



**NETWORKED  
& ELECTRONIC  
MEDIA**

**Position Paper on Future Research Directions**  
**Opportunities for an Innovative Europe**

**2nd edition**

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*This NEM Position Paper represents a high-level view for themes that would be relevant for the upcoming EU Framework Programme 8. The document is a follow-up to the previous NEM Specific Research Agenda (as found at [www.nem-initiative.org](http://www.nem-initiative.org)). It also reflects NEM's vision for a future European Networked society. The position paper gives concrete indications on future research in the NEM domain. A list of research topics prioritised in line with comments and ideas expressed by the NEM community is given in the Annex to this document.*

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## Executive Summary

In this follow-up to the previous NEM Specific Research Agenda we consider the landscapes of future research and economy from the perspective of NEM, the European Technology Platform on Networked and Electronic Media. Starting with an analysis of the future societal and business opportunities in the wider IT sector, and taking into account Europe's cultural diversity, and its awareness of environmental issues and societal challenges, the document presents ten Actions considered necessary to achieve the goals of the NEM European Technology Platform – either to be promoted or to be implemented by NEM and its stakeholders:

### **Action 1 – Evolution from NEM value-chain to NEM innovation-chain:**

*Build EU Innovation Partnerships through NEM and our Innovation Catalysts; Education, Access to Finance and Broader Innovation.*

### **Action 2 – SME support:**

*Improve access to public funding and research programmes for innovative SMEs.*

### **Action 3 – Cross-sector innovation:**

*Proactively engage with the EU to build an Innovation Chain and Partnerships through connecting ETPs to build a systems approach to cross-sector innovation.*

### **Action 4 – Business opportunities:**

*Set up specific activities within NEM and seek specific research topics in the next work program addressing new business opportunities*

### **Action 5 – Market:**

*Develop a standardised micropayment service in order to offer customers and suppliers the possibility to monetise content exchange.*

### **Action 6 – Net neutrality:**

*Produce position papers to support regulators to take the right decisions.*

### **Action 7 – Acceptance of technology by society:**

*Hide technical complexity from the user so they can experience new innovative services without any technical knowledge.*

### **Action 8 – Link to Grand Societal Challenges:**

*NEM should lead think tanks on culture and edutainment and contribute to Energy savings as well as services for the ageing society.*

### **Action 9 – Regulatory aspects:**

*Develop pertinent research and position papers working on the fair balance between data protection and the business opportunities available with the advent of new IT services.*

### **Action 10 – New models for education:**

*Identify new educational programs for future NEM professionals, embedding innovation, creativity and international mobility in the new profiles.*

All-embracing Digital Inclusion is a must in order to overcome the digital divide and to turn Europe into the most advanced IT area world-wide. This is one of our grand societal challenges.

Clearly, new ecosystems and progressive education strategies have to go hand in hand with research and new business development by large, medium and small companies in the NEM field.

In 2011, the NEM Position Paper on Future Research Directions was updated and complemented with detailed recommendations for future ICT research topics in FP8 "Horizon 2020". The selection of topics is derived from a survey performed among all NEM members. The topics for which the NEM Community sees a specifically high importance in FP8 are:

#### **Media-related applications and business models**

Social Networking and Media Sharing

User Satisfaction and Quality of Experience

#### **Content Creation**

New Forms of Content

Representation of Content

Tools for content creation and manipulation

#### **Networking and delivery infrastructure**

Intelligent Delivery

#### **Content search and media presentation**

User-system interaction

Authentic, true-to-original media reproduction including Virtual Reality

#### **Technology drivers and enabling technologies**

Data security and personal privacy

Identity management and AAA (authentication, authorisation and accounting)

Personalisation/profiling: Smart user profiles across all services & devices

Power management technologies – energy saving in/by ICT

Machine-Machine Communication

A detailed description of all relevant NEM research areas for FP8 can be found in the newly added Chapter V of this document. An exhaustive list of all relevant NEM research areas for FP8 is given in Annex A.

The NEM stakeholders and authors of this Position Paper are firmly convinced that public initiatives, such as the European Commission's ICT Framework Programmes, form a powerful and effective instrument to profoundly foster European research, development, and innovation activities while accounting for the bigger picture of sustainable growth and societal challenges.

