



Vision & SRIA

2016

New European Media, *driving the future of digital experience*

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This document has been drafted by a set of NEM members under the leadership of Pierre-Yves DANET (Orange, NEM Vice Chairman), and being approved by the NEM Steering Board

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Executive Summary

“The media is the air we breathe and the water we swim in” A.López

Digital media is defined as products and services that come from the media, entertainment and information industry and its subsectors. It includes digital platforms (e.g. websites and applications), digitized content (e.g. text, audio, video and images) and services (e.g. information, entertainment and communication) that can be accessed and consumed through different digital devices.

The Strategic Research and Innovation Agenda (SRIA) is the new strategic roadmap for the media technology research, development and innovation developed by New European Media (NEM) technology platform that accounts for both the evolution of technology as well as radical changes or 'technology shocks'.

It aims to provide a guide to future actions in public and private funding programmes to ensure that research is adequately supported and funded.

New media is marked by the very fast evolution of its products and their components which are subject to very short R&D cycles. Dynamic, disruptive, visionary, are common adjectives applied to define how media evolution works.

As such, research efforts need to be based on a long-term programming approach that provides continuity across R&T efforts over next years. SRIA proposes a mission oriented R&D development that will meet the societal and market needs, will maintain and extend the industrial leadership, will be aligned with the environment protection and the energy savings, and will ensure safety and security, while prioritising research, through innovation and education.

NEM SRIA presents five chapters that gather the user, technology and market trends for most of the sectors where media has a principal position, a forecast of how the sector will look in 2020, and the NEM agreement on the research priorities and key enabling technologies.

Table of contents

Executive Summary	3
Table of contents.....	4
Scope	6
I- Foreword.....	7
II- NEM Sectors.....	10
II-1 Book Publishing	11
II-2 Broadcasting	14
II-3 Music.....	17
II-4 Multimedia.....	22
II-5 Advertising	24
II-6 Gaming	26
II-7 Fashion	28
II-8 Cultural heritage.....	31
II-9 Design.....	34
II-10 Education & training.....	37
II-11 User and social engagement and collaboration	40
II-12 Novel storytelling techniques	42
II-13 IoT integrated environment.....	43
II-14 Digital society - Impact of new media on lifestyle	46
III Technology trends	48
III-1 Content Distribution	48
III-2 Content processing	51
III-3 Distribution and display technology	52
III-4 Designing and maintaining security and privacy	53
III-5 Autonomy and automation	53
III-6 Service provision innovation	53
III-7 Enable bimanual interaction, natural walking interfaces, and whole-body involvement in VR.....	54
III-8 Maturation and enhancements of Brain-Computer Interfaces.....	54
III-9 Augmented Reality for Inquiry-Based Sciences Education	55
III-10 Challenges in evaluating human-computer interactions (HCI) and immersive content and technology	55
IV How the sector will look like beyond 2020	56
IV-1 Book Publishing.....	56
IV-2 Broadcasting services	56
IV-3 Music	57
IV-4 Multimedia	57
IV-5 Advertising.....	57
IV-6 Gaming	58
IV-7 Fashion.....	58

IV-8 Cultural heritage	58
IV-9 Design	59
IV-10 Education & Training	60
IV-11 User and social engagement and collaboration	61
IV-12 Novel storytelling techniques	62
IV-13 IoT integrated environment	62
IV-14 Digital society - Impact of new media on lifestyle	62
V- Research topics	63
V-1 Priorities	63
V-2 Enabling technologies	65
V-3 User aspects	67
V-4 NEM transversal aspects	70
Appendix A: Additional detail	71
Appendix B Additional Research Topics	74

Scope

This report is the result of extensive discussions and brainstorming with more than 50 experts from Europe's industry (large, medium and small) and academia on strategically important research, development, innovation on Creative content and media. The identified applications and technologies are those that experts believe Europe should invest and carry collaborative research.

This report is based on the previous editions of the Strategic Research Agenda, SRA Version 2014, based on several white and position papers and also survey made in the overall NEM community from both creative and Media

This new version of the SRIA is released for public consultation as well as to NEM steering board for approval. This SRIA is now compilation of all the inputs into a homogeneous document and an integrated technology roadmap.

The topics are based on range of talks that were given in workshops and conferences.

The presenters were representatives of all ICT ecosystems consisting of; network operators, creative industry, service providers, SME's, regulators and academia.

It is important to note that in the process of short listing of the topics (research and technologies), those that fall in the following categories were purposely excluded:

- currently on-going research projects in EU FP and National programmes;
- extensively covered in previous SRA versions and no longer regarded as a new challenge;
- currently under full investigation in standardisation bodies
- no economic and societal impact potentials

The following steps were taken, in an iterative manner as a first approach, in order to reach essential technologies and the evolution of their associated features over time:

- **Technologies:** Enabling technologies viewed as essential by the experts, in addressing the majority of the identified requirements, mainly focusing the effort on media&content technologies. The enabling technologies helped to facilitate the identification of strategically important research topics that were considered essential in their realisation. The research topics were those that deemed to be essential in solving the technological challenges in the face of scarcity of resources, such as AR, VR, content delivery, as well as those that help to hide or simplify the cost and complexity of usage and deployment of the technologies.
- **Roadmap:** it captures the evolution of technology in a time scale. It was decided to have a 5-year timescale for the technology roadmap, influenced by market drivers, as well as quantitative and qualitative aspects. As a specific technology can evolve over time with its new features to full sophistications, this was useful in identifying when a specific feature will be available and fully standardised, so that no further research effort will be required.

This new version of the NEM SRIA has the objective to contribute to the next Horizon workprogram in order to help the Commission to define the content of the related Objectives.

I- Foreword

NEM, the New European Media initiative, is the European Technology Platform of Horizon 2020 dedicated to Content, dealing with Connected, Converging and Interactive Media & Creative Industries. With the launch of Horizon 2020, the NEM Initiative is pursuing its objective to build sustainable European leadership in content, media, and the creative industries. The NEM Initiative promotes an innovative European approach towards a Future Media Internet that will enhance the lives of European citizens; initially and primarily through a richer and more engaging media experience, but with an increasing potential for contributions in other sectors including education, health and societal inclusion and innovation.

NEM, which was established in 2005, is an active community and network of more than 1000 members from industry (including large industrial organizations, start-ups and SMEs) and academia. NEM is an industry-led initiative delivering a vision, a strategic research and innovation agenda, as well as position papers. Through its General Assembly, Summit and dedicated workshops, NEM is also a centre of influence and a centre for networking. To reach the thousands of start-up companies and SMEs dealing with content in Europe, NEM has organized itself as a 'cluster-of-clusters', whose clusters are key local, regional or national organizations often serving as the local contact points and interfaces working closely with those entrepreneurial start-ups and SMEs on a daily basis.

NEM is also working closely with other ETPs like Network2020 and NESSI, as well as with other industry groups such as the Big Data Value Association, because some of the NEM research and innovation activities are closely linked to the 5G and Big Data activities and developments. Key areas that have been identified for work between these groups include the interface between content and networks, enabling more powerful applications and the Big Data domain, where content and related usage data could, for example, be analyzed to provide more personalized services. NEM is exploring and exploiting synergies with the TISP network (Technology and Innovation for Smart Publishing), which was formed in the framework of an EU-funded project and is aimed at boosting the integration of ICT and book publishing. NEM has also worked with the Network and Information Security (NIS) Platform to ensure the cross cutting areas of security and privacy are taken into consideration to enable the building of trust and confidence in services and applications. NEM is also building links to the various Coordination and Support Actions that run within the Work Programme.

Content & Creative Industries, a strategic sector in Horizon 2020

In July 2013, DG CONNECT and DG RTD recognized the NEM European Technology Platform as the official platform covering the Content & Media sectors and requested the NEM initiative to also cover the Creative Industry sector.

“Content is clearly central in the Horizon 2020 strategy”, as stated by President Juncker in his mission letter to Vice President Ansip¹: “I also want you to take particular account of the need to promote creative industries in Europe”, “During our mandate, I would like you to focus on the following, in your role as Vice-President: [.../...] Supporting the development of creative industries, helping Europe’s culture and audiovisual sectors to reach out to new audiences, adapt to the digital era and thrive in the connected Digital Single Market” and Commissioner

¹ http://ec.europa.eu/commission/sites/cwt/files/commissioner_mission_letters/ansip_en.pdf

Oettinger².” “You will also need to ensure that the right conditions are set, including through copyright law, to support cultural and creative industries and exploit their potential for the economy.” “During our mandate, I would like you to focus on the following: [.../...] Supporting the development of creative industries and of a successful European media and content industry able to reach out to new audiences, adapt to the digital era and thrive in the connected Digital Single Market”.

A diverse but strong economic sector...

European creative industries are a very dynamic sector, creating many jobs. The aggregate value of the creative sector was roughly €200 billion across the EU-27 in 2011³. It has grown from €170 billion in 2001 with a compound annual growth rate (CAGR) of 2 percent (see Exhibit 5). All growth in the creative industries is driven by digital media (an additional €30 billion in revenues in 2011 versus 2001). The Creative Industries have embraced ICT to develop new business models for the digital environment, thereby generating 4.4% of the European GDP, 6.8% of value added (as a percentage of GDP) in 2011, and representing 3.8% of the European workforce⁴. Recently, the recorded music industry saw revenues from digital channels of 6.8% in 2014 in Europe. Altogether, consumer spending in the creative sector is up 25% from 2001, with all growth driven by digital media.

The latest figures from the United Kingdom show that employment in the creative industries grew by 6.0% between 2011 and 2012, representing 8.0% of overall employment and 5.2% of Gross Value Added. In the EU as a whole, the creative industries account for 3.0 % of total employment (2008) and 3.3% of GDP (2006). The number of employees in the creative industries in the EU-27 was 6.7 million in 2008. However, the sector, mostly composed of micro SMEs, still suffers a slow adoption of ICT technologies, a precondition for competitiveness. Beyond their direct contribution to GDP, these sectors trigger spill-overs in other economic areas such as tourism, fueling content for ICT, benefits for education, social inclusion and social innovation.⁵

...facing key (r)evolutions:

Content and Creative Industries, while locally, regionally, and/or nationally implemented or even governed, are moving to a worldwide framework, thanks to the digitalization of the whole value chain, from creation through distribution to consumption. These industries are updating the whole process in paralleling a lot of actions all along that value chain and reducing the production time from capture to access. New paradigms are appearing in stocking, processing and accessing the content from the cloud. New ways to consume the content (over the top, on the move, remotely, on devices of all form factors and with increasing degrees of immersivity) are bringing new opportunities and challenges (technological, infrastructural and regulatory). Media convergence means that former “silos” are more and more breaking up, within industries but also between adjacent creative industries. Yet, we are still far away from a unified “creative sector”, let alone from a creative sector with easy access to collaborative research and innovation in ICT. This poses not only challenges for “hard” (technological) innovation, but also for soft innovation (company culture, business development, innovation infrastructure,

² http://ec.europa.eu/commission/sites/cwt/files/commissioner_mission_letters/oettinger_en.pdf

³ <http://www.strategyand.pwc.com/media/file/The-digital-future-of-creative-Europe.pdf>

⁴ <http://ec.europa.eu/eurostat/documents/341889/725524/Monitoring+the+Digital+Economy+%26+Society+2016-2021/7df02d85-698a-4a87-a6b1-7994df7fbeb7>

⁵ <https://ec.europa.eu/dgs/connect/en/content/creative-industries>

innovative uses of existing technologies, etc.). Especially in the content access and distribution domains, the market is witnessing the fast entrance of new players with disruptive and focussed approaches. This diversity often challenges established businesses and their business models, requiring them to be the involved in the latest technology research and innovation activities of their sector.

... requesting technology and innovation support investments:

To face this fast growing worldwide environment, to maintain - or even better to increase - the footprint of our Content and Creative industries at a worldwide scale, technology and innovation support investments in the Media & Creative industry need to be increased to a level corresponding to their economic weight. Beyond what has been already covered in 2014-2017 LEIT ICT, the technological building bricks defined in the NEM Vision & Strategic Research and Innovation agenda (SRIA) remain relevant. We are particularly convinced about the importance the next Horizon 2020 program focusing on solving those key challenges for Content & Creative industries at the infrastructure level (formation of an innovation network, virtualization, cloud, ...); at the data level (metadata, privacy, security,...); at the service level (business models, user experience, personalization,...) as well as at the content and format level (immersivity, interactivity, enriching and engaging new formats that deliver added value). Many of these aspects apply to all sectors within the creative industries – including Advertising, Architecture, AV, Cultural heritage, (Product) Design, Fashion, Film, Games, Publishing, Music – but not necessarily at the same speed. The projects should encourage the integration of the “technical” and “creative” sectors to achieve platforms, which are fit for purpose to extend the success of the European Media and Creative industries.

... using a range of instruments:

As the actors in the creative and content industry cover a wide range of size, market position and fields of application, we would recommend that a variety of actions be formed, including Research, Innovation and Coordination and Support Actions. In particular, CSAs should be stressed more in the upcoming funding periods, providing instruments for setting up innovation networks within and between respective creative industries & ICT research. All actions should have a range of durations in consideration of the fast changing nature of the sector, and should aim to involve SMEs from the creative sector even further. For achieving the latter, administrative overheads should be kept to a minimum.

... and calling for a public private partnership:

Beyond the traditional Horizon 2020 programs, the NEM community is convinced that a dedicated Public Private Partnership (PPP) is an effective tool to specifically address the Media and Content sector. In order to cater for the needs of the many small and medium enterprises in this domain, it is crucial to lower entry hurdles into innovation programmes. The main focus should be on measures to streamline and to speed up the idea-to-market process. A set of key players involved in NEM have expressed their strong willingness to create such a PPP on Immersive and Interactive Content, and a related proposal will be detailed in a separate document.

II- NEM Sectors

The **NEM Initiative** (New European Media Initiative) was established as one of the European Technology Platform under the Seventh Framework Programme, aiming at fostering the convergence between consumer electronics, broadcasting and telecoms in order to develop the emerging business sector of networked and electronic media. In order to respond to new need and requirements of the Horizon 2020 programme, the NEM initiative enlarged its focus towards creative industries and changed its name from Networked an Electronic Media Initiative to New European Media, dealing with Connected, Converging and Interactive Media & Creative Industries, driving the future of digital experience.

NEM focuses on an innovative mix of various media and creative content forms, delivered seamlessly over technologically transparent networks, to improve the quality, enjoyment and value of life. NEM represents the convergence of existing and new technologies, including broadband, mobile and new media, including creativity, across all sectors, to create a new and exciting era of advanced personalised services.

The following areas have been identified as main NEM research and innovation drivers. In the scope of its enlargement towards the creative industries, the NEM Initiative also includes review of the listed innovation areas below.

Book publishing, broadcasting, music, multimedia, advertising and digital signage, gaming, fashion, cultural heritage, design, education & training, user and social engagement and collaboration, storytelling, smart environment, digital society and the impact of new media in lifestyle has been selected as the most promised sectors in NEM community.

For each sector a review of user, technology, business and market trends have been gathered, and a foreseen 2020 scenario introduced.

II-1 Book Publishing

User Trends

A societal trend for **participation** can be felt in publishing: Users are no longer happy to be passive consumers of information and content, but instead want to be engaged with, contribute and most importantly, create content. User-generated content (UGC) and so-called “prosumers” are on the rise, as are crowd-based solutions like crowdsourcing, -funding or self-publishing. Micropayment systems like Kachingle or Flattr are another popular way of crowdfunding. Time and attention are the new scarcity, and are therefore the new currency in publishing. Aversion to advertising is growing, eg “banner blindness”. The idea of “digital only” reading is becoming more and more acceptable. E-books are regarded as “real books”.

Technological trends

Multipurpose devices like tablets sell better than single-purpose devices, which work for reading only. **Mobile technology & apps** work on a one-click-one-buy basis and enable controlled access to content via the walled garden – i.e. the closed system logic they use. However, it is questionable whether the walled garden approach will prevail in the medium to long term, following the introduction in 2008 of the web standard HTML5 and the semantic web. The advantage of HTML5 for end-users is that it runs on every platform.

Interoperability: Up till now, **different formats** have been used for e-books, the most common among them being Adobe’s PDF format and EPUB,⁶ a standard backed by the International Digital Publishing Forum (IDPF), which has recently joined forces with W3C⁷. E-books often only function within a proprietary system. The question of uniform standards and interoperability of systems is thus a very important one, and it must be solved internationally.

Cloud computing: E-content displays service features and can be adapted to new business models similar to software-as-a-service (SaaS) models, which are distributed via the customer’s web browser, without the need to install the software locally. Metered models of licensing are the most common business models behind SaaS (and they include freemium systems). Platform-as-a-service (PaaS) models and infrastructure-as-a-service are other options opening up.

Digital printing technologies enable cost-effective printing in low quantities, which in turn allows for business models based on self-publishing and print-on-demand (PoD). With the miniaturization of printing devices, retailers can also make use of decentralized PoD.

Publishing companies can now practise sophisticated **data management**, including data mining in large quantities, thanks to search technologies and cloud computing. For now, the big players in the field of technology and software – Google with Google Play, Apple with iTunes, and Amazon – have set up proprietary e-commerce systems and do not share customer data with publishers.

⁶ EPUB is an open standard for eBooks, based on XML; it was defined by the International Digital Publishing Forum (IDPF) and replaced the older standard Open eBook (OEB) or Open eBook Publication Structure (OEBPS).

⁷ see press release : <https://www.w3.org/2016/05/digpub.html> en

Business and market trends

Most publishing markets internationally are either flat or in decline⁸ and they face mounting competitive pressure from neighbouring sectors. “At the same time, larger publishing ventures need to make significant investments to cope successfully with the transition to a more digital, more complex and much more international future. In the light of this, the recent wave of mergers and acquisitions hardly came as a surprise, and more consolidation must be expected.”⁹

At the same time, publishing is an area where **lots of new entrants and especially start-ups are active**, because the barriers of entry to the markets are low.¹⁰ Publishing companies often develop into technology companies, as they develop ICT services and consequently market them nationally and very often also internationally. Combined with this is that different business models and value propositions are being experimented with – one example is StoryDocks, a spin-off of the German publisher Oetinger, which understands itself as a “company builder”¹¹.

Several years after the start of a real e-book market, the digital transition in publishing is well under way, but at the same time the market is predominantly print-based. Digital book sales have been growing fast for the last 6-8 years, but are already slowing down in the countries where they reached quite high proportions. This has mostly to do with users’ choices: the technology is there to offer readers a good reading experience and e-books have a number of features that make them attractive to users: storage capacity, interactive and enhanced content, annotations, accessibility, etc.; at the same time, a lot of content is available and easily accessible through many platforms. Nonetheless, most readers simply prefer print books. For those reading in digital, tablets and smartphones seem poised to become the devices of choice, while dedicated eReaders are declining.

