includes location and camera angle of the multimedia stream, a description of the landmarks or activities present in the feed if available, the accreditation of the feed (crowd, VRT reporter, trusted agent,...), some more abstract topic classification the feed is belonging to, and so on.

VRT will research optimal techniques for providing feedback to (a potentially large number of) citizen-journalists, steering and training them for optimal results without demotivating them. The citizen-journalists can also be used for fact-checking information that was obtained from other (e.g. social) media. The orchestrated output could be produced in multiple alternative formats depending on the target devices used to render the streams. On a tablet, the orchestration could take the form of a mosaic, but the project will also consider the use of state-of-the-art VR technology to render the produced streams.
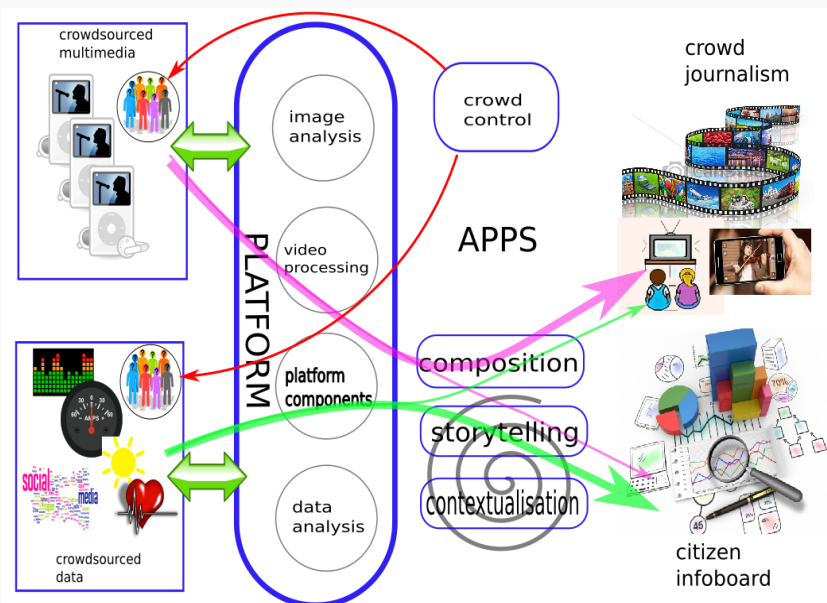
A particular aspect that will be studied in the project is how to assess the reliability of the offered information and multimedia streams and if and how this assessment can be incorporated inside the redactor application. In cooperation with iMinds an using its DataTank technology, VRT will also investigate how crowd sourced (sensor) data sources in a smart city context can be exploited to further augment news storytelling, as illustrated in the figure below. The challenge here is to find out which data is available and useful, and when it is particularly relevant for both news reports and citizen information purposes. The city of Ghent has confirmed its interest and willingness to participate in the exploration of MOS2S opportunities in this area. Likewise, Ghent will investigate synergy opportunities of the crowd journalism case and their future ambitions for digital communication and information dashboards towards their citizens, e.g. by having access to MOS2S generated content.

Couch-on-the-coach applications

A set of live event applications for TV, companion screen and in-stadium mobile usage. An initial live event application concept of coach-on-the-coach is developed. This set of applications uses data from the Electronic Player Tracking System for a visualisation overlay. The overlay can show real-time player positions, and real-time individual player features, such as current speed, distance travelled and even heart rate. New stadium application

Task	Description
	concepts may be considered during the project, focussing on data-driven video orchestration. VR applications for fan experience The 360/VR content will be used for new immersive applications, in HMDs and in a new VR player application on a virtual set-top box. Task led by Kiswe: Jorre Belpaire
T3.2	Platform integration This task will focus on the platform integration based on T1.2. The following integrations are to be performed. WWS platform integration The crowdsourcing related applications (client, control app) will be integrated and validated with a running WWS platform. The story redaction app can be tested on a running WWS platform providing multimedia and sensor feeds with appropriate metadata are available. Since there is a considerable user experience aspect to both crowd control and redaction, the integration and validation phase will include a report on the user experience aspects. The data ingestion adaptors will be integrated with their respective data feeds and a running WWS platform. KISWE platform integration When the integrated platform is available, KISWE intends to organise a user survey to decide on priorities and thresholds for quality aspects of the multimedia streams, possibly diversified per type of event. The KISWE platform will have the capability to automatically generate quality metrics for the multimedia feeds that are attached to it. This will potentially include a comparison between available feeds. The KISWE platform will feed the quality results back to the individuals capturing the multimedia streams, possibly by offering this info in overlay on the mobile device. KISWE will trial several alternatives to give this feedback and make a comparative report. Video orchestration platform integration This platform provides for video processing and efficient delivery. Task led by NOK: Philippe Dobbelaere
T3.3	Demonstrator design