## List of Contents

<b>List of Contents</b> .....	<b>4</b>
<b>Foreword</b> .....	<b>6</b>
<b>I. Where will we go? Where are the opportunities?</b> .....	<b>6</b>
Connected Society .....	6
Knowledge Society and content availability .....	7
User interfaces and immersive experiences .....	7
User and usage data .....	7
<b>II. Europe: Where are our strengths? Diversity as an asset</b> .....	<b>8</b>
Diversity of cultures their heritages and languages.....	8
Large archives/collections of highest quality content.....	8
Common societal mind-set.....	8
Collaboration has a long-standing tradition .....	8
High level of education (schools, universities, research centres, training of skilled personnel) .....	9
Awareness of environmental issues and societal challenges.....	9
Pursuit of sustainable approaches .....	9
Europe provides the legal framework for efficient exploitation of these assets .....	9
Intensified international cooperation to increase significance of European technologies and standards in the world.....	9
<b>III. Innovation Ecosystem and Innovation Partnership</b> .....	<b>9</b>
Innovation Partnership: From NEM value-chain to NEM innovation-chain.....	9
SME support and improved targets .....	10
Proactively engaging with the EU to build Innovation Chains and Partnerships.....	10
<b>IV. Market, societal challenges, education</b> .....	<b>10</b>
Market and business opportunities .....	10
Societal Challenges .....	11
Education .....	13
<b>V. Detailed recommendations for future research topics in FP8 ICT</b> .....	<b>13</b>
V.1 Media-related applications and business models.....	14
V.1.1 Social Networking and Media Sharing .....	14
V.1.2 User Satisfaction and Quality of Experience.....	15
V.2 Content Creation .....	16
V.2.1 New Forms of Content .....	16
V.2.2 Representation of Content.....	16
V.2.3 Tools for content creation and manipulation .....	17
V.3 Networking and delivery infrastructure.....	17
V.3.1 Intelligent Delivery.....	18
V.4 Content search and media presentation .....	18
V.4.1 User-system interaction .....	18

---

V4.2	Authentic, true-to-original media reproduction including Virtual Reality .....	19
V.5	Technology drivers and enabling technologies .....	19
V.5.1	Data security and personal privacy .....	19
V.5.2	Identity management and AAA (authentication, authorisation and accounting) .....	20
V.5.3	Personalisation/profiling: Smart user profiles across all services & devices.....	20
V.5.4	Power management technologies – energy saving in/by ICT .....	21
V.5.5	Machine-Machine Communication .....	22
<b>VI.</b>	<b>Conclusions and implementation guidelines .....</b>	<b>22</b>
<b>VII.</b>	<b>Annex A - Result of the NEM Survey on most important Research Topics.....</b>	<b>23</b>

## Foreword

*The principal concept embodied in this document is based on a recognition of the long-held view that a state of permanent change is the only form of stability. Heraclitus' philosophy is based on "Πάντα ῥεῖ" (panta rhei)" meaning "everything flows" in ancient Greek. 2400 years ago, Plato cited Heraklitus with the words: „Pánta chorei kai oudèn ménei" (Everything moves and nothing remains)<sup>1</sup>. This is ancient knowledge, but seems equally to characterise the world of our contemporary information society.*

*In summary, this treatise should draw our attention to the landscapes of future research and economy from the perspective of NEM, the European Technology Platform on Networked and Electronic Media. It expresses the common view of the NEM community and explains the need for public support for future collaborative research activities in the NEM domain.*

*This NEM Position Paper represents a high-level view for themes that would be relevant for the upcoming EU Framework Programme 8. This document combines the former separate and so-called Vision Document and the Strategic Research Agenda. It represents the 2011 version of these documents and was approved by the NEM General Assembly on 27 Sept. 2011. A list of research topics as resulting from the NEM survey of April/May 2011 is added as Annex A.*

### I. Where will we go? Where are the opportunities?

This document summarises the challenges and opportunities for the future European research directions in the NEM domain. Section I describes the main trends whilst Section II discusses Europe's strengths and determines Europe's diverse cultural heritage as the basis of Europe's knowledge potential. Section III deals with the various areas of innovations and concludes on innovation partnership as a means to cope with our grand societal challenges. Section IV orients itself to market, societal challenges and education. Sections III and IV encompass a series of precise action lines that we believe will bring Europe to the forefront of IT development. The vision is that industry and state authorities might go hand-in-hand in order to create Digital Europe, resulting in an unprecedented IT penetration within all areas of our society and our daily life. Section V contains detailed recommendations for future research topics in FP8 ICT in the NEM domain.