Main trends include further developments in the fields of enhanced and interactive content (including possible applications of the IoT to the book sector), personalisation and big data analysis (in particular of user behavior and preferences), the increasing digitisation of education. There is also room for further use of ICT for enhancing production and distribution of books (print and digital), improving the discoverability of books online, enhancing the development and adoption of metadata and standards for content description, discovery and distribution, as well as for continuing development of file formats (in particular ePub) and actionable identifiers. There are several metadata standards (Dublin Core, METS, MARC, ONIX, etc.) to describe, locate, purchase/license and recommend books and e-books, hence the need to define one unified metadata standard that also allows the description and consequent reuse of content chunks (chapters, paragraphs, images, etc.). Research and innovation should also contribute to mainstreaming accessibility of e-books for the visually impaired all along the value chain. It would be useful to enhance interoperability in the e-book sector (across file formats, reading software and devices), including in the field of DRM systems, and research should help develop user-friendly interoperable DRM. Social reading is another area with potential for further developments and applications, as well as everything related to mobile technology. Finally, a very important area for R&I is rights management and rights information management (also related to the DRM issue): the need to improve the IPR communication, management, protection and exploitation with various

⁸ Rüdiger Wischenbart: The business of books, study 2015: http://www.book-fair.com/pdf/buchmesse/wp_the_business_of_books_2015.pdf

⁹ *ibid.*

¹⁰ cf. « Best of publishing start-ups » List, https://docs.google.com/document/d/1QqkiCg4BktD2JC4WEX6ljRMUeLPB4boNz7B_acJGY_k/edit?pli=1

¹¹ <http://storydocks.com/>

mechanisms (e.g. new protection and tracking systems and standards). One possible avenue is end to end IP (real time tracking of content rights, tracing unlicensed content usage), including Blockchain technologies (standardising IPR/DRM deployment), to provide new ways to secure digital contents and to track and verify ownership through tools like smart contracts, authenticated by cryptographic data. Semantic web technologies and automated translation could also have an impact on the sector.

While the majority of readers prefer print books, digital has been an important part of business for scientific publishers for a long time, and has become very relevant for many trade publishers and is increasingly so for educational publishers. Huge investments are being made by many publishers into digital publishing, often subsidised by the revenues from print sales. The market share for digital books in Europe is currently around 5% of the total, with some countries (UK in particular) having a bigger share; this share is likely to keep growing in the coming years, but nothing seems to point at a possible demise of paper for any foreseeable future. E-books are however becoming a valuable business proposition for publishers, and they will be more as the market grows and economies of scale kick in. E-books are in fact not much cheaper than print books to produce, but are more likely to benefit from large scale production and increased efficiencies enabled by digital technologies.

In addition, e-books are usually sold at quite cheaper prices than print books, often more to meet users' expectations than due to actual cost differences. Viability of business models is one of the main challenges arising from the digital transition, as well as piracy, concentration in the retail sector and the lack of interoperability.

In terms of business models, while the majority of e-books are purchased through individual unit sales, a lot of experimentation is going on with subscription models (Spotify-like) and with library lending (the predominant model in certain areas of academic publishing, though several models are being experimented in other areas, including trade, based on different kinds of licences).

Overall, the book market has been relatively stable in the last 7-8 years: after reaching a peak in 2007, it was affected by the economic crisis, but not as badly as other sectors – although in certain countries (hit harder by the crisis) the effects on the market were more serious. There have been signs of recovery in the last few years, anyway. The transition to digital has had an impact, in particular due to the lower prices of e-books and the higher incidence of piracy, but the exact extent of this is hard to measure. Book sales in the EU currently generate some 22-24 billion € of turnover, corresponding to 35-38 billion € in market value; the figure will likely start growing again after some stagnation due at least in part to the economic crisis.

A trend worth looking at – but again, hard to measure – is the growing importance of self-publishing. Also, the opportunities offered by technology, especially print-on-demand, can have a positive effect on stock management and allow greater efficiency in determining print runs.

In general, it is worth looking at the different subsectors within book publishing (trade, scientific, academic, educational), as they have different production and consumption characteristics and different drivers, including for the use of digital technologies.

II-2 Broadcasting

User Trends

The fast expansion of high capacity data networks, offering consumers broadband Internet access has evolved the user expectations for broadcasting services. The Internet will be an increasingly important means of delivery of audio-visual content, including broadcasting. The continuing evolution of digital broadcast technology, resulting in a considerable increase of the capacity in the transmitted bandwidth and enabling more services, better picture quality and improved coverage.

Broadcasting as a “public service” in order to maintain the balance of news, culture, educational media etc. in a world where games and social media could become dominant.

Last trend is the increasing participation in media, with more and more user generated content.

Enhanced broadcasting services could be offered by terrestrial broadcasting network, cable, IPTV and satellite networks in combination with broadband networks; so called hybrid broadcast-broadband (HBB) services.

Enhanced broadcasting¹² services are developed around three concepts:

1. TV anytime, aiming at watching a specific programme at the time by choice of the viewer. Time shifted viewing is in particular of interest for shows, documentaries, movies etc., but a relative short time shift for sports and news programmes is also popular.
2. TV anywhere, aiming at watching the broadcast service not only in the living room, but also in other rooms, on the move, etc. Mobile devices like smart phones and tablet computers are used for this application.
3. Interactivity, aiming at contributing or reacting by the viewer to a specific programme, demanding for additional information regarding the programme or receiving programmes or information of particular interest.

Technological trends

Broadcasting services are reshaping their face. First, exploiting new network capabilities to be more efficient, flexible, and better able to support future innovation, looking for extra services and capacity for major events. Second, working with and exploring emerging formats like Ultra HD (4K) and 360-degree content. Third, integrating new video encoding, signalling, delivery, synchronization, captions and subtitles, and increasing accessibility of media, engaging and relevant for users in a wide range of devices.

Broadcasting is taking advantage of the evolution of content delivery to generate new service provisioning models. Two main topics that are changing the ecosystem are the convergence between broadcast and broadband delivery, and the huge impact of mobile technologies such as 5G that gives more ways to access the same content, or providing related contents to several consumption devices.

The gradual introduction of higher resolutions, 360°-streaming, VR/AR, more personalized content, are challenges to address in the next years that will impact the production workflow and media infrastructure. Archiving for the preservation of new forms of archive will be another related issue to solve as well.

¹² ITU. Trends in Broadcasting: an overview of developments

More desire to produce, store, track and identify different media objects/assets on scale and across a variety of genre, move focus to drama and factual.

Main research challenges:

- Creation and delivery of object-based audio-visual content responsive to users' input.
- Media for a heterogeneous set of new devices, how to create media in a cost-effective way as part of existing production processes.
- Areas of automation for machine supported production craft, given increased content.
- New types of interaction with targeted audiences.
- Understanding the creative processes needed to produce engaging experiences with new content forms, so the services developed have long-lasting value.
- Blurring of lines between audience and producer by opening up a platform.
- Audience analytics.
- Security, both for content providers and users. The ability to know what that the content is truly what it purports to be (especially for news).

Business and market trends

With the growth of online distribution models, the traditional mix of broadcast and physical media (such as DVDs) is changing. The following are the trends found by the UK Ofcom (Office of Communications) report of 2015, with the numbers in the linked report (http://stakeholders.ofcom.org.uk/binaries/research/media-literacy/media-lit-10years/2015_Adults_media_use_and_attitudes_report.pdf):

- Over the last ten years internet use has increased substantially, both at home and elsewhere.
- The computer (laptop/desktop/netbook) is still the primary device for accessing online content, but the use of alternative devices has increased substantially over the years.
- Technology based communication methods such as texting, emailing, and instant messaging have become increasingly popular over the last ten years, particularly on mobile phones.
- The use of social media has risen substantially over the years
- Following the ubiquity of digital TV, and increased DVR ownership over the years, watching through a TV set still remains hugely popular. However, this is less true for younger people, and viewing is increasingly being done online.
- Over the last ten years gaming has become more popular and increasingly mobile; driven by smartphones and tablets.
- The majority of other online activities have increased over the last ten years while other activities have remained static, or even decreased.
- Despite having fallen considerably since 2005, concerns with content on the internet are still at higher levels than for other media.
- Awareness of regulation is higher for both TV and radio than it was in 2005. Although awareness for the former is higher than the latter, the increase for radio has been more substantial.
- Nearly all internet users perceive themselves as confident in various aspects of using the internet, but the levels have remained similar over the years.
- Opinions on the potential for inaccuracy or bias in search engine results have remained constant over the last five years, with little variance in age.

- The majority of internet users say they would share personal information online, but there is evidence of added caution in doing so over the ten years of tracking.
- The majority of internet users are using technical indications such as padlocks and system messages to measure website safety, and this has increased among adults over the age of 25 since 2005.
- Fourteen per cent of adults in the UK are non-users of the internet, and this has remained stable since 2013.

II-3 Music

User Trends

Music Information Research considers the user perspective, both in order to understand the user roles within the music communication chain and to develop technologies for the interaction of these users with music data. MIR aims to capture process and model the data gathered through user interaction and develop methodologies for the design of new musical devices in order to enable new interaction possibilities between users and these devices. Important technological aspects are:

- **User behaviour:** music is listened to, performed and created by people. It is therefore essential to consider the user as central to the creation of user scenarios, hence to the development of technologies. Developing user applications involves analysing the user needs in respect of novel scenarios and the user behaviour in respect of existing ones, thus enabling the creation of the user-specification-development loop. Taking into account user needs applies to all stages of the development loop, however the analysis of user behaviour must be carefully conducted by a specialist. Gathering feedback from users is a research field in itself and shouldn't be done without carefully designed methods. Considering user needs through the analysis of user behaviour will have a great impact on the usability of the developed MIR technologies.
- **User interaction:** the grand challenge of user interaction is how to design MIR systems that put the user at the centre of the system. This applies to the whole interaction loop, including visualisation, input devices, manipulation metaphors, and also system adaptation to user behaviour. This challenge is relevant because it contributes to both the user's and to the researcher's (e.g. system designer's) understanding of the system's features and components, the overall purpose of the system, and the contribution the system can make to the user's activities. The benefit to users is more productive workflows and systems which better serve the users' needs. The researchers stand to benefit from the feedback loop which enables them to re-tune and develop systems with greater accuracy. Effective user-oriented research will have a major impact on the usability of MIR systems and their wider deployment.

Music Information Research involves the understanding and modelling of music-related data in its full contextual complexity. Music is a communication phenomenon that involves people and communities immersed in specific social and cultural context. MIR aims at processing musical data that captures the social and cultural context and at developing data processing methodologies with which to model the whole musical phenomenon. Important technological aspects are:

- **Music-related collective influences, trends and behaviors:** music is a social phenomenon, thus its understanding and modeling requires the inclusion of this dimension. Social interaction is a driving force of music listening, categorisation, preference, purchasing behavior, etc. Additionally, teams or crowds are usually able to achieve feats that go beyond what individuals accomplish, and this is especially relevant for annotation and other collaborative scenarios. Finally, scattered in different virtual places, formats and time-scales, there is much data available that contains implicit information about music-related social factors, which could make possible the understanding and prediction of trends and other collective behaviours related to music. To carry out this research, which

would complement the other, more traditional, approaches to music description, we need to involve people working in Social Computing, Sociologists and experts in Dynamic Systems and Complex Networks.

- **Multiculturality:** most music makes very little sense unless we experience it in its proper cultural context, thus the processing of music information has to take into account this cultural context. Most of MIR has focused on the mainstream popular Western music of the past few decades and thus most research results and technologies have a cultural bias towards that particular cultural context. The challenge is to open up our view on music, to develop technologies that take into account the existing musical diversity and thus the diverse musical cultural contexts. To approach the multicultural aspects of MIR there is a need to involve researchers from both engineering disciplines (Signal Processing, Machine Learning) and humanities (Musicology, Cultural Studies), and to involve people belonging to the specific cultures being studied. This approach will offer the possibility to identify new MIR problems and methodologies that could impact the whole MIR field. At the same time the development of Information Technologies that reflect diversity should help preserve the cultural richness of our world, which is threatened by the globalisation and homogenisation of the IT infrastructures.

Technological trends

Music Information Research focuses on the processing of digital data related to music. This includes gathering and organisation of machine-readable musical data, development of data representations, and methodologies to process and understand that data, taking into account domain knowledge and bringing expertise from relevant scientific and engineering disciplines. Important technological aspects are:

- **Musically relevant data:** music Information Research (MIR) is so far to a large degree concerned with audio, neglecting many of the other forms of media where music also plays an important role. As recently as ten years ago, the main media concerned with music were represented by audio recordings on CDs, terrestrial radio broadcasts, music videos on TV, and printed text in music magazines. Today music is an all-encompassing experience that is an important part of videxos, computer games, Web applications, mobile apps and services, artistic applications, etc. In addition to printed text on music there exist a vast range of web-sites, blogs and specialised communities caring and publishing about music. Therefore it is necessary for MIR to broaden its horizons and include a multitude of yet untapped data sources in its research agenda.
- **Music representations:** data representations impact the effectiveness of MIR systems in two ways: algorithms are limited by the types of input data they receive, and the user experience depends on the way that MIR systems present music information to the user. A major challenge is to provide abstractions which enable researchers and industry to develop algorithms that meet user needs and to present music information in a form that accords with users' understanding of music. The same challenge applies to content providers, who need to select appropriate abstractions for structuring, visualising, and sonifying music information. The development of standard representations will advance MIR by increasing algorithm and system interoperability between academia and industry as well as between researchers working on MIR subtasks, and will provide a satisfactory user experience by means of musically and semantically meaningful representations.
- **Data processing methodologies:** since its origins, the MIR community has used and adapted data processing methodologies from related research fields like speech processing,

text information retrieval, and computer vision. A natural consequential challenge is to more systematically identify potentially relevant methodologies from data processing disciplines and stay up-to-date with their latest developments. This exchange of data processing methodologies reduces duplication of research efforts, and exploits synergies between disciplines which are, at a more abstract level, dealing with similar data processing problems. It will become even more relevant as MIR embraces the full multi-modality of music and its full complexity as a cultural phenomenon.

- **Knowledge-driven methodologies:** For a long time, the MIR community has been focusing on a range of bottom-up approaches, addressing the kinds of data we use and the types of algorithms we apply to it. A major challenge is to complement this focus and explore other methodologies and fields of science which approach music in a more integrated way. After all, music information research is just one of many sciences that centre on and care about music, which include musicology, psychology, sociology and neuroscience.
- **Estimation of elements related to musical concepts:** by musical concept extraction we refer to the estimation of the elements of a notation system from the audio signal and the estimation of higher-level semantic information from these elements. These elements belong to a vocabulary and are assembled according to a grammar specific to a culture. The challenge here is to automatically derive musical concepts from audio signals or from commonly available symbolic data, such as MIDI or scores. Extracting musical concepts from audio signals is technically a very difficult task and new ways to perform this still need to be found.
- **Evaluation methodologies:** It is paramount to MIR that independent researchers build upon previous research, and an overarching challenge in MIR is to define and implement research evaluation methodologies that effectively contribute to creation of knowledge and general improvements in the field. In many scientific disciplines dealing with data processing, significant improvements over the long term have been achieved by empirically defining evaluation methodologies via several iterations of an experimental “loop” including formalisation, implementation, experimentation, and finally validity analysis. In MIR, evaluation initiatives have played an increasing role in the last 10 years, and the community is presently facing the validity analysis issue: that is, finding the most appropriate way to build upon its own legacy and redefine the evaluation methodologies that will better lead to future improvements, the resolution of which will in turn entail further technical challenges down the line (i.e., down the “loop”).

Business and market trends

Brands will develop a music strategy

According to Nielson’s 360 music report for 2015, close to 91% of all Americans listen to music more than 24 hours a week. As engagement grows in 2016 due to more platforms being readily available that are easily integrated into consumer’s lives, brands will have a key opportunity to enter this high engagement entertainment medium by committing to developing a Music Marketing Strategy, or a way for a brand to integrate the brand image with music to market to more savvy and difficult to reach consumers.

With so many new streaming services and music consumption platforms being released, music data will ultimately have more influence for brands to consider when making partnerships. This use of “big data” will take some of the risk out when brands look to involve artists in their

campaigns. With less risk in brand partnerships, you will see more brands both large and small have confidence in investing marketing resources in these worthwhile campaigns. With a strong data backed foundation, it will ultimately be easier for brands to see a clear ROI causing more brands to jump on this powerful trend in 2016.

The continued rise of the Emerging Artist

Large mainstream artist collaborations can certainly add value for a brand. It puts a large-scale name to a brand, and allows for instant media coverage and consumer recognition. Yet, most brands that are not in the “large” category usually can’t afford these types of collaborations. In addition, some brands who work with established artists sometimes don’t get that genuine collaboration feel because of the artist’s previous involvement with other brands diluting the impact. With that in mind, one of the big trends that will occur in 2016 will be for brands both large to small to more heavily invest in emerging artists, utilizing the up and coming talent to break their brands and target truly engaged consumers. The new emerging artist and brand collaborations in 2016 will rely more heavily on data than ever before. Understanding brand consumer data and cross referencing it with artist fan data will allow for a higher success rate of brand and artist collaborations. In addition, brands will look to invest more in artist’s end products such as brand sponsored albums, exclusive artist content, branded concerts, or VIP experiences. Association and product placement with a brand’s sponsored artist is no longer enough to create a successful collaboration. Unique and personalized experiences paired with engaging content is what will define a great brand and artist collaboration in 2016.

Streaming Wars Continue



As consumers shift towards streaming, there is a battle in getting consumers to pay for, and stick with, a specific streaming service. In 2016, battles between Pandora, Deezer, Apple, Google, Spotify and Tidal (amongst others) will intensify as each platform looks to differentiate itself in some way. Tidal with their concert exclusives at Barclay’s Center, Apple with their artist exclusives, and Spotify with customizable playlists to users; each platform is looking to create a unique value proposition to the user in terms of the experience of listening to music. There is no question that the streaming wars will only get more intensified as 2016 rolls on with YouTube Red and Soundcloud streaming services looking to enter and scale users in this tight streaming market. Whomever can dominate the streaming market in 2016 will be able to influence the future of how music will be consumed, distributed, and shared. The streaming service that ends up coming out on top in 2016 will need to clearly convey their value proposition to not only the engaged music fan, but more so to the casual listener and create individualized products with a higher diversity than the 9.99 per month price tag, that will fit a range of music listeners needs.