Task	Description
T3.3.1	Year1 demonstrator (Q3 2017): live sport event in Amsterdam Arena. In this task, a first demonstrator based on integrated platforms and technologies will be performed. A live event , e.g. sports game or concert, will be selected as context for the demonstration. First feedback from stakeholders will be retrieved, and a limited validation of technologies will be performed, to steer the next phase of development.
T3.3.2	Year2 demonstrator (Q3 2018): live event in Korea In this task, a first demonstrator based on integrated platforms and technologies will be performed. A live event , e.g. sports game or concert, will be selected as context for the demonstration. First feedback from stakeholders will be retrieved, and a limited validation of technologies will be performed, to steer the next phase of development.
T3.3.3	Year3 demonstrator (Q3 2019): Live crowd journalism In this task, carefully selected field trials and a final demonstrator that represent the crowd sourced journalism use case as well as possible will be performed. The demonstrator will integrate the crowd sourcing application, the crowd redactor tool and the crowd sourced (sensor) data dashboard. Field trials might include breaking news scenarios or specialized current affairs items as they emerge, if validation potential of the MOS2S tools is expected to be sufficient. For the demonstrator, crowd sourced coverage of the Flemish (and European) elections 2019 is provisionally selected. Crowd sourced sensor data might augment for instance storytelling on specific election themes. Possible cooperation with the Ghent city government will be considered throughout the field trials and in the final demonstrator. Besides the crowd contribution and dashboard applications, the demonstrator will also show novel storytelling experiences based on MOS2S tools. Note that demonstrators and their due dates are depending on the contacts with external stakeholders, such as KAA Gent / STVV and the events we can realize with VRT and in the Amsterdam ArenA. Year 1 - Task led by Amsterdam ArenA: Reinout Huisman / Sander van Stiphout Year 2 - Task led by ETRI: Seong Yong Lim Year 3 - Task led by VRT: Luk Overmeire

Contributions per partner	
Partner	**Contribution**
Nokia-Bell Labs	Bell Labs will support the demonstrators with a deployed WWS platform, including multimedia and data stream analysis services. All stream processing functionality required by the apps will be hostable inside the WWS platform.
KISWE	Kiswe will iteratively develop, test and refine a prototype mobile application and back-end for training and improving the quality of the UGC.
VRT	VRT will recruit a test community of citizen-journalists. VRT will offer test environments and facilities for the crowd-sourced news use case. It will put particular emphasis on designing and evaluating the usability of the orchestration cockpit and crowdsourcing contribution application. VRT will also investigate new ways of news storytelling based on crowd contribution for large events or breaking news scenarios. VRT also offers the prototype dashboard from iCoSoLe.
Imec	In close cooperation with VRT, Imec will iteratively develop, test and refine prototype applications (dashboard) for the crowd journalism use case. In parallel, Imec will develop a dashboard and supporting tools for crowd sourced (sensor) data interpretation and presentation that can fuel citizen information boards deployed by the city of Ghent. To do so, Imec contributes its TheDataTank, an open source platform for publishing and consuming linked (open) data[62].
BOR	BOR is going to work with its current clients to test RMOSH. BOR will offer continuous testing mechanisms through application integrations. It offers visual stabilization (stabilization of videos from different sources) and orchestration middlewares, and a rule engine for orchestration (existing infrastructure).
KoçSistem	KoçSistem will contribute to application design, platform integration and demonstrator design tasks. KoçSistem will develop the required middleware layers in order to integrate newly developed services, applications and components with existing infrastructure.
DIA	Dia will contribute to the definition of demonstrators related with the RMOSH scenario. Dia will contribute to the demonstrators also by developing, testing and validating cloud computing components and networking infrastructure.
TNO	TNO will work on mobile video capture module; real-time spatial segmentation of UHD/UWV video; video brokering and orchestration (e.g. synchronization) for mobile live video; editorial dashboard to monitor and select incoming mobile video streams

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[62] https://www.iminds.be/en/succeed-with-digital-research/available-technologies/datatank

Partner	Contribution
A.Arena	Amsterdam ArenA will provide infrastructure and support for a fieldLab with networking, local/cloud hardware (Huawei/Microsoft) and access to (live) events.
Inmotio	Inmotio provides a real-time and wearable sensor data acquisition system, focused on player tracking.
Bosch	Bosch contributes its UHD (up to 12 megapixel) box cameras, at least 15 frames per second, dual streaming to provide lower resolution for overview and higher resolution for close-ups and detail. It also offers advanced stitching solution and up to 50'' LED screens.
GameOn	GameOn provides application development skills and adaptation of front-ends and interfaces.
ETRI	ETIR provides a UWV capture system; 360VR camera platform (8Kx4K@60fps 360VR camera system for professional users; real-time 360VR generation), and a public screen / rendering system for UWV video.