Following is an abstract of the trends and opportunities currently identified:

## Connected Society

In the not-so-distant future, everybody and everything will be permanently connected to a network (fixed, mobile, satellite) wherever they are. This new paradigm will open many new opportunities for business, in particular in the NEM sector. For example, connected 'things' as well as 'people' will be able to provide information that will help to create or enrich content: intelligent objects (e.g., cars, smartphones, everyday appliances, goods, food) will gather real-time information in their respective environments (e.g., on the road, at home, in a store etc), while connected people will be able to express and share their experience, attitude, or preferences while interacting with the real world. The combination of the two (real time sensing and collective experience) is able to adapt, personalise and contextualise the relevant content, making it alive, evolutionary and ready to be used in realistic situations (e.g. maps & itineraries, movies & news, user & technical manuals, safety & eco-friendly procedures). Users will soon be able to use any type of device to access any type of content adapted to their spatio-temporal context (at home, on the move, driving a car, in a train, on a plane, ...). Network bandwidth and quality will increase significantly with fibre networks reaching closer to the end-user's point of access. Increasing bandwidth capacities of LTE/4G mobile networks will enable users to access high definition and even 3D/holographic content on the move. In addition, increasing uplink bandwidth will allow for new types of services such as online content storage, 3D videoconferencing, and tele-immersion.

All these network evolutions will help people to share in real time any type of content within their interconnected social communities, to communicate with remote contacts while feeling as if they are together at the same place.

However, high bandwidth network connectivity will not immediately become available everywhere in Europe due to a number of constraints. The roll-out of fibre networks will be limited by cost factors and LTE/4G coverage cannot be expected to cover all areas of all European countries within the next few years. Consequently, mechanisms able to optimise device connectivity according to the available networks are crucial for a seamless experience from the user's point of view, and unavoidable quality fluctuations need to be minimised.

As the currently growing landscape of application stores continues to evolve, we will see the concept extend towards more online content, applications and service (cloud-based) with pay-as-you-use business models, allowing people to forget about device compatibility, updates, or additional virus protection.

We can summarise this future network paradigm as:

- *Anything, anytime, anywhere on any device.*

<sup>1</sup> <http://en.wikipedia.org/wiki/Heraclitus>

## Knowledge Society and content availability

An impressive phenomenon of our information society is an ever-increasing amount of new audio-visual content that is available to all. Content is created by professional producers as well as by prosumers or just by Mr and Ms Anybody.

High-quality production tools are no longer the preserve of audio-visual (AV) professionals. The advancement in technology is available to all. HDTV cameras are common place, the first 3DTV cameras can already be purchased, at affordable prices, by any AV amateur.

However, much content is still only available on a specific display and/or at specific locations. It remains a challenge to turn the request for “anywhere, anytime, any device” into reality. So, content interoperability and scalability for seamless consumption is still an open issue in order to allow AV access at home, on the move, from the office, in the car, while abroad, etc.

As technical quality is potentially not an issue anymore (today, there is a proliferation of technically high-quality content) the perceived quality of the content comes through its intrinsic value. To distinguish valuable content from junk content is still up to personal judgement, and whether technology may be able to help in this assessment remains to be seen. Whether information in the content is actually true or false is independent of the technical production process, and cannot be related to whether the content has been created by multimedia professionals or as UGC. The research challenge is to assist citizens in finding and selecting truthful content when they wish to do so; quality content should be available to all, the younger and the elderly, for people with and without special needs.

- *A policy of all-embracing Digital Inclusion is essential in order to overcome the digital divide and to turn Europe into the most advanced IT area worldwide – for everybody. This is one of our grand societal challenges.*

## User interfaces and immersive experiences

Recent years have seen a plethora of intuitive user interfaces, on various platforms, such as smart mobiles, touchpads and game consoles. The 3D TV is catching up and IPTV is coming to our living rooms. In the near future, we will see a proliferation of 3D, immersive and beyond-HD experiences, with interfaces becoming even more intuitive, including speech, tactile and multisensory interactions.

This shift in the market opens up many new opportunities for business, particularly in the NEM sector. For example, connected TV is becoming a rich open platform, where web style applications are projected to bring another wave of economic growth in the NEM industries. Connected TVs as an open platform will deliver a multitude of new

applications and services to the home, particularly for the young as well as for the aging population of Europe and globally.