Festival culture gets more brand & tech centric

The integration of brands with festivals like Made In America, Coachella and Lollapalooza, to concerts like the Pandora Lexus Concert Series will grow in 2016. As more millennial’s engage in

the music festival culture, there is a large opportunity for brands not only to connect with this audience but capture key data and analytics through technologies like iBeacons, RFID and NFC. The challenge for brands will be to utilize tech such as the Doppler Labs customizable sound ear buds, the Samsung and Apple smart watch along with new experimental technologies like virtual reality and soundscapes to enhance the concert experience for consumers. If brands can ultimately be a concert or festival experience enhancer that creates memorable moments for fans of both the artist and brand, then both parties will see a mutual benefit in the partnership. Fans will feel they got a higher value because of the brands involvement and brand consumers feel cared about by the brand they are loyal too. This connectivity will allow brands to ultimately connect with savvy consumers by connecting a unique memory and experience with a brand.

Music as a bridge to consumers for Fashion brands

As fashion brands begin to target the end buyer and make Fashion Week more “consumer friendly,” music artists will untimely play a bigger part in the showcase of collections for brands for fashion week throughout the year into 2016. Some fashion brands and retail outlets have already begun to step foot in this trend, such as Macy's Fashion Front Row event that was held at MSG this past fall, showing over 60 designers and a 150 plus looks while weaving in a strong music performance element into the show to draw in a wider variety of ticket buyers. As fashion week's exclusivity dissolves and focus shifts to being consumer oriented, fashion brands will certainly need entertainment support beyond just the runway to correctly scale a consumer oriented fashion week. Much like Victoria's Secret Fashion Show that this year headlined Ariana Grande, or fashion sponsored shows like Fashion Rocks, a Calvin Klein sponsored event, fashion and music will continue to converge closer as a heavier focus is put on scaling a consumer oriented fashion week. Music artists will be the key to making events like this more marketable/shareable to the brand's “end consumer” which will ultimately increase the amount of artist and brand partnerships in the fashion industry in 2016 and beyond.

Wearable Tech blends with Streaming Music for New User Experience

Wearable technology will allow brands to tap into and interact with music consumers in ways that will match the pace of their daily lives. Much like how Spotify has added a running and workout segment to the Spotify experience, the wearable technology revolution will also allow music and brand marketers to capture more in depth data then ever before. If brands can capture information on users listening habits, mediums of listening, trends in listening, a predict the next moves of users accurately, brands can be content creators for music fans that match their targeted demographic such as branded playlists, exclusive content or VIP experiences to each individual user. Traditional advertisements aren't effective in capturing the music users attention. If brands can create integrated advertising and marketing strategies and platforms for users to engage with music such as branded content and playlists, brands will ultimately become more effective in driving key messages to consumers.

II-4 Multimedia

User Trends

Regarding multimedia, users' main request is to foster connectivity as the capacity of a program or device to connect with other programs or devices; internet networks and wireless phones bring it to mind. Essentially, connectivity allows us to connect with each other, and these connections mean multimedia most of time.

As with all technologies, users are waiting to see technology to push the limits and to find innovative ways to be integrated into their daily lives. Whereas interactivity allows for a dialogue between human and machine, in contrast, connectivity gathers, links and connects users (and this includes M2M), no matter where they are.

Having achieved so-called "human" connectivity, the next challenge is to extend connectivity to our environment – in other words, to develop an interaction between the individual and their surroundings. The goal then becomes to make space an interface where content that adapts to the activity taking place in that space can be projected: *"it is the space surrounding us, installed with sensors, that reacts according to what we are doing"*¹³.

Technological trends

- **Network and IoT:** network ubiquity with 5G, M2M technologies (Lora, Sigfox...), broadband for all everywhere, new network capabilities based on cloud solutions these are the main topics that will pave the infrastructure evolutions in the next five years
- **Multimedia and big data:** UHD and its evolution (more "K"), new format of coding, data analytics with associated algorithms that will allow better personalized service will change user experience of content and consequently the tools to produce them and to tune the content to the end user habits in content consumption with more interactivity
- **Digital confidence:** the cyber world will be an insecure place for content protection Cyber technologies will be need to protect content producers and ensure privacy of the end user while accessing these digital contents
- **Mixed realities:** clearly virtual reality and augmented reality are key for the next decade content consumption. The new devices and their use will impact the way to produce digital content in games, training and education, creative and cultural industries. Virtual Reality and Augmented Reality are also changing the way people interact with content and between people. New Interfaces need to be designed, developed and tested in order to give another step forward in new storytelling.
- **Software:** because at the very end all these new content will be created, produced, transported, protected with SW the SW technologies will be key for content
- **User collaborative producer:** this domain is dealing with collaborative economy with a complete reshuffling of the business models based on platforms

¹³ *The Future 100: Trends and Change to Watch in 2015.*

Business and market trends

With regard to Multimedia topics, NEM community has stated four main markets which are key for its territory and will be representative playground for NEM actors.

- **The intelligent house:** this includes the place to live with enhanced services based on more and more intelligent boxes, with interactive content consumption second screen value added services at home including elder people or ill people staying at home smart building will be major for energy savings and environmental management it also includes the place to work smart industry is a key sector for mixed reality as it is for smart data management
- **The intelligent territory:** Digital content is invading the economy and the territories from smart city to smart farm or smart seaside: very value added service will be impacted by digitalization including commerce, energy, transportation, tourism, culture. This will create new business models based on social platforms
- **The health:** Health will be transformed with 4P medicine that will arise only via digital content, digital tools to monitor efficiently the patients with data analytics to predict and prevent illness
- **e-Health:** will also be an answer to medical desert arising in many developed countries allowing remote diagnostics and remote real time monitoring
- **Education:** Digital content will transform the way to learn and the way to teach Via the MOOC. The academic knowledge is now available via the web. The teacher will be more an accompanist of the learner to ensure that the needed competencies are acquired. New digital tools and innovative methods based on digital content will help the learners
- **The automatic expert:** Augmented Reality and Virtual Reality together with Artificial Intelligence will help users to complete skilled actions in a natural way like a human expert.

II-5 Advertising

User Trends

The main point for users on advertising is not getting annoyed somehow by it. Users are used to ads and disposed to live together with them while they belong to something that simplifies their lives.

So the key is to success in targeting by engaging their audience at the right time with content that's relevant to them.

Technological trends

The role of advertising now, more than ever, is to create a relevant connection between a brand and what people really care about. Advertising is a moving target, and marketers are tasked with keeping abreast with this near-constant emergence of trends and technologies. To keep pace with a dynamic industry and continually make marketing communication smarter, advertising will increase spending on marketing tools and tech as marketing analytics and predictive intelligence.

Marketers are boosting budgets for advertising on social platforms in 2016. Advertising is becoming more and more about content, with a focus on storytelling. Campaigns and messages are made with a more journalistic approach.

Social platforms will be considered part of the media mix, alongside traditional TV, print and out-of-home advertising, but it is proving increasingly harder to break through on traditional channels. Nowadays, it is common to see an acceleration of brands trying to create their own brand platforms, which act as a destination for their consumers to gather around a shared point of interest. Video is becoming increasingly important and powerful because of the ways it can be integrated into social platforms.

Mobile advertising

Mobile advertising is the fastest growing sector of the advertising industry, in 2015 it generated 30% of total digital advertising income, which hit a new record of \$27.5 billion. Mobile advertising is only going to grow in future as it becomes perhaps the dominant platform for the advertising industry. It has three distribution channels – mobile apps, mobile web and messaging. One of the major ongoing challenges of digital advertising is ads blocking. Desktop ads blocking software is being popular on a desktop but the ads blocking issue is quickly moving into the mobile area.

Mobile advertising represents a significant portion of digital advertising, the ongoing evolution of mobile devices presents new opportunities for new ad formats and more sophisticated targeting. Due to its higher mobility a smartphone allows to generate a greater mobile ad revenue than a tablet computer. The bulk of mobile ad revenue is controlled by the leading social networks and Google.

Advertising challenges

One significant change is the undeniable rise in CRM and data-driven marketing that will lead the change in creative direction. Big Data helps drive better consumer insight, but it is necessary to infuse creativity with Big Data. This creative reimagining of CRM means that advertising is now able to go from 'people' to 'person.'

It is expected to experience another transformational shift in mobile. A brand's ability to connect with a consumer will primarily exist through mobile connections. Such as when, based on

consumers' personal preferences, brands provide contextual content that seamlessly transitions into serving a location-specific value.

The concept “mobile-as-a-mindset” will realize through a collection of integrated technologies, some virtual and some physical, such as wearables. The rise of integrated mobile will create a seamless physical-to-digital or “phydigital” ecosystem.

Business and market trends

Redefining the Customer Experience Model

Marketing departments are moving from classic advertising and non-interactive communication toward becoming a natural part of the sales cycle and an extension of customer service with the main objective of achieving more effective customer engagement. Marketers, using integrated tools, can engage with customers online, track the buyer’s journey, measure sentiment and loyalty, and match behavior with outreach tailored to meet their audience’s needs and interests. But for customers already bombarded with information, a great customer experience is becoming baseline.

New models of ad insertion

Companies are impelled to create advertisements that seamlessly blend with—rather than interrupt—the browsing experience, as well as to use those customer-centric insights to drive content and social engagement.

Immersivity

Virtual reality literally drops people inside their favorite TV show, provides an on-the-ground preview of their next vacation, or puts them behind the wheel of their next car. Customer experience is priority number one and—although it’s still evolving—3D technology is poised to move from novelty to mainstream. It will start most heavily in the gaming industry, but as the technology to create and consume becomes more accessible, smart marketers will look for ways to bring their products to virtual life.

Social Media

Social media is not advertising nor marketing, and it doesn’t work as a “strategy” on its own. Social media is one platform of many, a tactic that does a great job of supporting broad campaigns but flounders by itself. This distinction will shape marketing strategies and budgetary considerations in the near future.

Omnichannel for Retail

An integrated customer experience is essential, one that creates one smooth interaction, rather than multiple micro events. Omnichannel will improve the bottom line for both retailers and B2B.

II-6 Gaming

User Trends

Gaming any where, any time, any device and going as most immersive as possible are the main requests from gamers.

With the advent of smartphones, the gaming experience has been taken out of the arcade and the living room. This is the era of smartphones. Nowadays, smartphones are offering more mobile gaming experience to its users. Every day new games are launched in mobile stores for the users to make them **go mobile and go gaming** the same time. Companies have already started wearable techs to support gaming. VR headsets are also the part of **wearable gaming technology**. **Virtual reality** is known as the biggest breakthrough in the gaming world. Still many virtual reality gaming consoles have not been released commercially but there is lot going on to develop VR headsets. VR headsets are in demand as they offer immersive experience of online gaming.

Technological trends

Internet and latest technologies have changed the gaming world in completely new ways. There was a time when people only know video game as a technology but now there are so many technology breakthroughs you can see in the file on gaming in 2016. Most popular technological breakthroughs foreseen are mobile gaming, wearable gaming, and virtual reality gaming.

Gaming looks for evolving in three main directions. First, improving its technological core to get the next step in terms of providing richer, smarter and more complex gaming platforms. Increasing capacities can develop more advanced **game worlds**, and improve the **artificial intelligence** supporting for games. New input and output devices will change drastically the way games are played. Additionally, a complete set of new tools for game design and game evaluation (through new metrics) are needed to provide an answer for these trends.

Final objective is achieving the next level in **gameplay, interaction and game experience**, involving playful interactions, new content formats, wider game contexts, fostering narratives and procedures, and consolidating a new generation user experience.

All these concepts are pivotal for the gaming ecosystem and involve a redefinition of some of the key procedures of the sector as **game design thinking, business models, validation procedures**, or **nomenclature and process**.

Gaming challenges

- **Game Artificial Intelligence:** Better realism (behavior), collecting and using real time data, intelligent models for steering game play (feedback & feed forward)
- **Game Design:** Clear reusable design strategies & methods, better tools (shift to user-made)
- **Game Metrics and Models:** User models & stealth assessment, usability & effect evaluation, better quantitative & qualitative measures (bio feedback)
- **Playful Interaction:** Beyond interaction design (playful versus usability), new practices: hybrid, augmented, VR, tangible interactions
- **Transfer of Games:** Return of investment, validity of game content (no grounding), re-use, Games-as-a-Service
- **Game Design Thinking:** Influence of games making and playing on design (collaborative, thinking by doing, experiences, affinity spaces)

- **Business:** Different business models for applied and entertainment games, scale of business (Indies), from 'paid by the hour' to 'games as a service'
- **Theory, Nomenclature & Process:** No common language, scattered theory, game design theory is still incomplete

Business and market trends

Multi-screen adds a new dimension to games as they can now be played on television and consoles, or mobile devices.

The Freemium or Free-to-play model is expected to generate revenue for games across all platforms. F2P essentially works by providing the audience the game itself for free, then allowing them to customize their experience through in-game purchases.

The "games as a service" will remain a viable business model for games, especially for those graded as AAA, or those with the highest development budgets. Essentially, this business model entails continuous development for games through cloud-based web services.

Virtual Reality and Augmented Reality are already getting investments from companies. Augmented Reality basically places digital information over your physical environment through a wearable user interface.

E-Sport games are still planned to be blockbusters, and an improved experience to engage users will be provided by platforms that have been encouraging E-sports enthusiasts to interact, build a community and share gameplay. This introduces a new experience for the audience of E-sports, and opens new opportunities for monetization.

One of the most intriguing topic for gaming sector is the role of playtesting and user research specialists. Developers employ the understanding of players and cutting-edge research labs to gather **actionable feedback** on game usability and the player experience, toward the development of **truly successful games**. So, they ensure players' experiences are as close as possible to the **designers' visión**.

Playtests conduct research focused on actionable results, evaluate games with expert reviews in conjunction with game developers to perfectly match the needs of game development. The assessment of games engages from project start to product launch by building in testing from early stages of development, in order to avoid costly usability issues, barriers to monetisation and flaws in the player experience.

II-7 Fashion

User Trends

Each season, the design and merchandising departments worldwide are waiting what's in trend for coming seasons. They rely heavily on creating a new line using these valuable data collected by professional agencies.

To cope with the ever-changing technologies, the markets and consumer are rapidly evolving from traditional, static, demographic-based criteria to more towards dynamic, modern, mood, lifestyle and psycho graphic influences.

Sustainability: social pressure urges corporate responsibility; Business organisations, NGOs and unions signed the covenant sustainable clothing and textile with the goal to registrar and to eliminate risks in the production chain. The initiative has the aim to create a safe and transparent fashion chain.

Technological trends

Fashion trend forecasting resources help predict trends in the fashion industry. Fashion & trend forecasting is the prediction of mood, behavior and buying habits of the consumer at particular time of season. It is no longer a question of finding your markets or consumers by age, geography or income, but looking into how and what they buy, based on their culture, mood, beliefs, occasion & geographic locations, it is also dependent on fashion cycle and plays a major role in introductory phase of recurring fashion cycles.

There are other detected tech-based challenges to be coped with the fashion sector:

E-commerce retailing: the industry needs to focus on a better collaboration between online and offline retailing. Opportunities can be found in new (omni-channel) retail concepts, technology and knowledge sharing between other branches.

Supply chain, logistics: initiatives where garment suppliers and retailers work together in the electronic exchange of product, inventory, ordering, delivery and sales information (EDI and chain digitization) have been around for some time now. Business models such as consignment, concessions and vendor-managed inventories are common in other industries (for instance in food and do-it-yourself sectors) yet is relatively new to the fashion and textile industry. When companies focus on sharing software and knowledge, properly functioning logistic systems can be created for the whole sector.

Future Jobs, education and training: when the industry is forced to change companies then employees involved need to evolve too. Specialised education and future jobs, which focus on sustainability, technology in textile, analysing big-data, logistics and retailing, can fill gaps within the entire chain.

Business and market trends

The fashion industry deals with problems that affect the industry on every layer, from manufacturer to retailer. Several reasons can be identified: from the economic crisis, changing consumer behaviour, the need for sustainability and corporate responsibility, the rise of online channels to the

emergence of large international players and last but not least, the weather. Together these factors unfortunately result in a declining fashion market in Europe.

- Work wear

The work wear industry has its own dynamic and largely depends on the staff turnover of large sectors such as the health-, construction- and transportation industries as well as security and consumer-oriented services. The profits and rise of these industries are formed by the investments or cuts made in the industry. Recent economic growth in for instance the construction industry resulted in new possibilities. Carpet and Interior Compared to the fashion industry the effects of the economic crisis have taken a large toll on the carpet and interior industry. This particular industry strongly depends on the build of new houses, project developments and people relocating. Without economical improvements developments are minor.

- Textile

The textile industry is an industry that is hard to define since the companies often operate in highly specialized niches. This can also be identified as the strength of the industry: a much higher value added at a lower possibility of substitution when compared to fashion. Competition is however present from large companies which operate on international level in low wage countries.

Modint / CLICKNL / NextFashion identify several opportunities for the entire sector (fashion, work wear, carpet, interior and textile) that are strongly related to the problems described above:

New Markets, crossovers: A lot of Dutch organisations have been producing large quantities of stock for low prices to compete with major players, however it's not a fair competition since the major parties can afford to produce even larger quantities, are organised vertically and have better organised online channels. As a result Dutch companies fail to keep up. There is a chance however, especially when discovering new markets. Opportunities can be found for instance in the markets specialising in fashion for seniors, sports- or performance wear, and cross-overs with sectors (health, construction, ...) where added functionality in clothing could help solve issues in those sectors.

Internationalization, export and sourcing: many companies are successful in the EU, only a few reach beyond these borders. Exporting companies are collecting market information and information on customs matters. It's also important to collect knowledge on clothing technical issues such as labelling, business contracts and intellectual property. As the government invests less in export promotion and businesses show little willingness to take joint action, it is difficult to find enough participants for trade missions, trade fairs and other export promotion activities.

Textile and clothing technology: within the textile and fashion industry one can identify a focus on more efficient manufacturing by experimenting with new forms of manufacturing techniques (3Dprinting,, use of robotics), but also on new (sustainable) materials and new functions of clothing and textile. Clothing will become 'platforms' for new technological options such as data generation or other high performance functions for instance for uniforms of police, military, healthcare industry, etc. These opportunities can be exploited with the following conditions in mind:

Communication and Network: Modint emphasizes on the need for open communication between all parties in the whole industry and knowledge institutes to make sure every party is up to date on any developments within the industry.

Investments in innovation: to develop research into market-ready models investment is essential. Possible solutions can be found in launching customers (a.o. public parties), crowd funding, banks,

private funds and venture capital companies. The government has solely the image of grant provider yet also needs to be recognised as a potential developer and client.

Collective interests and services: all the different educational institutions and business organisations offer collective services where knowledge sharing is the most important focus. When companies and chains are redeveloped to perform better new industries and business models arise:

New industry, new business models: New retail models with particular forms of cooperation between retailers and suppliers have been developed over the years. In addition, examples of the rental, sharing and lending of clothes come to mind. A more recent example is 'fashion as service' where fashion evolves from product to platform, where sustainable and personalised products are the main result.