Deliverables				
ID	Type	Description	Access	Due month
D3.1	SW	Application design (y1, y2, y3)	Confidential	M10, M21, M33
D3.2	Doc.	Platform integration (y2, y3)	Confidential	M17, M27
D3.3	Doc.	Demonstrator design and evaluation report (y1, y2, y3)	Public	M12, M24, M36

3.3.4. WP 4: Exploitation and Dissemination

Instructions are the same as for WP1. Copy the template content of WP1 as many times as you have Work Packages in your project

Leadership	Amsterdam ArenA: Sander van Stiphout	
Timeframe	Start: M10	End: M36

Objectives and expected results

The consortium will deploy dissemination activities in the scientific community by targeting publications in top-quality journals -- such as ACM, IEEE -- and meetings. Commercial presentations and demos at international industry events (IBC, NAB) should lead to early adoption by commercial and industrial players in the market. MOS2S will liaise with industry fora and standardisation agencies (IETF, EBU, ISO/MPEG, W3C, SMPTE) to promote integration of the technology in standards and increase its acceptance and build a community around it. The project will develop a logo and website, and promote itself through social media, to increase awareness of the project activities and its results in all communities.

Task descriptions

Task	Description
T4.1	Innovation potential evaluation and business modelling; here, we will evaluate the commercial innovation potentials for smart city and media orchestration technologies with appropriate methodologies such as e.g. SWOT analysis for the overall system or major parts of it (such as e.g. cloud-based encoding and distribution potentials). We will further investigate business potentials in order to determine viable business models for the different players of the MOS2S market and technology value chain. Within this task roles and market figures of comparable businesses will be taken into account. The business model generation will closely investigate cost and revenue streams per use case. By applying appropriate methodology such as e.g. the "Business Model Canvas" or DAMIAN. We will ensure that all aspects of the value chain will be investigated as an underlying foundation of the business models to be developed within this task. Task led by KPN: Job Meines
T4.2	Exploitation and market exploration; this task involves setting up a detailed exploitation plan that defines the partners' plans and roadmap to exploit and to commercialise the output of the project. The exploitation plan will be closely developed with the findings of T4.1. The overall aim will be to improve the partners' competitiveness within the value chain for smart city and media orchestration technologies. The exploitation plan will also cover marketing strategies as an integral part for exploiting the project results. Task led by AA: Sander van Stiphout

Task	Description
T4.3	Dissemination: this tasks involves the dissemination of results to the larger academic and industry community, through MOS2S presence at conferences, industry events and standardization fora. The following main elements will be covered: ■ establishment and maintenance of a project website with regularly updates, as well as a regular project newsletter; ■ dissemination of the project activities and results at international conferences such as Smart City Event, Smart Cities Conference, Smart Venue; ■ dissemination of the project activities and results at international technology trade shows and conferences such as CES and NAB in Las Vegas or IBC in Amsterdam, or ACM MM, ACM TVX and MMSys. ■ contributions to relevant standardization fora, such as MPEG, W3C and IETF. Task led by Samsung: *<to be determined>*

Contributions per partner	
Partner	**Contribution**
Nokia Bell Labs	Nokia aims to valorise the MOS2S results in multiple ways: scientific publications to show thought-leadership in the field of streaming data, reuse of the services created in MOS2S in long running demonstrators and/or living labs, and finally of course also the creation of new products/services. For the latter, Nokia Bell Labs will disseminate results specifically to its internal business units (customer experience products for the test and video analytics functionality, CDN related products for the crowd-sourced mediaserver functionality)
KISWE	The MOS2S developments will upon successful validation and implementation be integrated in Kiswe's current live sports & entertainment streaming platform, Trekker Live. A successful integration will lead to a substantial growth of active users on the platform and as such require Kiswe to further invest in scaling the platform and hiring more development and operational resources at Kiswe Mobile Europe.
VRT	In MOS2S, VRT will pay particular attention to the potential exploitation of the developed MOS2S tools in its next-generation news creation and event reporting workflows. For this, potential users will be involved and informed from early on in the project. VRT will disseminate the MOS2S results through internal workshops, national and international seminars and conferences, including EBU workshops.