The 3D and immersive experiences of this future are rich with intuitive interactions and will create new business services such as tele-immersion and tele-medicine, as well as for more traditional entertainment applications. Adding geo-location will enable Augmented Reality applications to become more broadly accepted and used, for example in tourism and cultural sectors.

Intuitive interaction and ease of use is paramount in this future. The younger generations are expecting the same ease of use on their TVs as in their mobiles and touchpads. Multi-touch screens, audio/speech interfaces and more futuristic brain/machine interfaces will create a more direct dialogue between users and the machine, and increase the acceptance of new NEM related services.

In this future, building rich engaging experiences is the key to economic growth. For example, the ability to create shared experiences, on multiple screens at home and on the move, enriched by location-based data to build context, will allow the current content sharing paradigm to achieve its true potential of delivering rich experiences through the networked electronic media of the future.

All these advances will blend the real with the virtual, and unlock the full potential of immersive shared experiences and services with direct application to addressing some of the grand societal challenges of Europe, including the domains of transport and health. Research in immersive technologies as well as in solutions beyond 3D and HD – areas in which Europe has a strong R&D drive – is crucial. Equally crucial is to increase the speed with which this high-quality European research is taken to the market. NEM can help through our rich ecosystem and dissemination activities. We can summarise this User Interfaces and Immersion paradigm through:

- *Experiencing content is king – rich, connected, immersive, intuitive experiences are the future.*

## User and usage data

The success of the Internet is mostly due to its simplicity and its ability to unify. This has been the case with the IP protocol suite at the infrastructure level, and then with the Web at the content level. With fibre to the home and 4G cellular networks, the next challenge is to make it easy for Internet users to access the massive quantity and diversity of information available on the Internet with the best possible quality. The success of this Internet of services will reside in our European ability to design and deploy a converged service means that will give access to all types of information found or to be found on the Internet: health, transportation, pictures, music, movies, power, sensors, social, etc. The Internet of Services is user-centric.

It will enhance the users' experience, preserve their privacy, and offer high-quality services that improve life.

The development of new business models and opportunities for all actors in the electronic media and content industry relies on our ability to work together to design and exploit the converged service platform. Content here is defined broadly, and encompasses power, entertainment, transportation, personal data, and sensors. We are in a closed-loop situation where network providers need customers to acquire premium content to grow their network, content creators need to bring personalised content to the customers, and customers are demanding an easy way to discover and access quality content and services. Content creators and network providers are at the heart of the challenge. There is a need to give Internet users access to a large variety of high-end personalised services and content that will be easy to discover and deliver. This will result in a faster adoption of on-demand content, online games, social networks, catch-up TV and other services such as home automation and wellness (health, power).

In order to facilitate universal adoption of online digital services based on the benefit of Future Internet capabilities, it is mandatory that those emerging services and their associated content are provided securely and in a trustworthy way between all the users who act as content providers and content consumers. To reach this objective, the Future Internet infrastructure components must be secured against intrusion, hacks and misuse. The privacy of each actor must be guaranteed and controlled especially in order to allow network authorities mandated by law, to trace illegal behaviours of connected individuals or service providers.

Content will be transformed into smart content by adding metadata during the content creation process or during exchange. This additional information will enable consumers to use any device or application to browse, search, and purchase content from globally distributed collections of content catalogues. However as users will move from one device to another, and also from their home to outside, it is mandatory that their respective smart user profile is transparently accessible from everywhere, for an easy and intelligent usage.

To boost Europe's potential for large deployment of online digital services and content, one can imagine the benefit of having access for users to shared applications for creation and distribution of new innovative services and content. These possibilities will be offered by application services located in the Cloud. The virtualization of resources will strongly impact the capabilities of users to build new innovative offers based on a lower entry ticket because of high utilisation and secure sharing of physical resources. Edge devices (like gateways or set-top boxes at home) will play a key role for enabling virtualisation

implementation because they will offer the link to services and data accessible on the Cloud.

## II. Europe: Where are our strengths? Diversity as an asset...

### Diversity of cultures their heritages and languages

Europe is built of a variety of peoples with different cultures and cultural heritage. Europe inherits from the Greek and Latin civilisations, whilst it has been influenced over more than twenty centuries by many other civilisations, resulting in our cultural treasures of today. All European citizens share a significant common cultural framework that alleviates their communication, collaboration and living-together. We need only look to the long-lasting record of collaborative European research for proof of this statement

### Large archives/collections of highest quality content

Europe's long cultural history and diversity is the source of Europe's vast collection of works, notably the archived cultural media content. There is probably no other place in the world where the density of art and intellectual production has been higher. Our archives (print, sound, film, video and other media) form the precious base for Europe's audio-visual business. Moreover, the availability of such stocks encourages the cultural community and the industry to maintain their cultural leadership by making these treasures available to all and by developing the preservation and distribution technologies to do so.