II-8 Cultural heritage

User Trends

Cultural-cognitive touristic trips are emerging as ones of the most successful types of modern travel. They grow quickly and cover more areas and fields of social and economic life. They account for about 37% of all travels and the demand is growing by 15% annually.

In a certain sense, cultural tourism is elitist type of tourism. It attracts tourists with higher education and more specific interests in particular - with an affinity to history. In this sense, the geography of tourism is closely related to the science of history, and this is due to the fact that besides the results of historical and archaeological research it is needed to be considered and geographical parameters of the location of historical sites - both now and in the age in which they were created.

For the different types of tourists qualities influencing the attractiveness of tourist destinations are their cultural and social characteristics. Fashion, customs and traditions also affect the behavior of consumers of tourist services. Greatest interest to tourists causes a number of cultural elements of the nations.

Technological trends

Cultural heritage area presents four main areas of innovation:

Preservation: Focused on how to ensure the usability of digital files in the short and long term, including new digital born phenomena such as online video, video art, interactive productions, games and virtual reality. Main topics are:

- a. Useful and accessible: ensuring the usability of digital files in the short and long term is necessary. Even with expertise available for converting analog-to-digital carriers, technology rumbles on and digital files age quickly. The new challenge is to guarantee the availability of these files for future user groups of all kinds. The archive must also be able to move with the possibilities of digital media and seek solutions to save interactive creations and keep them accessible.
- b. Trusted digital repository: a digital archive can be optimized by following international standards such as the Open Archival Information System (OAIS). By obtaining a standardized certificate, entitled Trusted Digital Repository, the archive will also demonstrate its stability to the outside world. To meet the guidelines of OAIS, an archive needs to follow technological developments closely. Developments in research groups and the media industry on management systems, file formats, opportunities and threats are relevant to follow.

Metadata and Context: structured, objective and factual information that provides answers to basic questions such as whom, what and where. The innovation field Metadata and Context is strongly linked to two other areas: Users and Access. Queries from users vary from target group to target group, from scenario to scenario and from user to user. The innovation field Users gathers more insight into the needs and patterns of different user groups. The innovation field Access mainly looks at the use of metadata and context in applications for end users.

Main topics are:

- a. Access and connecting: metadata describes (the origin of) an information source with the aim of making it possible to locate, use and manage this source. A context source is a document that can be used to interpret the production, publication and reception of

audiovisual archive material from different angles. This allows you to place a document in a 'broad contextual framework'. Metadata is critical for making collections accessible and to establish connections with other data and context sources. By providing context to its collections, archives can provide support and enrichment to internal and external user groups. On the one hand we see that the amount of data ingested in the archive increases, while the available capacity for manual describing and contextualizing decreases. On the other hand, we see an increasing demand for descriptions, preferably at segment level and including time codes, in order to better match users' search queries.

- b. Focused on users: questions on the more efficient organization of the descriptive and contextualization process and increasing the quantity and granularity of metadata are key within this innovation field. In this we take the quality standards that Sound and Vision sets as an archive into account, and methods to establish links with other information and context sources. For example, via the Sound and Vision Thesaurus and Linked Open Data structures.
- c. Technical: inflow optimization, deployment of technology for automatic metadata extraction, automatic enrichment of metadata, crowdsourcing, contextualization, metadata and Links

Users This innovation field looks at use from two perspectives; from the end users and user scenarios; from technological development. Main topics are:

- a. Niches and access: a user seeks access to our collection. This can be a program maker, a researcher, or an individual looking for an excerpt from a favorite TV program. Various types of end users and a range of possible user scenarios impose specific requirements on how archives make their collections available. This applies to both metadata and context and search technology. We notice niches arising within user groups and the changing prospect on access. Users no longer access only the archive website via the homepage. This scenario is shifting to a model in which we actively bring the collections to users at other locations besides our own sites. "We need to not just be 'on the web', but we need to be 'of the web'" (Seb Chan). This makes it important to continuously gain knowledge about (changing) user requirements. Especially in the context of new technologies that affect use of audiovisual content.
- b. Domain: Creative Industry (B2B), public, education, scientific use, social media

Access covers topics that deal with granting access to the archive collection. Based on knowledge on use and users, and with the help of available metadata and context information. Main topics are:

- a. Complex playing field: In our society and in the media landscape a lot takes place online, or is well on its way to. The demand for online access to audiovisual heritage material and new forms of supply and use is also increasing. In a network with a wide variety of providers and user groups, heritage institutions transform into hubs. It is a complex playing field, which demands a lot from the organization: organizational, procedural and in the technical field.
- b. Knowledge as a basis for development: a distinction is made between
 - i. traditional forms of access through a web portal such as zoeken.beeldengeluid.nl;
 - ii. alternative forms of access through links with external parties, or;
 - iii. museological forms of access.

The gained knowledge helps archives in developing and shaping the various forms of access. Knowledge helps to anticipate organizationally and process-oriented to new forms of access. For example, we collect knowledge and new ideas on alternative forms of presentation in a museum context and knowledge on topics related to copyright and open access. Furthermore, we gain knowledge and practical experience on technical developments such as search and recommendation technology and infrastructures.

Business and market trends

Cultural heritage has become one of the most trending enablers of tourism industry. The market for heritage tourism is rapidly evolving, presenting many opportunities for exploration and that a number of areas need particular attention. For example, information about demand could be used more effectively when developing products and managing places. Also, heritage values could be better explained and presented to improve visitor behaviour, experience and product relevance. Infrastructure, accommodation and support services could be better coordinated and planned to ensure that tourism is sustainable. The development of a set of themes for the interpretation, marketing and development of cultural heritage tourism products and services engages potential consumer and opens potential markets for supplying industries.

The identification of broad areas of mutual research interests in heritage conservation and tourism management to foster synergies and cooperation between these fields while identifying the critical factors for successfully balancing a viable cultural heritage tourism enterprise with heritage conservation goals is critical to establish a solid base to grow.

Anyway, as a previous step, it seems clear that the examination of how cultural heritage and contemporary cultural diversity impact on visitor experience and the development of a methodology that can be used to estimate the economic value of significant cultural attractions.

II-9 Design

User Trends

European manufacturing industries operate in an increasingly difficult competitive environment. In such circumstances improvements to all aspects of a manufacturing enterprise's activities are needed to enhance competitiveness. However there are some activities that provide more opportunities for radical innovation and which are more critical than others are, and product design and development is one of these. In particular, there is tremendous scope for the application of NEM technologies in this specific area, to support both virtualisation through the use of models and simulation, and for the application of other novel technologies in different stages of the design and development process.

Technological trends

Manufacturing Processes, automation, and maintenance have become "Virtualized" across the product lifecycle enabling virtually simulated Environments for all Domains. PLM Scope has expanded: Design/Build has become Design/Simulate/Validate/Build/Support/Maintain.

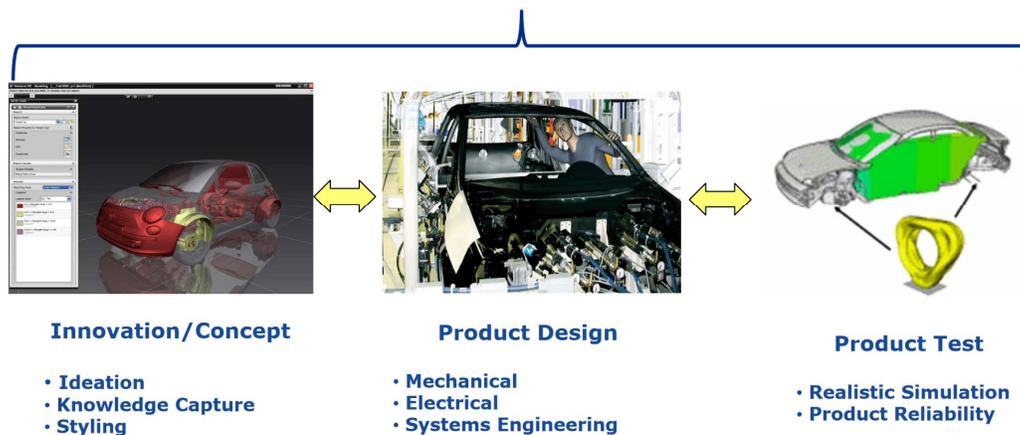
Digital manufacturing simulation tools enable users to create virtual production processes to validate and test factory floor operations, maintenance, and operator training. Validation of the physical world through simulation of the virtual world.

Virtual environments can be created to simulate entire production systems, machine Tools, field operations and maintenance replaces building expensive physical prototypes with virtual prototypes for testing.

Already the expected standard for realistic product testing (CAE) can significantly shorten the production system ramp-up time leading to faster product launches.

Virtual commissioning for production systems reduces time to launch and physical commissioning costs. Real-Time virtual simulation for training, operations, and support can be used for all industries.

Virtual 3D Design



Business and market trends

Industrial leaders are digitising essential functions within their internal vertical operations processes, as well as with their horizontal partners along the value chain. In addition, they are enhancing their product portfolio with digital functionalities and introducing innovative, data-based services.

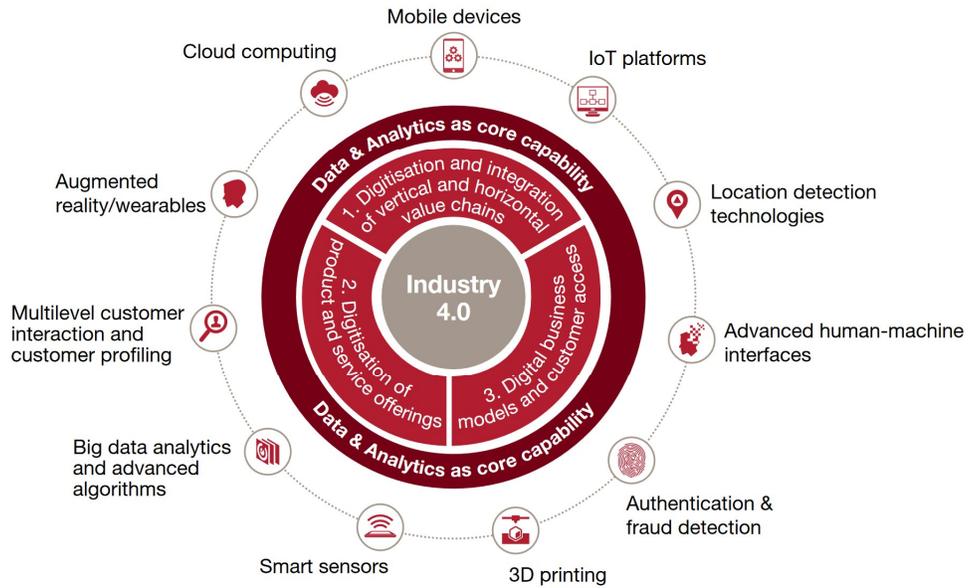
At the end of this transformation process, successful industrial companies will become true digital enterprises, with physical products at the core, augmented by digital interfaces and data-based, innovative services. These digital enterprises will work together with customers and suppliers in industrial digital ecosystems. These developments will fundamentally change individual companies, as well as transform market dynamics across a whole range of industries.

Industry 4.0 digitises and integrates processes vertically across the entire organisation, from product development and purchasing, through manufacturing, logistics and service. All data about operations processes, process efficiency and quality management, as well as operations planning are available real-time, supported by augmented reality and optimised in an integrated network. Horizontal integration stretches beyond the internal operations from suppliers to customers and all key value chain partners. It includes technologies from track and trace devices to real-time integrated planning with execution.

Digitisation of products includes the expansion of existing products, e.g. by adding smart sensors or communication devices that can be used with data analytics tools, as well as the creation of new digitised products which focus on completely integrated solutions. By integrating new methods of data collection and analysis, companies are able to generate data on product use and refine products to meet the increasing needs of end-customers.

Leading industrial companies also expand their offering by providing disruptive digital solutions such as complete, data-driven services and integrated platform solutions. Disruptive digital business models are often focused on generating additional digital revenues and optimising customer interaction and access. Digital products and services frequently look to serve customers with complete solutions in a distinct digital ecosystem.

Industry 4.0 framework and contributing digital technologies



II-10 Education & training

User Trends

Students are showing an increased interest in online learning citing a desire to have more control over their learning and believing that they will get more support from an online teacher. Gaming is growing, and the gender gap is closed. In 2015, 60 percent of students are using laptops as a gaming device. Cell phones and game consoles tied with 54 percent use, while tablets clocked in at 44 percent. Of particular note is students' interest in taking gaming technology and applying it to learning difficult concepts, as well as their interest in using games as a way to explore career opportunities. Evans also noted no gender difference in students' interest in games, with younger girls actually showing more gaming activity than their male counterparts.

According to Project Tomorrow¹⁴ survey: "Today's students are looking at social media not as a separate thing that you do occasionally but as a pervasive part of the way they are living their lives outside of school — one they want to connect with their lives inside the classroom."

The data for text messaging, networking sites (Twitter, Facebook, Instagram, etc.) and chat rooms, it was clear the the student expectations for the use of these technologies far outpaced those of administrators, teachers and parents. Administrators scored the highest among the non-student groups represented.

Finally, students' ranking of the relative importance of devices in their classroom experience shows that 56 percent of students said laptops were most important; 51 percent chose digital readers; and 48 percent selected tablets. Something of interest is that 62 percent of students want to bring their own devices.

Technological trends

STEM education is related to teaching and learning skills of Science, Technology, Engineering and Mathematics (Journal of STEM Teacher Education, 2014). Lately, the term STEAM is used to include arts (Language Arts, Social Studies / Civics, Fine & Musical Arts and Physical Arts) in STEM programs (Bybee, 2010) (Sanders, 2009). The aim of the STEAM in education is to combine all subjects to each other in an interdisciplinary way, providing a holistic approach for learning in a rapidly changing business and professional world. The main benefits of STEAM in education emerge from the interaction of students with real problems that require creative problem-solving, creative thinking and innovative ideas. This shift from traditional education philosophy to integrated STEAM programs can assist students in and out of the classroom, by enhancing 21st century skills such as critical analysis skills, problem solving skills, higher order thinking, creativity and innovation, communication and collaboration skills, flexible and adaptive thinking.

For addressing this paradigm, in education and training four main areas has been described:

Models & Methodologies

Media technologies are providing a boost for innovative teaching and learning technologies as collaborative virtual learning. They are reshaping the web-based methods and tools in traditional, online education and training; and the design and development of online courseware.

¹⁴ Available at Project Tomorrow

Other important topics to address in the near future are e-Pedagogy, information and knowledge processing and knowledge representation and ontologism; cognitive modelling and intelligent systems including algorithms and programming for modelling.

Technologies

The key technologies gathered are innovative virtual reality (VR) and web-based teaching and learning technologies, advanced distributed learning (ADL) technologies, web VR/AR and mixed technologies; web-based education (WBE), web-based training (WBT); new technologies for e-learning, e-training and e-skills/e-competences; educational technology, web-lecturing technology, mobile e-learning, communication technology applications, digital games based learning (DGBL), computer graphics and computational geometry and intelligent virtual environments.

Software Solutions

New software environments for education & training, software and management for education; VR applications in web-based education, computer graphics, VR/AR and mixed-based applications for education & training, multi-agent technology applications in WBE and WBT; streaming multimedia applications in learning, scientific web-based laboratories and virtual labs, software computing in VR and Artificial Intelligence, avatars and intelligent agents.

Innovation in education and research

Collaborative rich-media applications, student and teacher software, improved learning methods, interactive and collaborative methods to help teachers incorporate technology into their lesson plans and enable students to learn anytime, anywhere.

In one hand, new VR headsets (Oculus, HTC Vive, Cardboard, etc.) are allowing 3D immersive training/education experiences. The usage of VR headsets for example in a training perspective allow professionals to conduct training in a controlled virtual environment where they can improve upon their skills without the consequence of failing the execution¹⁵.

Or in education context this technology allows students to travel to other countries to learn about customs and traditions¹⁶.

In the other hand, new AR headsets (MS Hololens, Daqri, etc.) allow mixed reality personal experiences for example to assist an employee in the process of learning how a machine works.

Other main technology trends for education are 3D printing, IoT and wearables.

¹⁵ <http://archvirtual.com/project/virtual-industrial-warehouse/>

¹⁶ <https://www.google.com/edu/expeditions/>

Business and market trends

AR/VR market trends in education according to a Goldman Sachs report (including military training):

	Current market size	Datapoints on the population that could use VR/AR	2020 Base case assumptions		2025 Base case assumptions	
			Users	Software revenue	Users	Software revenue
	<i>The market VR/AR is playing into</i>	<i>To gauge the magnitude, the population that VR/AR could sell into</i>				
Videogames	\$106bn videogame market	~230mn installed base of video game consoles ~150mn PC gamers in developed markets	70mn	\$6.9bn	216mn	\$11.6bn
Live events	\$44bn in live sports ticketing revenue	~715mn viewers of World Cup ~160mn viewers of the Super Bowl ~92mn ESPN subscribers	28mn	\$0.8bn	95mn	\$4.1bn
Video entertainment	\$50bn online video TAM	~450mn household online video addressable market	24mn	\$0.8bn	79mn	\$3.2bn
Real estate	\$107bn total real estate commission market in US, Japan, UK, and Germany	1.4mn real estate agents in US, Japan, UK, and Germany	0.2mn	\$0.8bn	0.3mn	\$2.6bn
Retail	\$3bn in ecommerce software market (impacting \$1.5tr ecommerce market)	1bn+ online shoppers In-store shoppers	9.5mn	\$0.5bn	31.5mn	\$1.6bn
Education	Education software market: \$5bn for K-12, \$7bn for higher education	~200mn primary and secondary students in developed markets In US, ~50mn K-12 and ~20mn college students	7mn	\$0.3bn	15mn	\$0.7bn
Healthcare	\$16bn patient monitoring devices market	~8mn physicians and EMTs in developed markets In US, ~800k physicians and 240k EMTs	0.8mn	\$1.2bn	3.4mn	\$5.1bn
Engineering	\$20bn engineering software market	~6mn engineers in US, Europe and Japan ~2.4mn engineers/technicians in the US	1.0mn	\$1.5bn	3.2mn	\$4.7bn
Military	\$9bn defense industry training and simulation market	~6.9mn military personnel in "high income countries" (World Bank) ~1.3mn US military personnel	Assuming proprietary HMDs	\$0.5bn	Assuming proprietary HMDs	\$1.4bn
Total			95mn	\$13.1bn	315mn	\$35.0bn

+

<http://www.goldmansachs.com/our-thinking/pages/technology-driving-innovation-folder/virtual-and-augmented-reality/report.pdf>

II-11 User and social engagement and collaboration

User Trends

Media consumers engage with each other over social media as part of their media experience, and the human need to share experience and emotion. The quantity and level of media content which these consumers, as prosumers, contribute to their friends and family, their followers on twitter, youtube or facebook is increasingly dominating both their lives and internet traffic. According to a 2015 study, video accounted for 64% of consumer internet traffic in 2014, with the majority of those contributing being “millennials”, the biggest demographic group online. Those who make their living out of creating and distributing professional, high quality content need to find new ways of engaging with, and adding value to, these consumers, and how to make media a part of their everyday experience, whether that is in entertainment, gaming, cultural experience, shared social events such as concerts, engaging and immersive news presentation or new forms of drama with which they interact.