Partner	Contribution
Imec	Imec will streamline its cleansing/mapping/publishing tool chain (TheDatatank & RML processor) for real-time (sensor) data & will disseminate via the publication of high-end research papers and presentations in local, national and international seminars, workshops, conferences, and journals.
BOR	One or two of the project members will also contribute to MOS2S at graduate level in one of the top faculties at Ankara. We will publish articles, conference papers and workshop presentations on MOS2S. Bor is also eager to develop a web portal for community members.
KoçSistem	The dissemination of the task results of KoçSistem will be achieved through local, national and international seminars, workshops by publishing academic research papers and presentations.
DIA	Dia will contribute to the dissemination and exploitation activities through participating in the related seminars, events and conferences and also by organizing meetings with potential customers to realize exploitation goals.
TNO	TNO will disseminate MOS2S results via the publication of high-end research papers and presentations in local, national and international seminars, workshops, conferences, and journals. TNO will further contribute to relevant standardisation activities, in particular MPEG MORE. TNO will provide value chain analysis expertise to industry partners.
KPN	KPN will contribute to the dissemination activities by participating in the relevant events and conferences and also by preparing white papers to share with the commercial environments. KPN will also contribute to the business modelling activities and work on exploitation of project results by organizing meetings with existing and potential customers of the target outcomes. KPN will support standardization efforts by other partners, through e.g. reviewing and co-signing.
A.Arena	Amsterdam ArenA will valorise and disseminate MOS2S results via its role in the Amsterdam ArenA Innovation Centre, and arrange for specific dissemination opportunities and events.
Inmotio	Upon successful validation and implementation of MOS2S developments, Inmotio will disseminate specific propositions towards its customer base.
Bosch	Bosch will validate and disseminate results specifically to its internal business units and via its role in the Amsterdam ArenA Innovation Centre.
GameOn	Game On will validate consumers app for viewing and sharing video content, with the possibility for in-app purchases, in combination with a (web-based) video platform for sports venues that handles storage, metadata management and further remarketing.

Partner	Contribution
ETRI	ETRI will contribute to the dissemination activities by participating in the relevant events and conferences on site or remotely with 360VR and UWV capturing system as one of multiple camera sources.
Samsung	Samsung will contribute to overall project dissemination activities, and will promote the project results at standardization meetings.

Deliverables

ID	Type	Description	Access	Due month
D4.1	Doc.	Innovation potential evaluation and business modelling (y2, y3)	Confidential	M18, M36
D4.2	Doc.	Exploitation and market exploration (y2, y3)	Confidential	M18, M36
D4.3	Doc.	Dissemination (y1, y2, y3)	Public	M12, M24, M36

3.3.5. WP 5: Project Management

Instructions are the same as for WP1. Copy the template content of WP1 as many times as you have Work Packages in your project

Leadership	TNO: Gjalt Loots	
Timeframe	Start: M01	End: M36

Objectives and expected results

Management will cover overall coordination and collaboration of all project participants to ensure proper work package activities. It will organize project resource distribution in order to deal with identified problems or risks in an effective manner. As control instance of the project, WP5 takes care on quality related activities to ensure consistent project output. Legal, contractual, ethical, financial and administrative issues will be also part of the management work package.

Task descriptions

Task	Description
T5.1	Project management; this task will establish the management structure at the beginning of the project, aiming to ensure the involvement of all partners in management decision-making. It will also establish a decision structure for the prevention of conflict and the resolution of any disputes that may arise. This task also includes budget control to ensure appropriate use of resources, and the preparation and submission of cost statements and financial reports, where required. Quality assurance and project management procedures will be described in a handbook, which will contain rules and guidelines and will provide the partners with common forms and templates. Task led by TNO: Gjalt Loots
T5.2	Reporting; the task will deal with preparing and post-processing of reviews from the consortium side, handling of the communication with project officers and includes all the reporting aspects as defined in the quality assurance and project management handbook. Task led by TNO: Gjalt Loots
T5.3	Change management and work plan updating; this task includes project steering and management of changes, including technical coordination, and implementing change management mechanisms which guarantee a maximum degree of flexibility, whilst also maintaining coherence and focus on the objectives. The steering and change management work will result in continuous adjusting and updating to the work plan of the project. This task also covers reviewing and updating the risk analysis and contingency plans. Task led by TNO: Omar Niamut
T5.4	Internal communications; involves management of internal communication, and organisation of management meetings, which are scheduled every four to

Task	Description
	six months, to provide a progress check and ensure frequent face to face communication between partners. It will also provide the consortium with electronic collaborative tools needed for communication and coordination. Task led by VRT: Luk Overmeire

Contributions per partner	
Partner	**Contribution**
Bor	Bor is going to act as Turkish country coordinator. According to this duty Bor is going to be responsible for consolidating the efforts and contributions of all Turkish partners into the project and organizing them to contribute to deliverables.
VRT	VRT is going to act as Belgian country coordinator. According to this duty VRT is going to be responsible for consolidating the efforts and contributions of all Belgian partners into the project and organizing them to contribute to deliverables. VRT will further set up internal communication means.
TNO	TNO is going to act as overall project coordinator. According to this duty TNO is going to be responsible for consolidating the efforts and contributions of all partners into project and organizing them to contribute deliverables. TNO will further do reporting and coordinate the work plan updates.
A.Arena	Amsterdam ArenA is going to act as Dutch country coordinator. According to this duty Amsterdam ArenA is going to be responsible for consolidating the efforts and contributions of all Dutch partners into the project and organizing them to contribute to deliverables.
ETRI	ETRI is going to act as Korean country coordinator. According to this duty ETRI is going to be responsible for consolidating the efforts and contributions of all Korean partners into the project and organizing them to contribute to deliverables.

Deliverables				
ID	Type	Description	Access	Due month
D5.1	Doc.	Project management report (y1, y2, y3)	Confidential	M06, M18, M30
D5.2	Doc.	Work plan update (y1, y2, y3)	Confidential	M08, M18, M30

4. Rationale for public funding

Auto-generated section: input to be provided only on the Community website. Do not edit or remove this box and do not provide any text within this annex in this chapter, but provide the requested information directly on the ITEA Community website.

On the website you must fill in one section per country represented in the consortium. This section will indicate the national coordinator and detail the national rationale for funding. At the end of the national rationale for funding, the national coordinator has to indicate the national ICT clusters the project has contacted and intends to join (a clear status with regards to the cluster has to be indicated).

The national rationale for funding has four components:

- national gain: you have to explain the benefits for the participating countries (e.g. support to national strategies, standardisation, open source, knowledge dissemination, wellbeing improvement, impact on national productivity, etc.), how the country benefits from collaboration with other countries and the risk level of the investment (i.e. why is a public incentive preferred for such investments),

- return on investment (RoI): you have to explain how the money invested by both Public Authorities and companies is expected to generate value, revenue, jobs and/or economic growth, etc.,

- value creation of the national sub-consortium: how cross-fertilisation between the various participants is achieved;

- adequate balance between the national partners (e.g. ratio of effort as a percentage for academics, SMEs, etc.).

For each partner, in addition to contact details and a generic description (incl. type and size of the entity), two specific descriptions are requested:

- relevance of the partner within the project by describing its main role in the project and the main added value to the international consortium and vice versa;

- market access, i.e. how the partner intends to exploit the project results and how the market(s) will be accessed (exploitation prospects and capability); current main markets and main customers, as well as planned exploitation plans and strategies are welcome whenever doable.

It is crucial that all national coordinators get in touch with their national Public Authorities (PAs) to present them the project (idea, partnership, budget, etc.), checking funding opportunities and ensuring that the national consortium is eligible, even in countries that are not part of the ITAC (ITEA Authorities Committee). Beware of eligibility issues at national level.

For ITAC countries, information on the contact persons is available on the ITEA public website (in section "Participate in ITEA / Funding"). For the EUREKA countries that are not member of the ITAC, the contact persons are National Project Coordinators (NPCs); http://www.eurekanetwork.org/eureka-countries).

Annex A: Summary of costs & effort breakdown

Auto-generated section: input to be provided only on the Community website. Do not edit or remove this box and do not provide any text within this annex in this chapter, but provide the requested information directly on the ITEA Community website.

This annex will contain a comprehensive summary of the costs and effort, by providing 1) costs & effort per country per WP (with totals), and 2) costs & effort per partner type. This data is automatically computed based on the detailed figures of costs & effort provided online by each partner on the Community website: it is therefore crucial that all partners provide relevant input for both costs & effort, and do not leave blank fields, which would generate erroneous breakdowns.

Detailed costs & effort per partner are provided in the related country perspective section of §4.

Annex B: Consortium feedback on the PO evaluation

Auto-generated section: input to be provided only on the Community website.

This annex will be filled in only at FPP stage, and will remain empty at PO stage.

The STG PO evaluation will be provided after the PO submission. It is highly recommended to take into account the comments and recommendations of reviewers, and to adapt accordingly your proposal. Your feedback should be described concisely in this section: inputs are to be provided on a special page of the ITEA Community website, which will be provided together with the PO evaluation itself.