Technological trends

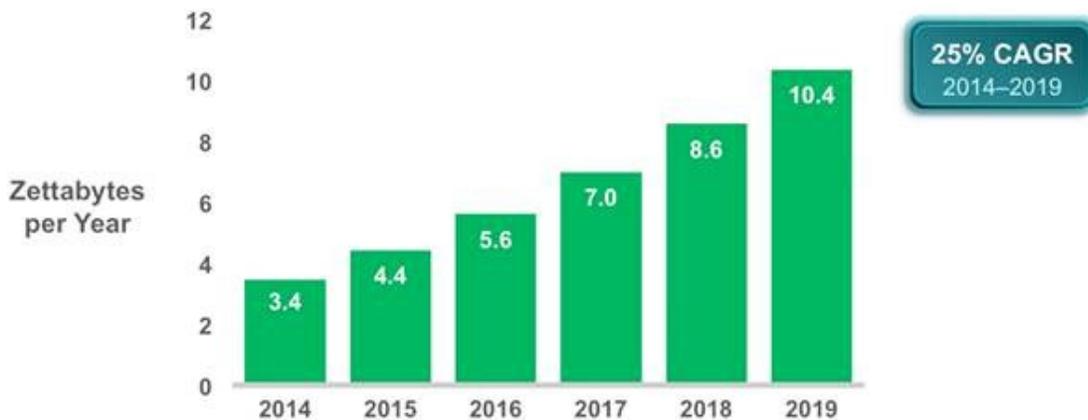
Given that media consumers will be using a range of devices to consume media there are aspects of user engagement that the providers of content will need to develop. Content discovery is an ongoing challenge that will become more difficult with time and new forms of user interface and human computer interaction (HCI) will be necessary. Getting this right will be crucial for the commercial content providers, and their business models will have to change if they are to stay in business. Advertising revenue is reduced as more content is spread across more devices, subscription models are compromised if the offering is not accessible, pay per use is dependent upon a compelling product. Evolving business models arising from new forms of user engagement are therefore a significant research topic.

Currently, millions and millions of users are using some kind of social online networks to share their experiences and content with online friends. Documents, videos, music and pictures are shared on-line, relying on the privacy and security controls offered by the social network platform, with little control from the end user. This creates serious privacy concerns, since the control over the content shared on-line on the social network, is out of hands of the user.

There is a need to propose a different approach for content privacy shared on social networks that is user-centric and not on the social network platform. In order to achieve that, an architecture based on a user rights management platform that will enforce the necessary security and privacy mechanisms that extend the original controls provided by the social network platform is needed. That way, users will be able to control the privacy settings and protect their content, even when they are no longer participating on the social network.

CISCO Figures for Consumer Cloud Storage

- By 2019, 55 percent (2 billion) of the consumer Internet population will use personal cloud storage, up from 42 percent (1.1 billion users) in 2014.
- Globally, consumer cloud storage traffic per user will be 1.6 Gigabytes per month by 2019, compared to 992 megabytes per month in 2014.



Management of access to content (DRM evolution), management of exhaustive content withdrawing, are key questions for users with the explosion of content sharing on social networks.

Business and market trends

Social media thrives on real-time engagement, but each year the window for response becomes smaller and smaller. According to Search Engine Watch, 70% of Twitter users expect a response from brands they reach out to, and 53% want a response in less than an hour. That number jumps to 72% when they're issuing a complaint.

One of the key strategies marketers need to implement in near future is faster response times by means of advances made to social listening and automation tools. Social media is moving fast, and any business that has a presence on any of the platforms is expected to keep up.

The more engaged the customers are, the better the sales. Over the last couple of years, social media has played a crucial role in this area. Research found social influences more shoppers' buying decisions than retail websites. Compelling stats like the one above has led to the creation of more commerce-focused features for marketers and advertisers.

II-12 Novel storytelling techniques

User Trends

At its very core, visual storytelling is tied to our instinctive desire to connect with others through engaging tales and narratives. New forms of display, new ways of interacting and sharing and new consumer behaviours demand new ways of constructing and presenting stories. The construction of narrative threads that engage with and interact with the consumer will be complex, and specialised tools will need to be created that will support new forms of storytelling. Once again, this is not just about gaming, but includes interaction with cultural heritage, immersion in on-line story-books, location based geographical games and education and training.

Associated with new story forms will be the need to develop new ways of archiving and preserving these stories. Because of the interaction with the consumer the story that emerges will be ephemeral. There is a question of what is to be preserved for the future, how it is maintained and what the business model will be to pay the cost of such preservation.

Technological trends

Visual storytelling involves the use of graphics, images, pictures, and videos to engage with a target market and convey a brand's message in an effort to drive emotions and encourage a particular action.

Visual storytelling is defined by a number of mediums and strategies. These included things such as:

- **Video contents.** Video is the most powerful form of visual storytelling. However, it's also the most difficult medium to master, from a marketing perspective. Anyway, many small and medium-sized businesses are progressively adopting video.
- **Infographics; statistics and graphics.**
- **Branded images.** With the growth of visual-based social platforms, such as Instagram, many marketers have found branded images and GIFs to be powerful visual storytelling mechanisms.

A seamless integration of a variety of mediums—from the written word and still images to interactive graphs, maps and animations—the interactive story is paving the way for new forms of transmedia storytelling in our convergence culture.

Business and market trends

The proliferation of digital marketing technology is happening at an astounding pace. In fact, it gets faster and faster each year with visual storytelling leading the way.

The demand for visual storytelling in the content marketing industry is going to see tremendous growth in near future. This is predicated on the fact that content generates up to 94 percent more views when compelling visual elements are incorporated.

Mass adoption of virtual reality (VR) technology – both on business and consumer sides – is still a couple of years away; however, look for another step to be taken right now. Trendy brands will try to make a splash by leveraging new VR tools at events and physical retail locations.

There will be significant growth in the wearable device market from now till 2020, which naturally means savvy digital marketers need to prepare content for these new devices.

II-13 IoT integrated environment

User Trends

The evolving Internet of things means we are surrounded by data, some is our own, some is public and some commercial. Media production can take advantage of this data, for example in personalisation based on locality, hot topics and even weather, which could lead to other social consequences, such as seeing the data that is related to others around us (who are they, what are their interests, what books have they read lately), visualising our own behaviour and physiological responses in interactions with others or media productions, making educational content based on public information, connecting story lines to weather or location etc. These are all topics for research and innovation that include social and behavioural study as well as techniques for technical realisation.

Four recommendations are provided from QoE assessments for enhancing the user experience of the IoT

- **Simplicity is key.**
- **Create seamless, intuitive interactions.**
- **Be transparent about communication.**
- **Balance security with accessibility.**

Technological trends

The Internet of Things (IoT) involves embedded computing devices interconnected with the existing Internet infrastructure. Examples include automobiles with built-in sensors; smart thermostats; and home appliances that are networked for remote monitoring. The impact of the IoT on storage is two-pronged in types of data to be stored: personal data (consumer-driven) and big data (enterprise-driven).

For IoT to really thrive, vendors and customers will need to embrace open standards that improve device monitoring and management; big data information gathering and analytics; and overall network communications.

Key IoT standards initiatives are underway at the IEEE Standards Association. Also, vendor-led groups are driving open source efforts to advance IoT beyond the connected home.

The increasing digitization and automation of the multitudes of devices deployed across different areas of modern urban environments are set to create new security challenges to many industries

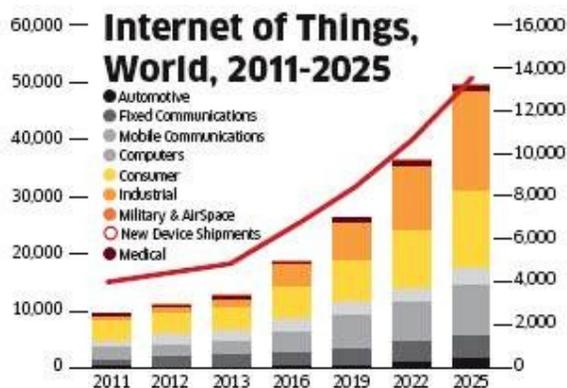
There will be a vast amount of data providing information on users' personal use of devices that, if not secured, can give rise to breaches of privacy. This is particularly challenging as the information generated by IoT is a key to bringing better services and the management of such devices. The impact of the IoT on storage infrastructure is another factor contributing to the increasing demand for more storage capacity, and one that will have to be addressed as this data becomes more prevalent. The focus today must be on storage capacity, as well as whether or not the business can harvest and use IoT data in a cost-effective manner.

In the Internet of Things, the short-term challenges identified are, on one hand, the need to cope with billions of IoT devices, which encompasses the virtualization of sensing, energy consumption management including the progress on the “hardware-related” energy harvesting, the interoperability of IoT data, the friendliness for the environment and scalable discovery and

registration; and, on the other hand, the IoT management for robustness and reliability which is addressing the IoT in becoming more mature and established, enabling contextually also the support for critical services, and including IoT virtualization, orchestration of resources and how to counter security threats. In the long-term, the main challenge identified is the intelligent reasoning of IoT data to address how to best leverage on IoT harvested data, notably to produce the usable and useful knowledge for compelling IoT-based services and applications; this is including the need for avoiding data deluge, semantic modelling, distributed reasoning and data-to-knowledge conversion and low-latency.

Business and market trends

Almost every industry will be touched by this technology, but some of the biggest changes will be seen in manufacturing, healthcare, transport and energy industries. Smart cities will move forward using IoT technology. Smart devices connected to the internet will make our lives both simpler and more complicated.



While all this happens, security will become a central issue within a year or two, if it is not already. It is great to connect all the wonderful devices, but what if someone could hack them and control them? For example, if your car is connected to other cars and the Internet, someone could take control remotely and crash it. Or someone could take control of your appliances at home. Hacking is possible on any device that is connected to the Internet and has a piece of software controlling it. Fortunately, the industry is aware of the problems and is beginning to take precautions.

While it's hard to draw hard lines on the evolution of technology based on the calendar, some trends are clearly visible, especially in the early days of a technology. ET compiles some predictions for 2015 and analyses how Internet of Things will shape up in the near future.

According to Business Insider:

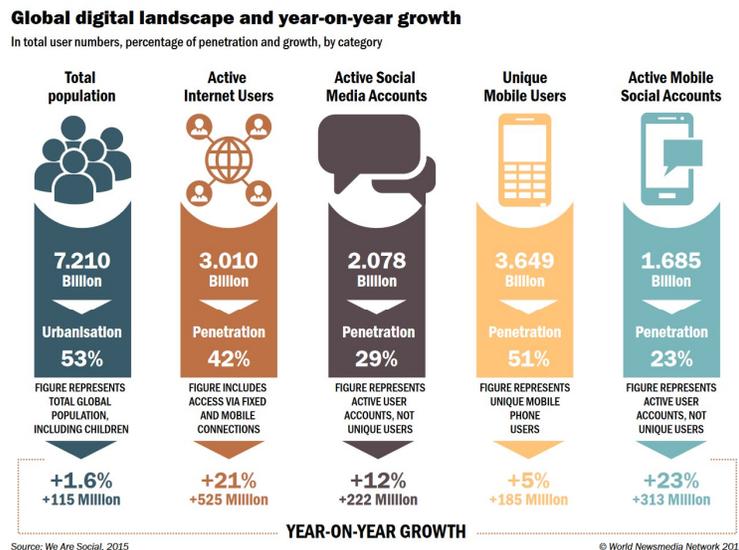
- There will be 34 billion devices connected to the internet by 2020, up from 10 billion in 2015. IoT devices will account for 24 billion, while traditional computing devices (e.g. smartphones, tablets, smartwatches, etc.) will comprise 10 billion.
- Nearly \$6 trillion will be spent on IoT solutions over the next five years.
- Businesses will be the top adopter of IoT solutions. They see three ways the IoT can improve their bottom line by 1) lowering operating costs; 2) increasing productivity; and 3) expanding to new markets or developing new product offerings.

- Governments are focused on increasing productivity, decreasing costs, and improving their citizens' quality of life. We believe they will be the second-largest adopters of IoT ecosystems.
- Consumers will lag behind businesses and governments in IoT adoption. Still, they will purchase a massive number of devices and invest a significant amount of money in IoT ecosystems.

II-14 Digital society - Impact of new media on lifestyle

User Trends

Digital products and services makes our lives easier. New media will reach into all aspects of our lives. It will change our approach to education, which will become lifelong learning, the classroom will disappear in favour of on-line education-on-demand courses based on exploration and discovery. We will modify both personal and social behaviour, with social control being delivered via ‘nudges’ conveyed through media, greater awareness of social issues will be fostered, interactive media will be more responsive to the challenge of the aging population. Improved and more natural interaction with the electronic world around us through the development of human-like interaction agents will enable greater access to knowledge than ever before.



Source: We Are Social, 2015; *Global Social Media Trends 2015*, European Publishers Council

Media have always been influenced by social developments and the rapid and remarkable developments in technology and global economics are today significantly altering lives, community, and established social institutions—including media.

With the proliferation of media platforms and providers, people experience a surfeit of information and entertainment choices, which require them to use increased discrimination in evaluating the content and value of media messages.

Technology trends

The changing media environment created by proliferation of media platforms and providers is affecting the kind of information and entertainment the public receives and the effects of those changes on individuals and society.

Certain elements of the transformation of the media are unambiguous: There is increasing importance of audio-visual media, accompanied by decreasing use and prominence of text-based media (newspapers, magazines, and books); there is a proliferation of market-funded, highly commercialized content that is often influenced by global rather than domestic concerns;

digitalization has and is producing new platforms for content distribution; and the amount of news, information, and entertainment available to the public has never been higher.¹⁷

The Internet is the decisive technology of the Information Age. The Internet and the Web constitute the technological infrastructure of the global network society, and the understanding of their logic is a key field of research.

Improvements in connectivity (IoT rise) and network capacity, personalization (curation) of the content, user management of the content with seamless interaction, and augmented reality will be behind the new ways user will interact with content and content will provide a new impact on user lifestyles.

Business and market trends

Our society digital in all its domains from work, spare time, school and healthcare. Driven by IoT, more and more things around us communicate to each other and the environment. We have access to knowledge, entertainment, services and products everywhere and anywhere. In the same time sharing economy enables sharing commodities in new ways. This will influence production and consumption of digital content, and its role in sectors such as education and health care. Issues to be explored are, among others, personalization, understanding of end-user's context, needs and intentions, as well as new interaction forms.

¹⁷ What Society Needs from Media in the Age of Digital Communication

III Technology trends

This chapter gives a structured and consistent overview of all the technologies covering requirements from all NEM sectors developed in the previous chapter

The objective with SRIA is to identify critical inflection points that we believe should inform industry strategic thinking, and to explain how we think these will manifest over the next years for companies in Technology, Media, Telecommunications, and other industries.

Media is very closely related or belongs intrinsically to some of the most trending topics in technology nowadays. Big Data is an umbrella term for a variety of strategies and tactics that involve massive data sets, and technologies that make sense out of these mindboggling reams of data. The Big Data trend has impacted all industries, including the media industry, as new technologies are being developed to automate and simplify the process of data analysis, and as throngs of data analysts are being trained and hired to meet the demand for the analysis of these data.

For newspapers, television, magazines and Internet-only publishers, Big Data strategies can include audience analytics to enable a better understanding and targeting of customers; tools to understand public and private databases for journalistic storytelling; tools to manage and search the exploding amount of video, social media and other content; tools to target advertising and ad-campaigns; tools to automate the production of text and video stories, tools to identify waste and enable efficiencies; among others¹⁸.

Content distribution requires much more than IP connectivity between a media repository and a consumer. Consumers need a sufficient Quality of Experience which can be provided by a controlled throughput and latency. It can be achieved through various technologies such as QoS enforcement (Information Centric Networking, DiffServ, QCls, access control etc.), distributed storage of media close to consumers (also known as Content Delivery Networks) or broadcast and multicast. Overall, thanks to the ever more competitive telecommunication 5G services market, new business models will emerge, promoting closer collaboration between network service providers, and between network service providers and their suppliers¹⁹.

III-1 Content Distribution

Modern online media delivery services, such as online video streaming and other web browsing, face a substantial traffic growth which puts stress on the networks and on the delivery of the content, and most of that traffic comes for media consumption that is becoming even more social and mobile.

Regarding the Content Distribution sector, the content delivery chapter is the most relevant one with new networks which will be able to deliver any content, anywhere anytime on any device. It has to be transparent for the end users.

In order to achieve this goal, there is a need to insure a complete convergence between the different networks (fixed, mobile, satellite, cable) and also to define how content providers will be

¹⁸ Big Data for Media. Martha L. Stone. Reuters Institute for the Study of Journalism.

¹⁹ 5G and M&E Whitepaper

able to configure the network according the specific requirement of an application (bandwidth, latency, security, ...)

Security and right management to support new media business models will evolve to protect creators and right holders and ensure the sustainability of the markets.

Network extension could be easily setup in order to cover specific events using drones or other technologies, it will be a very important trends for Media which can take advantage of these new capacities.

Autonomous cars, trains, planes, are also trends that media should look at because it will be a new media environments where users will have time and possibilities to consume media and content.

5G Technology

For the network operator, there are several technology trends that have to be taken into account for the next decade

One of them is the development of the next 5G network which will not only provide more bandwidth and lower latency but also better convergence between networks (fixed and mobile) and also new possibility to configure the network according to the applications needs (SDN/NFV).

Another big challenge will deal with user content/data privacy because nowadays people are reluctant to put confidential data in the cloud, we will need to work on data placement and also synchronization in order to offer to end user standard ways to store content (at home, in the cloud, in device, ...).

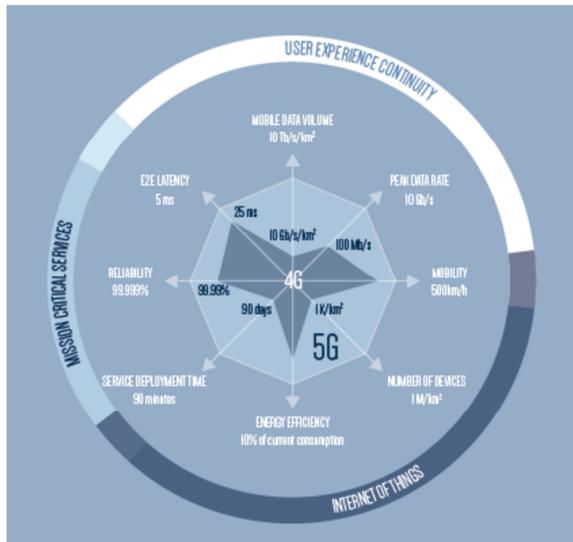
5G will not only be an evolution of mobile broadband networks. It will bring new unique network and service capabilities. Firstly, it will ensure user experience continuity in challenging situations such as high mobility (e.g. in trains), very dense or sparsely populated areas, and journeys covered by heterogeneous technologies. In addition, 5G will be a key enabler for the Internet of Things by providing a platform to connect a massive number of sensors, rendering devices and actuators with stringent energy and transmission constraints. Furthermore, mission critical services requiring very high reliability, global coverage and/or very low latency, which are up to now handled by specific networks, typically public safety, will become natively supported by the 5G infrastructure.

5G will integrate networking, computing and storage resources into one programmable and unified infrastructure. This unification will allow for an optimized and more dynamic usage of all distributed resources, and the convergence of fixed, mobile and broadcast services. In addition, 5G will support multi tenancy models, enabling operators and other players to collaborate in new ways.

Leveraging on the characteristic of current cloud computing, 5G will push the single digital market further, paving the way for virtual pan European operators relying on nationwide infrastructures.

5G will be designed to be a sustainable and scalable technology. Firstly, the telecom industry will compensate tremendous usage growth by drastic energy consumption reduction and energy harvesting. In addition, cost reduction through human task automation and hardware optimization will enable sustainable business models for all ICT stakeholders.

Last but not least, 5G will create an ecosystem for technical and business innovation. Since network services will rely more and more on software, the creation and growth of startups in the sector will be encouraged. In addition, the 5G infrastructures will provide network solutions and involve vertical markets such as automotive, energy, food and agriculture, city management, government, healthcare, manufacturing, public transportation, and so forth.



The usage of voice services as they are today is decreasing, people preferring to use asynchronous ways for communication and there is a challenge to define new form of communication using for instance immersive technologies.

Internet Of Things is also one of the major trends, sensors and any devices will upload large amount of data that have to be transferred to network platforms able to put them at disposal to third party developers through standard APIs.

The use of second screens or companion devices or applications is trending in today's broadcasting industry, where new display options, such as tablets and smartphones, are revolutionizing the way businesses think about digital media.

A second screen allows displaying extra information, could enable real-time chat about visual broadcasts, such as news or current event broadcasts. Second screens also can help shape how businesses reach customers, and how consumers use state-of-the-art technologies in an increasingly digital world.

The use of second-screen broadcasts also coexists with the emergence of portable data delivery through cloud-based software systems, along with other ways of getting content over wireless platforms directly to a customer's device.

Immersive technologies

While Augmented Reality (AR) and Virtual Reality (VR) technology used to conjure up images of sci-fi films, these days the trend is visible in everyday life. Marketers are using the technology more and more: Jaguar Land Rover's Virtual Experience allowed customers to engage and interact with an almost life-size high resolution of any Jaguar or Land Rover vehicle. Users can take a 360 degree interior and exterior view, even opening doors and starting the ignition. Google Cardboard, a VR platform developed by Google for use with a fold-out mount for a mobile phone, has partnered with a variety of companies such as Volvo, who allow users to test-drive a range of their cars with the app. Healthcare is also one of the most important and practical applications of AR technologies.

AccuVein's Vinny Luciano said 40% of IVs miss the vein on the first stick, with the numbers getting worse for children and the elderly. Accuvein uses augmented reality by using a handheld scanner that projects over skin and shows nurses and doctors where veins are in the patients' bodies. Luciano estimates that it's been used on more than 10 million patients, making finding a vein on the first stick 3.5x more likely. What's more, many people who are blind have some remaining vision. Stephen Hicks, researcher and founder of VA-ST, has created a visor that creates stencil outlines around a person's face or buildings in order to help those with some remaining vision to improve their vision. The company won the 2014 Google Impact Challenge and are potentially set to be on the market in 2016.



III-2 Content processing

Crown Content: There will be a duality of proprietary (whether private or commercial) and open content. Classifying, annotating and fusing open content will remain to be an open question during the next decade.

- Shorter term: Fusion of audiovisual crown content like creating multiview videos from single view videos from several users (e.g. videos of events like natural phenomena or locations like summits reached by hill climbers).
- Longer term: Automatic extraction of meta-information and representation of content in a form suitable for content fusion (a general content representation architecture).

Object-based representation, coding and rendering. Sound & Vision representations are on their way to change: Object-based and wavefield coding is already finding its way into standards and systems (MPEG-H, AC-4), Video will follow with lightfield capturing, coding and rendering and subsequently representing and coding single visual objects.

- Shorter term: Lightfield capturing, processing, coding and rendering.
- Longer term. Object-based video coding.

Lowest delay capture to photon video delivery. For many applications (augmented reality, interactive applications, tactile internet) lowest delay capture to photon (down to 1 ms) is required.

- Shorter Term: Lowest delay video coding based on HW-supported integrated texture coding, low delay high bandwidth wireless local transmission

- Longer Term: Dynamic, adaptive Lowest delay lightfield coding and transmission

The content production value network will dramatically change. Virtual studios and immersive sensing technologies enable the capture of sound wavefields and lightfields that by far exceed the required information. Post-production and Digital Sound & Vision Effects are significantly eased and in some facets can be done real-time during production.

- Shorter term: “Early-post”: High quality on-set prost production in virtual studio environments.
- Longer term: “A posteriori story telling”; other than in the past, where the story board has been the nucleus of content production and due to the enormous costs content production had to be limited to the required minimum, for many stories there will be a cornucopia of available material, so that story-telling can use pre-processed or crowd content.

High quality cross-infrastructure IP-delivery of mobile, broadcast and internet content. This will be a umbrella topic of the upcoming framework program, evolving more services (fixed line telephony has gone IP, cellular telephony with 4G is evolving towards full-IP) towards an everything-over-IP solution, separating the content from the infrastructure and being able to use the most efficient (whether technically or economically) infrastructure for a specific content.

- Shorter term: Merging broadcast to all-IP distribution in cable and satellite networks.
- Longer term: Dynamic broadcast, exploiting all infrastructures in a synergetic manner.

III-3 Distribution and display technology

Distribution is shifting away from over-the-air multicast technology towards internet distribution and 4G distribution across the mobile network. This is a trend that will continue, and that will have far-reaching consequences for both the producer of content and the recipient. This is not just about how the signal gets to the recipient – it is about how the recipient receives and consumes the content they want. Tablets can browse the web, display e-books or show TV or films, they can be a communication platform between friends and they can host games. Non-static TV sets are no longer the primary entertainment display device, and all devices have equal currency, thus content needs to be available anytime, anywhere, any device (ATAWAD) without the assumption of a primary display. This in turn will affect the style of content, the ability to access content, levels of personalisation, hyper-localisation, advertising and business models and cost of delivery per consumer. The take up of new display types will have a major impact on both content creation and consumer expectations. VR and AR displays will be used for consumption of both long-form and short-form content, but will also be used in other environments such as education, cultural experience, social interaction and game play, and these personal displays will be associated with portable receiver equipment, and thus by definition will be drawing material asynchronously from a very high bandwidth always on 4G+ connection.

We should not, therefore, underestimate the impact that changing and emerging display technology will have on the entire media landscape. It is for this reason that novel ways of using mobile and immersive technology and new forms of business model form one of the core strands of applied research in the media space.

III-4 Designing and maintaining security and privacy

Security can take many guises. There is the security around protecting IPR and commercial position, there is the security necessary to protect against cyber attack, there is the securing and protecting personal information relating to employees and customers and there is security in the form of preserving and maintaining content.

In the applied research space we are concerned with the unsolved issues around security, the underlying challenges and how they can be resolved using emerging or future technology. And we are interested in what new threats to security might emerge as technology evolves. We recognise that security needs to be designed in to any new system, and that it can no longer be a last-minute add-on to an existing design, but the tools to determine security risks and to identify how vulnerabilities can be managed are still research topics.

We should also consider preserving and maintaining assets as part of securing commercial position. As a wider and more complex range of content and formats is produced and distributed, whether that is by media production, digitised written word, images, games or art, so the challenges of recording, preserving and accessing this range of media content become more significant. Much effort has been expended in the past on digitising and storing media assets, providing an invaluable historical archive, but the continued usability of that archive is threatened by the rate of change of digital formats and the ability to adequately record newly generated content is hampered by the sheer scale of the quantity of material created and by the complexity contained within modern content production. How can an interactive, live broadcast be preserved? How can a visitor's interaction with a video art exhibit be incorporated into the archive record? The techniques and business models around these challenges need to be researched and resolved at least as quickly as the new media world is evolving.

III-5 Autonomy and automation

Different forms of robotics, automation and autonomous system is going to dominate our nearest future. First articles written by robot journalists have already been published and bot chats are entering new areas every day. Drones and autonomous vehicles are increasingly used. Whereas, the technology itself (artificial intelligence) would be of interest for other technology platforms, from the NEM industries perspective, one would need research on collaboration between humans and automation within media production and consumption. Particularly, concepts of trust, user experience and values have to be reconsidered. Research is needed on new ways of collaboration. For example, one should explore how robot journalists, human journalists and citizen journalists can collaborate in new production and how societal values are communicated to automated processes and tools. Which tasks should be done by humans and which should be automated? What are the consequences of increased automation for media industries? How to interact with autonomous systems?

III-6 Service provision innovation

Service provisioning is dominating our economy, and contributes to more than 2/3 of gross domestic products in industrialized economies. In the transition to a service economy we have witnessed an increased servitization of manufacturing firms, adding services to their products or presenting their products as part of service offerings.

The prevalence of Internet-based consumer devices has changed the way services are delivered and consumed, but also how they are managed, operated and supported in service companies. In this changing landscape, service research is becoming increasingly important. Enhanced service quality and service experiences are two research priorities that has been identified. These priorities have direct financial implications for service companies, as well as for the customers' perceived usefulness. Whereas service delivery and -consumption has traditionally been described as a dyadic interaction between a customer and a service provider, this is not reality of current services. A broad range of services, from delivering news to health and care systems, involve numerous actors, rely on outsourcing or user generated content. There is a need to expand the dyadic perspective towards a network perspective to account for the overall experience as seen from the end-user' perspective.

Visualizations are known to be cognitively efficient for disseminating knowledge among actors with different backgrounds. Customer journeys are one of the most used visualization techniques when designing services. However, further research is needed to explore the applicability and usefulness of frameworks based on customer journeys for a formalized description of service processes.

III-7 Enable bimanual interaction, natural walking interfaces, and whole-body involvement in VR

VR systems can be used in numerous applications such as: industry (virtual prototyping, assembly or maintenance operations, data visualization), entertainment (video games, theme parks), arts and design (interactive sketching or sculpture, CAD, architectural mock-ups), education and science (physical simulations, virtual classrooms), or medicine (surgical training, rehabilitation systems). A major change that we foresee in the next decade concerning the field of Virtual Reality relates to the emergence of new paradigms of interaction (input/output) with Virtual Environments (VE). As for today, the most common way to interact with 3D content still remains by measuring user's motor activity, i.e., his/her gestures and physical motions when manipulating different kinds of input device. However, a recent trend consists in soliciting more movements and more physical engagement of the body of the user. We can notably stress the emergence of bimanual interaction, natural walking interfaces, and whole-body involvement. These new interaction schemes bring a new level of complexity in terms of generic physical simulation of potential interactions between the virtual body and the virtual surrounding, and a challenging "trade-off" between performance and realism. Moreover, research is also needed to characterize the influence of these new sensory cues on the resulting feelings of "presence" and immersion of the user. Another challenge is to work on collaborative interaction in order to enable an efficient collaboration between operators immersed in a single virtual environment from remote locations and with heterogeneous equipment.

III-8 Maturation and enhancements of Brain-Computer Interfaces

Besides, a novel kind of user input has recently appeared in the field of virtual reality: the user's mental activity, which can be measured by means of a "Brain-Computer Interface" (BCI). Brain-Computer Interfaces are communication systems which measure user's electrical cerebral activity and translate it, in real-time, into an exploitable command. BCIs introduce a new way of interacting

“by thought” with virtual environments. However, current BCI can only extract a small amount of mental states and hence a small number of mental commands. Thus, research is still needed here to extend the capacities of BCI, and to better exploit the few available mental states in virtual environments. It is also necessary to make BCI more robust, and with shorter user and machine training/calibration times.

III-9 Augmented Reality for Inquiry-Based Sciences Education

We also explore AR, notably for education. The challenges are designing an AR environment according to Inquiry-Based Sciences Education (IBSE) principles that requires pupils to experiment by interacting with and physically manipulating the content to be learnt and understood (e.g., planets to learn astronomy). Thus, we aim at combining enhanced display possibilities of AR with physical manipulations of tangible markers to didactical principles. Another opportunity is Spatial Augmented Reality (SAR) which consists of projecting directly in physical space information coming from the digital world. Beyond conventional display methods based on screens or planar projections, this approach opens new perspectives for future applications in areas as diverse as aircraft maintenance or scientific mediation. However, even though inherent problems of computer vision and computer graphics are being solved today, the problems related to interaction remain largely unexplored. The characteristics of the used medium challenge the traditional approaches, and new techniques must be explored. There thus a new to focus on the design, implementation and evaluation of these new interaction paradigms.

III-10 Challenges in evaluating human-computer interactions (HCI) and immersive content and technology

Finally, an interesting challenge is also to evaluate human-computer interactions (HCI) and immersive content. Recently, physiological computing has been shown to be a promising companion to Human-Computer Interfaces (HCI) in general, and to 3D User Interfaces (3DUI) in particular, in several directions. Among them, we are first interested in using various physiological signals, and notably brain signals, as a new tool to assess objectively the ergonomic quality of a given 3DUI, to identify where and when are the pros and cons of this interface, based on the user’s mental state during interaction. For instance, estimating the user’s mental workload during interaction can give insights about where and when the interface is cognitively difficult to use. This could be useful for 2D HCI in general, and even more for 3DUI. Indeed, in a 3DUI, the user perception of the 3D scene – part of which could potentially be measured in EEG, is essential. Moreover, the usual need for a mapping between the user inputs and the corresponding actions on 3D objects make 3DUI and interaction techniques more difficult to assess and to design. Beyond evaluation alone, physiological computing could also improve existing 3DUI by increasing the symbiosis between the user and the interface, e.g., for visualization and analysis of large amounts of (3D) data.

IV How the sector will look like beyond 2020

"Marketing and customer relations will be automated within 5 years through smart data produced by connected objects"

"Communication agencies will be uber-ised within 5 years thanks to the emergence of dedicated marketplaces and the freelancer community"

"Marketing automation is going down to the very small SMB level with solutions accessible for all"

"The hyper-local and social data is a land of conquest still to be cultivated, Facebook is well placed to take this position"

"The consumer will drive their data through their consumer profile as they are now used to driving their profiles on their smartphone"

IV-1 Book Publishing

Digital will be an important part of the business, but most likely not predominant, certainly not for the near to mid-future. It's hard to make predictions, but the digital share of the market may stabilise anywhere between 10 and 30%, still a business worth several billion € just in Europe.

Technology will allow creating increasingly enhanced and interactive e-books, possibly exploiting the opportunities of the IoT in certain sectors; augmented reality could be one a relevant feature of future books, and gamification will play an important role. Social reading will be increasingly significant.

Most likely people will read e-books on tablets and smartphones, with dedicated eReaders maintaining a small part of the market or maybe almost disappearing.

The increasing digitisation of education will boost the creation of digital learning environments, with a high degree of personalisation.

IV-2 Broadcasting services

In five years:

High-quality content (education, news etc.) available on new kinds of devices, e.g. immersive experiences that extend natural history programmes into a VR game-like world.

Traditional "linear" TV still plays a major role, but is easier to discover (thanks to richer metadata about programmes, making them discoverable via, for example, social media platforms that "know" about your interests) and is increasingly consumed over IP (both live and on-demand).

Content is atomised, personalised, immersive, adaptable.

In ten years:

Users' demands of content are ubiquitous so the same content can be re-purposed.

Traditional "linear" TV still exists, but programme content is more often seen in small parts, delivered as required to a diverse range of devices to enhance related experiences.

Linear programmes can transcend the boundaries of individual devices with production processes adapting cost effectively.

Experiences can be shared across any format and location.

Experiences can be shaped to the context of audiences.

Machine produced reversions, automated workflows based on user demand, diverse content from many genres pulled together in personal ways.

IV-3 Music

In 2020, music consumption will be associated to big streaming platforms while new connectivity and network capacity will enable new consumption experience.

Immersive systems including 3D audio will allow an improved music experience and to recreate the magic of live music even at home. Selecting specific instruments, moving around orchestras and concerts, mixing different players and scenarios to customize music affinity will enrich the capabilities of today.

Targeted music for different activities gathered in channels i.e jogging, relaxing, or pre-selected from user profiling and daily activities schedule

3D printing will be the main tool for music manufacture. The process of 3D printing still feels relatively new, but in only a few short years, this means of manufacture has leapt a terrifying distance.

IV-4 Multimedia

In 2020, it is sure that the content digitalization of content will be quasi definitive and the digital technologies mastering will be key for content creators. New devices (that we don't know today) will be deployed in conjunction with a lot of cooperative objects that will interwork with the end user and the content. Immersivity of content will be a must for multimedia. Cross fertilization of contents will be possible via digitalization. Cyber security of access to content will continue to be a key factor for end user and content creators.

We are not sure that the key players of today in content creation will not be replaced by digital players (GAFA...) with a clear risk for Europe to lose its creativity.

IV-5 Advertising

New storytelling and branding experience will promote the engagement of users. Even VR/AR will allow experiencing new products and services to push purchasing.

Improved user profiling via implicit behavioral analysis will improve the knowledge of final users and targeting, then ROI. Social media interaction will be used by means of big data analysis to improve the "just-in-time" offers.

Multi-access through different platforms will not be longer a problem as more accurate user identification through deep analysis will allow recognizing the end user at the end of the chain, even out of logged environments.

Respectability, trustworthiness, loyalty... will become the main objectives of branding trough advertisement, even joined by an alliance with other partners.

IV-6 Gaming

Big on-line collaborative and immersive gaming that can be held in different devices, even if the way the game is played need to be adapted, customizable roles and characters, free-to-play besides special packets purchasing.

Wearable elements integrated in gaming experience to expand the gaming landscape out of the houses and to integrate interaction with city elements (through IoT and AR) as part of the storyline will provide a complete new experience and will boost creativity. Even educational series for civility, inclusion and inter-cultural knowledge can benefit from gamification.

The establishment of sandbox games as a powerful tools for use in the classroom, by scientifically grounding authoring principles of sandbox-game content and empowering teachers to utilize digital gaming technology for learning in classroom environments will reinforce gaming positioning out of entertainment.

IV-7 Fashion

Fashion should provide an answer to consumption pattern gaps. Consumers are increasingly adopting a “buy now, wear now” mentality, though according to the current fashion calendar, merchandise is typically sold ahead of each season.

Demand for on-trend and in-season products accounts for the explosive growth of fast-fashion retailers—growth outpacing that of specialty retail stores. Vertically-integrated retailers will speed-up product manufacturing in short cycle times, expediting the delivery of designs from the runway to stores. Wholesalers and department stores are increasingly adopting vertical brand strategies to meet consumer demand for on-trend and in-season product.

Consumers will provide more input into the design process. Designers will adopt crowd-sourced collections, and shoppers will be able to customize their purchases in a variety of ways. Fashion trends will be covered on easily-accessible new media outlets and shared on social networks.

Consumers form opinions and make decisions about fashion using input from a wide variety of sources, necessitating innovative and diverse marketing strategies. Challenging the editorial voice of traditional print outlets, new media and social networks are reshaping fashion media. Growing online coverage of the industry means that consumers can form opinions and make purchase decisions using input from a wide variety of sources. In fact, consumers increasingly trust reviews, blogs and social networking more than traditional media.

Footwear and dresses will be designed, customized and even printed in 3D directly from customers, opening a new manufacturing model in parallel with the classic fashion model of nowadays.

IV-8 Cultural heritage

The future of cultural heritage will be built around the creation of a personalized, immersive, interactive ways to enhance our understanding of the world around us, adopting digital media for engagement, participation and inclusion.

Future will bring the development of complete systems for changing the way citizens perceive Cultural Heritage by means of the creation of a framework of both methodologies and technologies (innovative ways to access cultural contents, organise data on cultural assets) that will result in an immersive platform to re-contextualize cultural heritage. This re-contextualization of the elements will take into account aspects like original location, creation circumstances, ownership throughout time, historical background, etc. All this information will be presented to the user by means of a “virtual cultural book” with the support of advanced virtual reality, 3D reconstructions and augmented reality technologies, and will endow the intended users with a wider understanding for cultural heritage interpretation.

Development of novel Augmented Reality applications for architectural overlaying of historical buildings and architectural historical evolution can recreate scenes from the past with an immersive user experience. Dynamic positioning techniques will be employed to endow outdoor visits with updated contents in architectural visits. Information gathered will be useful for the recommender engine to learn of user preferences.

Digitization, (online) globalisation and new media have offered many opportunities and challenges. It changed the way we connect, interact, participate and co-create and it caused or at least boosted social innovation. Now there is a growing need for ways to rethink both the museum as a cultural and social institution and the accompanying revenue models. We think of the museum as incubator, as the ethical mind in a broad discourse on meaning, purpose and information overload. By doing so, we will be able to build sustainable museums, personal and truly social museums. Museums that will not only safeguard our heritage, but make this heritage relevant on the long term for the community in which the museum co-exists. Aside from the museum itself, the museum of the near future will have a great influence on societal change, urban planning, cohesion in diversity, and ways to solve problems of inequality and the need for literacy. Therefore the identity, positioning and marketing of our museums need to go hand in hand with our efforts for stunning exhibits, authentic interpretation, enthusiastic crowd-sourcing, empathic outreach, inclusion, engagement...

IV-9 Design

Design and simulation advances getting closer to implementation will empower industry capacities and speed of reaction to improve competitiveness.

The integration of design and manufacturing including detailed modeling of manufacturing processes to enable joint optimization of design, manufacturing and organization will be the key in the near future.

Training will be integrated directly within the tools and workflow, and even organizational issues will be simulated (i.e. new business processes, market forecasting and factory planning). Even the characterization of materials for production will be part of the new functions provided.

Virtual reality for simulation-based learning tools will speed-up the future workers learning curve and will improve security.

Systems will be more transparent and understandable, and the representation of social and organizational processes across cultures will be accessible even to non-experts.

Problem-solving decision will be supported by methods to capture and catalogue implementations and developments issues through intelligent analysis and visual tools.

In parallel, the role of consumer and its relationship with industry will be completely different. Currently, the customer is usually located at the end of a product's lifecycle. However, by 2020 'crowdsourced design' will have become a serious method for product life cycles. That means the customer is very actively involved in product design or choice in variants. This way, producers capitalize on customer creativity and wisdom, which results in products that meet target audience requirements

IV-10 Education & Training

There is widespread consensus on the potential of digital technology to contribute to the modernisation of education, while at the same time it seems clear that technology alone is not enough to bring about the desired changes. In any case, much experimentation is going on in the educational sector, and the digitisation of schools and other educational institutions is progressing, though at an uneven pace. Infrastructural and skills deficiencies are among the main identified barriers to the process, along with a clear strategy and view about what is actually needed to modernise education.

However, a lot is happening in this field and educational publishers are making huge investments in digital products and establishing cooperation with educational institutions across Europe. Positive experiences in this kind of collaboration can be replicated, especially if the underlying reasons are known; as research can shed light on those reasons, publishers are interested in working with research institutions to carry out studies on the effects of the implementation of specific pedagogies, products and learning environments.

As the use of digital materials keeps growing in schools, these become an ever increasing part of educational publishers' business; at the same time, many pure technology players are entering the field of digital education. Teachers use digital materials from a variety of sources, but mainly from educational publishers, which are investing strongly in innovation.

Digital learning materials can be particularly effective tools for teachers to offer students efficient personalisation and customisation of education. Teachers can enhance their roles as coaches of the educational process, giving students more motivation and aligning teaching methods to the students' individual needs and capabilities. Given that the deployment of ICT is rarely equally effective for all students (and in some cases can even be counterproductive), educational publishers offer a very diverse range of digital learning materials, to make learning processes more attractive, efficient and effective.

In order to increase the students' motivation, for example, learning materials can be presented in a way that resonates and connects with the current generation of students, shows them the progress of their performances or adjusts the course material to their individual preferences. Digital learning materials can help teachers save time in monitoring and comparing the students' learning performances and adapting the teaching process to performance levels, identifying strengths and weaknesses. In addition, learning materials can automatically adjust instructions and tests to the students' individual levels, in order to improve the learning results through tailored pedagogies.

Modern learning materials of educational publishers offer more and more possibilities to align learning contents, learning processes and students. Adaptive learning still has a lot of potential for growth, via several functions, such as: making recommendations for theoretical modules and exercises based on the students' progress; adjusting the presentation of learning materials to the

students' preferences; enabling students and teachers to connect and add materials; providing students with insights into the difficulties encountered by individual students and their relative performances; and many more.

For ICT to realise its full potential, the introduction of digital learning materials alone is not enough. All stakeholders involved (teachers, schools, publishers, etc.) need to work together to ensure that ICT and digital materials are properly embedded in a pedagogic strategy, that teachers have the required skills and confidence and that the technological infrastructure (including hardware and connectivity) allows a smooth and safe use of digital learning materials.

Besides using digital learning materials and student monitoring systems, schools want to retain the freedom to choose the materials and administrative systems that better suit their pedagogic visions and educational processes, including when these come from different suppliers. It is thus vital that those materials and systems are able to combine and exchange data. Publishers support this view and have engaged in research into technical standards to enable the possibility to exchange data, i.e. interoperability. More research is needed into how technology can be deployed successfully and what level of content descriptions can contribute to providing an adequate level of flexibility in practice. The ability to combine various content sources can also introduce excessive levels of complexity, so that again, more experiments are needed, also in the field of metadata.

As the use of student data makes it possible to exploit the full potential of digital learning materials for offering personalisation to students and supporting teachers in increasing their efficiency and effectiveness, it is essential that such data are used carefully and transparently. Research can help develop ways of further improve the privacy guarantees related to the use of digital learning materials (for example in areas like anonymisation and pseudonymisation) while at the same time not stifling the potential of adaptive learning.

IV-11 User and social engagement and collaboration

Using personalization and customer journey analytics technologies to enrich customers' experiences will be key in the future customer journey and experience.

Social media will move ahead of user-company communications. Social media's role in the complete customer journey will be better positioned to enable transactions over social channels, or facilitate the customer journey from social media to other traditional or digital channels.

Sales organizations will rely primarily on mobile digital technology for their sales force. The types of devices and nature of application will greatly expand to support processes and real-time communication. These strategies must move toward a multichannel approach to encompass and take advantage of concepts, such as the Internet of Things.

Stores and brands will increasingly collect customer data in 2020. They generate detailed profiles based on purchases in the past and data submitted by the customer. Moreover, owing to the Internet of Things they can learn important lessons about consumer behavior. Products will be equipped with more sensors than ever before, generating knowledge on which features are successful and which ones are not. They can also advise individual customers about timely replacements.

IV-12 Novel storytelling techniques

Next generation storytelling will empower user to new limits. User experience and reactions with brands will form part of the brand image. Storytelling will be dynamic. This means the development of incremental elements will be continuously added to the brand idea. And they will be delivered through different communication channels for the purpose of creating unified and coordinated brand experience. The excellence of the content will be built upon a strict curation of the content (avoiding noise). For this, new capacities need to be addressed as serial, multi-faceted, spreadable, immersion and discovery storytelling, all together for the targeted objective, the user engagement.

IV-13 IoT integrated environment

Internet of Things will be integrated in almost any sector or service. Sensing capabilities will be present in any aspect of daily live collecting valuable info and feeding prediction and personalization algorithms.

The information processed under Big Data schemas will take autonomous systems to next level: driving, energy efficiency, climate control, logistics ... will benefit from the real-time data acquisition. Tourism offers, customizable manufacturing, content curation will exploit the knowledge of user profiles and past implicit experience of users to reach a quasi-perfect personalization.

Medical diagnosis and assistance, education and skill training will also exploit the new capabilities, many of them through wearables, for improving the quality of life and the results of their activities.

IV-14 Digital society - Impact of new media on lifestyle

Main point envisioned for the evolved digital society are here collected as bulletpoints.

- Digital identity for every person, company, brand, service, and object
- All is traceable and trackable
- Technology will be pervasive (but non-intrusive)
- Direct relationship for every transaction
- Most everything is real time
- Predictive, with an ecosystem that anticipates and responds to its environment behind powerful analysis systems
- Objects communicate with each other without humans and act independently
- Distributed intelligence enables self sufficiency
- Experiences will be hyper-personalized
- Analog and digital world merge, with seamless experiences across both
- Everything can access everything else remotely
- Sharing becomes predominant mode of use

V- Research topics

NEM analyzed the last NEM SRIA 2014, compared it with current and future call programmes of Horizon2020 and identified new challenges via a qualitative survey amongst NEM members by mid-February 2016. These topics were listed in a survey comprising 109 topics grouped in 23 chapters which was distributed amongst NEM members, following the NEM General Assembly in mid-March. 37 NEM members took part, each had 5 points to distribute amongst the overall 109 topics (for the outcome of this survey please see the excel list attached). The priorities that were voted for most constitute this NEM priority list ranking: The NEM editing group has selected the topic chapters which got more than 4 points, 16 of them are listed below in document.

V-1 Priorities

Following the update of the NEM Strategic Research and Innovation Agenda (SRIA) in 2016, it has been decided to extract the most important research domains and objectives that have to be pushed in the next WP2018-2020, completely in line with the priorities elaborated in April 2016.

The NEM ETP members are supporting the following list of priorities:

1. Content distribution
2. Hyper-personalization
3. Immersivity
4. Media analytics
5. Professional media workflow
6. Secure and trustable content - Block chain

These topics target technical/technological trends rather than following market trends. They are shared by several of previously identified sector trends (SRIA Section II). SRIA aims at boosting the potential impact and providing a better overview of the NEM community.

Content distribution integrates all the new trends on the evolution of networks and the provisioning of media services. These include the increased capacity of the actual networks, the potential impact of 5G networks for new business models, the increasingly convergence of “hybrid” services built upon the combination of different networks. The convergence between broadcast, multicast and unicast as well as the potential of SDN networks should be a tremendous opportunity for the media and content industry.

Hyper-personalization will consider the different aspects of maximizing opportunities to customize content to consistently target the right audience throughout the customer lifecycle. Thus it will create meaningful connections and drive engagement among audience. It can be applied to most of the media markets we have compiled. It also encompasses the ATAWAD (any time, anywhere, any device) concept which provide to the end user the best format according to the device used.

Immersivity should take advantage of all the great work done for the I2C PPP proposal. It is very likely to be one of key drivers of media in the upcoming years to reshape the way contents and

services are provided and the user interaction is completely renewed. There are a lot of technical topics along the value chain involved, so it can integrate many NEM actors as well. It should encompass the following activities already described in the I²C PP proposal: Storytelling Creation for I2C, Mixed Content Immersive Technology, Content Generation Tools for I2C, Science, Technology and Arts in Immersive and Interactive Media.

Media analytics will cover the media analytics tools for Big Data and Social Media, positioning media as a core sector for Big Data technologies including the social media. It will also address media search engines which is a potential open field for the European industry.

Professional media workflow to address migration, virtualization, co-creation... aligned with production core technologies. Digital cinema, as well as professional content provider workflows have to deeply evaluate new technologies in order to take advantage of them but also to fit the end-user needs who expect more and more personalised content. As a consequence, the producing environment has to be rethought as well as all the tools used by professional content providers.

Secure and trustable content - Block chain seems to be promising for DRM and micro payment between users according to recent experiences and publications. This new technology is still very new but seems to have the potential to fix issues that we have not yet solved. A consistent DRM is still expected from end users and for content providers, and as block chain technology is a contract between two entities without any central point, it seems very promising. In the same way, users are increasingly used to creating content with their mobile and are also interested in selling it, micropayment is the solution and the block chain technology could facilitate one to one payment.

V-2 Enabling technologies

- Content Generation
 - Immersive Content formats for both video and audio
 - Augmented Reality
 - New formats: 3D Virtual/augmented reality using new devices (glasses, 3D Screen, windscreen display, ...) see Appendix A
 - From focussed program on I²C initiative
 - Content Generation Tools for I2C
 - Robotic camera teams see Appendix A
 - Control interfaces and tools
 - Content Generation – Appendix B1
 - Content Generation Tools – Appendix B2
 - Capture & Rendering – Appendix B9

- Content Analysis
 - Media and Usage Data analytics in order to propose better service personalisation and recommendation.
 - New ways of interaction in complex working environments
 - Content data analytics – Appendix B10
 - Content sharing – Appendix B11

- Content Distribution & Processing
 - Content delivery – Anytime, Anywhere, Any Device (ATAWAD) see Appendix A
 - From focussed program on I²C initiative
 - Mixed content Immersive Technology
 - Networking aspects: wireless broadband technologies for generation, processing and analysis see Appendix A
 - Distribution processing – Appendix B4
 - Applications and services supporting creative industries – Appendix B6
 - Content sharing – Appendix B11
 - Media Convergence – Appendix B12
 - Devices – Appendix B13
 - Content delivery – Appendix B14
 - Content delivery convergence – Appendix B15

- Content Visualisation & Interaction
 - Media orchestration – (tools for) managing multiple, heterogeneous devices over multiple, heterogeneous networks, to create interactive and immersive experiences. Use cases in Appendix A
 - Augmented Reality
 - New ways of interaction in complex working environments
 - New formats: 3D Virtual/augmented reality using new devices (glasses, 3D Screen, windscreen display, ...) see Appendix A
 - From focussed program on I²C initiative
 - Mixed content Immersive Technology
 - Media Convergence – Appendix B12
 - Devices – Appendix B13
 - Content delivery – Appendix B20

- Content Protection & Rights Management
 - Secure and trustable content
 - Digital Rights Management and content protection, in particular, with the development of user-friendly systems that offer protection without hampering the user experience while at the same time communicating clearly all the relevant information
 - Automated expression of rights (digital rights information management), machine-readable, in order to facilitate identification, negotiations and transactions concerning protected digital works
 - Digital Rights Management (DRM) interoperability across value chain (or standard solution)
 - Applications and services supporting creative industries – Appendix B6
 - Content sharing – Appendix B11
 - Digital Rights Management – Appendix B16

V-3 User aspects

- Interaction
 - Engagement and crowdsourcing
 - Users as prosumers and creators/contributors

Content is increasingly being created by those who are 'prosumers' - producers and consumers of content - are sharing with friends and family via YouTube, Facebook and other social media channels, but are also contributing to professionally produced and distributed content such as news and documentary features. New techniques, business models and copyright approaches are needed in order to respond to this trend.
 - Crowdsourcing

Currently, crowdsourcing is a factor in self-publishing and crowd-funding of books, but can be expected to extend further in the future to encompass many other media-based content creation activities. New business models are needed to account for an advertising-free publication model at a time when acceptability of non-professional and user-generated content is growing.
 - User engagement
 - Content discovery is a challenge that needs to be addressed as the volume of content grows exponentially
 - New ways of engaging the online generation in created content need to be developed and effective business models proposed to support and add value to everyday media consumption in entertainment, gaming, cultural experience, news consumption, drama etc.
 - New routes for engagement through enhanced user interfaces and produced content that utilises multi-sensory engagement through visual and audio immersion, haptic interaction and heightened sense of presence
 - Social media and engagement with each other (social sharing) and with the content creator
 - Integration of social media with more traditional content delivery, leading to shared and participative activities within media content.
 - Incorporation of social media interaction into story-lines and as part of dynamic real-time productions
 - Direct communication between media creator and consumers via social media for feedback, audience tracking and analysis and content shaping.

- Communities can be engaged through social media based contact aimed at defined social groups who can engage with each other and share information and thoughts within the context of a piece of narrative or informational content based around shared activities or interests
- Cultural activities, learning activities, tourism experiences, local knowledge can be orchestrated and shared through common platforms connecting people via social media.
- Issues of privacy and security will need to be addressed in the context of social media, with understandable controls given to the users as well as protection given to the content and copyright owners.
- Multi-lingual and translation services will be needed to enable people of different cultures and nationalities to share and interact across Europe
- Human-machine interaction
 - Many types of human-machine interaction will be developed in the near future, allowing consumers a wider range of activities and a broader spectrum of experiences that can be gained from their engagement with media.
 - Intelligent online applications
 - Agents
 - Avatars and robots
 - Haptic sensors
 - Brain Computer Interface (BCI)
 - Enhanced Sense of Presence (ESP)
 - Sensing and Monitoring
 - Quality of Experience
 - Audience monitoring and analysis
- Personalization
 - storytelling
 - social vs. individual, community
 - Personalisation of content
 - Access anytime, anywhere, any device
 - Immersive and AR: how it changes viewpoint of viewer/consumer, how it might be used/abused in the future
- Education, learning and training
 - Education and training, lifelong learning, information discovery

- Preserving content and experience for future generations
- Social implications of wider user engagement
 - Creating awareness of social issues and using nudges to foster behavioural change
 - Staying safe online, maintaining trust in what is delivered
 - Impact of other commercial applications from other fields (design, art, dramatic arts) and how they might be integrated into everyday life and experience

V-4 NEM transversal aspects

- Societal challenges: i.e. the cultural, societal and political aspects of the creative sector, and how ICT can support progress in this field (e.g. Big Data analytics vs. privacy, User Generated Content)
- NEM sectors: i.e. the different creative sectors and their potential synergies, such as fashion, film, design, publishing, broadcasting and games all have their own, specific innovation strategies, and also areas where these overlap - yet project calls do not yet focus on different creative sectors, but on the creative industries as a whole - which does not reflect reality (yet).
- NEM adjacent domains: i.e. domains in which NEM may bring forward its requirements and enabling technologies, providing a unique view on the challenges in that domain; 5G, Big Data, Cloud, Internet-of-Things, Smart City, ...
- NEM DSM: policy and regulation, business support, market take-up, economic growth, industry relevance, standardization...
- NEM Access: ICTs have provided a wide access to information and have become an important tool for accessibility to people with disabilities. According to data compiled by Eurostat, 45 million people aged between 15 and 64 reported a disability in 2011 in the European Union. New media should support the design for all concepts to provide with the most powerful user experience for everyone.
- Right management: The EU's involvement in sport-related media and intellectual property has wide-ranging implications for the economy and organisation of sport, a fact reflected in sections of the Treaty on the Functioning of the EU (notably under article 165) and the Charter of Fundamental Rights of the EU. Although EU rules on the internal market and competition do not specifically target sport, they can have an important impact on the way sport events are broadcast or transmitted over networks. Also in 2011, the Commission adopted a wide-ranging strategy on intellectual property rights in following up on the proposed actions of the Digital Agenda, and a Green Paper on the online distribution of audiovisual works was published.

Appendix A: Additional detail

1. New formats:

3D Virtual/augmented reality using new devices (glasses, 3D Screen, windscreen display, ...)

A variety of emerging devices open the opportunity for holographic content, i.e. true 3D volumetric media:

- Virtual reality headsets, which currently are positioned for VR gaming and 360-degree video, but evolving in the next generation towards consumption of Free Viewpoint video. Genres include all content types currently positioned for 360-degree video: (live) sports, musical performances, virtual tourism, educational content, adult content, fiction, news and documentaries, eSports video streams. UGC will constitute the second wave of content, in the form of short video clips in a social media context of messaging and sharing and live streams shared on social media platforms
- Augmented reality headsets offering for instance life size representations of performing artists in the comfort of the living room (music, comedy, dance, adult, fashion shows, product demonstrations) and holographic communication (real-time conversations and holographic messaging and selfies)
- Handhelds (smartphones and tablets) with auto-stereoscopic multi-view capabilities will allow users to enjoy the cases described above when they are not in a position to don a VR/AR headset.
Challenges include
- Robust algorithms to create volumetric media from multiple cameras, stereo cameras, smartphones with multiple cameras and/or depth cameras, multiple robotics cameras (e.g. follow-me drones). Hybrid approaches combining local preprocessing and cloud-based synthesis. Calibration-free set-ups.
- Novel volumetric media representation formats, balancing compression processing requirements, compression efficiency, bandwidth and manipulation capabilities. (UGC holographic communication will require manipulation capabilities similar to current visual messaging like beautification, stickers and comments, backdrop changes, fun masks and transformations etc)
- Bandwidth efficient delivery to consumers of volumetric video. Streaming of the complete holographic video is bound to pose substantial bandwidth challenges. Research into novel networking solutions that stream personalized perception-based holographic video to users from CDN's, taking into account bandwidth, latency and cloud/local processing loads.

2. Robotic camera teams

- Usage of multiple robotized audio-visual capturing sensors for creation of multi-angle content for 'traditional' 2D screens and for creation of free-viewpoint video for consumption with VR and AR HMDs. Capturing modalities include visual, audio and depth (radar, sonar, lidar, time of light). Robotization includes ground-based tele-operated and autonomous vehicles and airborne drones and balloons

- Definition and implementation of capturing strategies for robotic camera teams that optimally use the available cameras to capture the actions/scene portions of maximal audience interest and/or ensure quality of the captured 3D models. Such strategies can take into account audio-visual analytics to detect salient events of interest, additional sensors (see further down) to detect events of interest, real-time viewer attention focus in the case of live transmissions
- Precise location technologies providing info on 6DOF for the capturing robots for purposes of 3D info synthesis and positioning and movement coordination
- Low latency networking technologies for high bandwidth media information, event detection signals and control channels for real-time capturing robot orchestration
- Predictive analytics for prepositioning capturing robots (trajectories of objects and people, human actions including movement and speech)
- Orchestration of dynamic positioning of robotized lighting modules
Control interfaces and tools for this, including
- Visualization of active/available capturing sensors, their modalities and coverage
- Possibly using VR/AR technologies
- Intuitive high-level abstractions to guide swarms of capturing robots

3. **Content delivery** – Anytime, Anywhere, Any Device (ATAWAD)

Future content consumption will happen on an increasing variety of devices (HD, 4K, 8K TV screens, smartphones, tablets, Virtual Reality and Augmented Reality headsets) in a variety of formats (2D, stereoscopic, multi-view, 360-degree, 180-degree, restricted free viewpoint, free viewpoint for VR and AR, with stereo sound and 3D sound). Viable content production and distribution platforms will depend on master files from which the required media format can be derived on demand, at reasonable processing cost and latency, in cloud CDNs. Content preparation for delivery to a specific device/user must take into account the device characteristics like media presentation capabilities and local processing power, bandwidth and latency conditions (including cost of those), user preferences and real-time interaction, transformation rules designed by authors at the moment of content creation and/or AI based transformation rules using media analytics, cloud processing capabilities and cost.

4. **Networking aspects:** wireless broadband technologies for generation, processing and analysis

- high-bandwidth audio-visual capturing (360-degree, free viewpoint)
- time synchronization between capturing devices
- low latency transfers for event detection signals and capturing robots control
- adaptive hybrid processing strategies, balancing local and (edge) cloud based processing for media synthesis and analytics

5. **Media orchestration** – (tools for) managing multiple, heterogeneous devices over multiple, heterogeneous networks, to create interactive and immersive experiences.

Use cases, development tools, orchestration platforms and device management platforms (media presentation devices and sensors) for a variety of scenarios:

- Synchronized parallel usage of multiple media presentation devices. Examples include multi-screen presentation (main + second screen, multiple handhelds for multi-angle, shared screen + personalized audio streams for commentary,

translations and social media readouts, VR/AR + haptic media control streams, shared/personal screens + environmental media like lighting control)

- Seamless sequential usage of heterogeneous media presentation devices over different networks. Example: 1) VR HMD with built-in headphones -> 2) Main TV screen + Bluetooth connected speaker set -> 3) peripheral kitchen screen + personal earbuds -> 4) audio-stream only + pushed highlight clips to smartwatch -> 5) video stream + speech-to-text on smartphone or AR headset.
- Opportunistic harnessing of available sensor devices for interactive features. Available sensors can include microphones and cameras in TV sets, tablets and smartphones, environmental home cameras and microphones (e.g. home surveillance cameras), microphones in speakers and virtual assistant home hubs, movement sensors in smartphones and wearable devices. Interactivity examples include voting by natural language interaction and gestures, content selection by natural language, gestures and pointing, ...
- Multi-user shared content consumption experiences, whereby users can be co-located or remote. For instance shared 360-degree video watching with possibility to point out areas of interest, be aware of focus of attention of other users.
- Combinations of the scenarios above

Appendix B Additional Research Topics

1	Content Generation
1.1	How much more effective can immersive content be to support the rehabilitation of individuals suffering with physical or mental illness. From the immediate therapeutic impact or transporting an individual who is geographically restricted, to the role that effective storytelling and creative content can play in guiding and teaching, through experience, those skills that support individuals in their recovery and longer term wellbeing.
1.2	<p>Includes creating content that is needed using existing technology to capture live-action cinematic content and the tools required to process that data and prepare it for use in an experience. Should include both large company and user-generated content.</p> <p>Includes Immersive Technology analysis of Big Data</p> <p>User testing of what content works/doesn't work including perception and cognitive studies to evaluate the impact on end users</p>
1.3	<ul style="list-style-type: none"> • Generation of interactive experiences through AR and 3D motion tracking placing digital content without QR codes or image markers. • Generation of additional content for augmenting, enriching and personalizing the media experience (e.g. by using companion devices)
1.4	CCG has expertise and competences in the development and advancement of accessibility solutions specifically for converging media and content, including technologies for subtitles, sign language, descriptive language, and automated graphical presentation of avatar character, automated translation and adaption, personalized setup in an accessibility scenario.
1.5	Natural Language processing technologies can be used to understand the user and create content in real time adapted to the interests of the user or the particular situation.
1.6	"A posteriori story telling"; other than in the past, where the story board has been the nucleus of content production and due to the enormous costs content production had to be limited to the required minimum, for many stories there will be a cornucopia of available material, so that story-telling can use pre-processed or crowd content.
1.7	Long form immersive content

2	Content Generation Tools
2.1	Self representation of the user in numerical world using avatars
2.2	<p>A platform which includes cost-effective tools created by other parties to be more easily used (either via open hooks or APIs) would accelerate and make such content much more efficient.</p> <p>A set of middleware hardware/software that allows companies/consumers to deliver content to various mainstream immersive tech in the future.</p> <p>If such middleware leads to the creation of a standardized workflow and/or format which will encourage the uptake of the technology then this should be supported. Possible common standards.</p> <p>Shared infrastructure for cross sector content development</p> <p>Tools should use Cloud Technology where appropriate to avoid local processing limitations.</p> <p>Automatic generation of content from data e.g. crowd sourced data</p>
2.3	<ul style="list-style-type: none"> • Creation of new platforms to develop immersive experiences and guided tours for cultural areas. This can be used as a tool for the analysis of Big Data which is a very useful way of getting information from users in order to improve these immersive experiences. • Creation of gamification tools to offer new ways of interaction to engage users in playful ways of discovering cultural contents.
2.4	<p>Development of tools for understanding real world scenarios and user properties in order to adapt the immersive content or the interaction approach for the singularities of every space where the content is to be consumed.</p> <p>CCG will contribute with an "Avatar Platform" that includes tools for accessibility content creation.</p>
2.5	<p>The use of a cloud infrastructure can be of help to accelerate the development in content generation, distribution and visualization, as it offers a pool of theoretically infinite resources that adapt on demand to resource intensive applications. However, the setup of the cloud infrastructure and services can be a difficult task for non experts. Thus, it is necessary to research on techniques that allow to efficiently automate the deployment of content generation tools for I2C within private and public infrastructures.</p> <p>Moreover, Natural Language Processing technology can be used to understand the topics that are being discussed in social networks. This information can be used as an input for the tools that generate content, in order to create contents adapted to the “trending topics” or to the interests of the targeted public.</p>

2.6	<ul style="list-style-type: none"> o Fusion of audiovisual crown content like creating multiview videos from single view videos from several users (e.g. videos of events like natural phenomena or locations like summits reached by hill climbers). o Automatic extraction of extrinsic and intrinsic meta-information and representation of content in a form suitable for content fusion (a general content representation architecture [CRA]).
2.7	Use of object based generation for new means of creation and varying stories
2.8	Alternative/complementary tools to fit all end users needs, such as multilanguage, multiculture, multiability (senior citizens) etc.
3	Science Tech Arts
3.1	<p>Organise high profile events with international outreach to showcase cutting edge examples immersive applications, involving industrial players, artists and engineers.</p> <p>Activity more focussed on creation of Narrative, Directing, Action, Writing and conceiving the story/setup required.</p>
3.2	<ul style="list-style-type: none"> • Tools to facilitate the interaction between artists and visitors through immersive experiences with different end viewing devices. This can make a real-time visit possible, including live comments and feedback between the artist and the audience. • It is necessary to foster new interdisciplinary collaborations between artists and technologists with business people to really reach market. • Technology enhanced registry of creative processes for more immersive user experience.
3.3	CCG will contribute to the development of "A Virtual Reality (VR) Museum Content Generation Tool with Avatar Guide" - a tool to present art content in a VR world.
3.4	To mirror EU social reality and inclusion policies: Pilot examples of good practise with multi-language, multi-disciplinary, multi-culture, multi-perception and multi-ability
4	Distribution Processing
4.1	Digital geometry processing: denoising, consolidation, registration, reconstruction, classification, matching, parameterization
4.2	Important for advertising industry. Application area education & active learning. News in

	<p>real-time.</p> <p>Activity would also include technology allowing of tracking of particular object types in either the CG or live content via machine-vision object recognition.</p>
4.3	<ul style="list-style-type: none"> • Performative arts should be included as an application area. • Although image is very powerful, audio should be also taken into consideration as well, to achieve more complete experiences. • Education is also another key area for this topic. • Coordination between heterogeneous consumption devices to create truly immersive and personalized experiences
4.4	<p>CCG proposes the development of "A Visual Analytics Platform" to support intelligent data visualization tasks (e.g. •Processing of large amount of 3D data into deliverable amount to end user, •Important for advertising industry. Application area education & active learning)</p>
4.5	<p>5G Networking technologies should be designed to allow users to enjoy Immersive Experiences that are generated in a remote place (e.g. in the cloud). It is necessary to study the particular requirements for this application, and to build communication networks with very low latency in which the interaction between the user and the system is almost immediate.</p> <p>Processing and semantic analysis of multimedia content by means of machine learning and computer vision techniques. Besides object detection and tracking, more complex scene analysis functionalities may be of interest: understanding interaction between objects appearing in the content, type of scene (indoor, outdoor, beach, building, office, etc.), actions undergone in the scene, affective cues, etc. Overall, the goal would be to provide a high level description of the content for efficient cataloguing and indexing.</p>
4.6	<ul style="list-style-type: none"> • Object-based representation, coding and rendering. Sound & Vision representations are on their way to change: Object-based and wavefield coding is already finding its way into standards and systems (MPEG-H, AC-4), Video will follow with lightfield capturing, coding and rendering and subsequently representing and coding single visual objects. <ul style="list-style-type: none"> o Shorter term: Lightfield capturing, processing, coding and rendering. o Longer term. Object-based video coding. • Lowest delay capture to photon video delivery. For many applications (augmented reality, interactive applications, tactile internet) lowest delay capture to photon (down to 1 ms) is required. <ul style="list-style-type: none"> o Shorter Term: Lowest delay video coding based on HW-supported integrated texture

	<p>coding, low delay high bandwidth wireless local transmission</p> <p>o Longer Term: Dynamic, adaptive Lowest delay lightfield coding and transmission</p>
4.7	<p>Access services, including alternative language tracks, in immersive content. Broadcasters are mandated to provide subtitles With a small extra-effort the same development could be an important arm to work towards media accessibility and inclusion.</p> <p>Some solutions will be directly applied to media accessibility.</p>
4.8	
5	Methods and tools
5.1	Methods and tools for service design and innovation in creative industries
5.2	User-centric research design
6	Apps and services
6.1	Applications and services supporting creative industries
6.2	<ul style="list-style-type: none"> • Support to develop new business models • Support heterogeneous (hybrid broadcast/broadband) distribution and media contents (multiple formats).
6.3	Across industries traditionally separated: videogames, advertisements, cinema, theatre, opera, university lectures, user generated
7	Implementations
7.1	Implementation of use case scenarios for particular creative sectors (film, advertising, etc. – not limited) and trials
7.2	It is necessary to create trials for platforms that provide interactive and immersive contents through a 5G communication network. Furthermore, it is important to consider as much as possible all the “profiles” involved in the value chain during trials and demonstrate that the technologies used are not lock solutions and can be applicable to different scenarios

7.3	Use case scenarios from a user-centric perspective
8	Technology
8.1	<ul style="list-style-type: none"> • This aspect is key for Europe’s R&D strategies in encouraging research that can reach the marketplace • This should also take into consideration promotion cherish and value of non-conventional Cultural Heritage such as ephemeral or intangible cultural heritage
8.2	New content design for educational programmes not only in schools but also to increase user awareness in different domains (ex. energy efficiency) or help in how to bring/use new technologies to some sectors less advanced in this aspect as agriculture, sea/water use,...
9	Capture Rendering
9.1	Human activity capture in ecological environments
9.2	<ul style="list-style-type: none"> • Cost-effective tools for 360° capture,3D reconstruction of objects and interior spaces. • Motion and gestures capturing
9.3	IoT protocols have to be adapted to provide more information about the context, and to create more immersive experiences.
9.4	<ul style="list-style-type: none"> o Shorter term: Lightfield capturing and rendering. o Longer term: Object-based video coding.
9.5	All IP. Cloud based production, including all the rights issues. IP studio technology should enable geographically dispersed teams, so that only a few people have to go the location shoot or the sports match
9.6	Automation for accessibility and its content production
10	Content Data Analytics
10.1	Content matching between the involved (heterogeneous or hybrid) media contents
10.2	CCG proposes the inclusion of pattern recognition and machine learning techniques to (1) learning users’ behaviors for supporting user’s stratification and content personalization;

	and (2) automate semantic scene understanding for content query and interaction.
10.3	<p>The value of content is, not only in the visualization itself, but in the analytics provided from the content. The content production can integrate different standards (ej xAPI) for the collection of data. When developing an authoring tool for AR or VR all life cycle of content production can take into account communication standards for data analytics tools.</p> <p>Natural Language Processing technologies allow users to interact with the system in a natural and comfortable manner in order to personalize their interaction with the contents</p> <p>Application of computer vision and machine learning techniques for efficient indexing and cataloguing of multimedia content, allowing for fast search and retrieval of specific targets.</p>
10.4	<p>Deep Learning: automatic understanding of human behaviour from image analysis</p> <p>Semantic Analysis: text understanding and information extraction</p> <p>Sentiment Analysis: opinion mining, mood detection, polarity classification</p> <p>User modelling: building up and modifying a conceptual understanding of the user, personalization, increase of the usability and accessibility of products and services</p>
Apps	
Computational engineering, urban modeling and planning	
Content production and adaptation for multi device scenarios	
Contents can be personalized or adapted according to the interaction with the user	