### Common societal mind-set

Owing to their common history and educational traditions, European citizens have a common mind-set for societal conciseness and problem solving (despite all their individual cultural and linguistic diversities). We understand Europe as our common heritage *and* future; we realise the challenges of climate change and the need for green energy and production; we have agreed on a common European Commission and common policy in numerous domains.

### Collaboration has a long-standing tradition

Collaborative research emerged in the Western part of Europe and has now spread, with strong momentum, to encompass the new EU countries. Cultural differences bring cross fertilisation in the approach to new topics, notably in the research domain. There are plenty of examples from space exploration, through the aircraft industry to the Large HADRON Collider (LHC) at CERN.



### High level of education (schools, universities, research centres, training of skilled personnel)

Education is a very strong point of Europe, well recognised at the international level. The dense network of universities and technical schools, which, for a long time, have been developing contacts and co-operation, is a strong asset from which all citizens take advantage, through the training of skilled personnel and through the availability of relevant and well-structured expertise that can then be applied to our industrial production. More than any other resource, education is the pillar of Europe's prosperity and wealth.

### Awareness of environmental issues and societal challenges

There are big (societal) challenges facing the global community. In practically all cases, modern ICT can significantly contribute to counter these challenges: from humanitarian interventions in cases of natural disaster and the problem of fighting poverty to the alleviation of the effects stemming from global warming or to helping the elderly or people with disabilities to live more safely and have assistance in their familiar environment. Europe has already proven its ICT capabilities in these new domains, and beyond in the classic network technologies such as GSM or DVB, both of which were developed in Europe. The tsunami alert system installed in the Indian Ocean is also a prime example. In combination with other technologies such as sensing water waves, ICT resulting from collaborative R&D work in Europe has created a decisive solution that could save many lives in the future.

Europe is cognisant of the potential of ICT for industrial export and is already placed at the forefront of applying ICT to new societal challenges. Further research should help to maintain and foster this position in initiatives concerning the application of ICT to energy savings, the ageing population, Internet for all (e-Inclusion), security etc.

### Pursuit of sustainable approaches

Europe's most important task is to take advantage of all the assets listed above in a form that these assets can be exploited effectively for the benefit of the European community. It is a positive consequence of Europe's current political construction that relevant structures for initiating research programmes have been installed that, in turn, provide the basis for the implementation of a common and efficient approach to research and technical development. In fact, this model has been followed by others world-wide. The coordinated European approach is now a rule for all topics that should best be addressed at European level, to the benefit of all citizens in our Information and Knowledge Society.

### Europe provides the legal framework for efficient exploitation of these assets

By establishing collaborative R&D programmes, the European Commission has created the legal framework for developing technologies which allow the exploitation of our cultural and industrial assets across national borders. European researchers have thus a long-standing tradition in collaborative projects – this by itself is a great asset in the global competition for technological and societal leadership.

### Intensified international cooperation to increase significance of European technologies and standards in the world

Although there are examples to the contrary, Europe is potentially weak in getting its solutions and technologies accepted and exploited at a global level. In recent years, there has been some success, however, the way in which Europe's technologies penetrate the global market may need to be broadened from a small path to a wide avenue. Europe's influence in global businesses may need the development of bilateral cooperation with many countries that, in actual fact, are demanding Europe's technology, notably Europe's ICT technology. This is a very long process that has already started, but there is still a long way to go. One solution could be to follow this motto:

- *Put Europe at the forefront of sustainable and green ICT solutions*

## III. Innovation Ecosystem and Innovation Partnership

NEM is moving towards a Technology and Innovation Platform, creating an innovation partnership geared around the grand societal challenges. This includes use of NEM technologies and research outputs, as well as design-driven and business model innovation, to fast-track solutions and to deliver innovative products and services. We would like to play a proactive role in making Innovation Partnerships happen and assist the EC in implementing its 2020 Strategy and in particular the Innovation Union and Digital Agenda. We propose the following key actions:

### Innovation Partnership: From NEM value-chain to NEM innovation-chain

NEM members cover the whole value-chain from R&D, corporate R&D, Education and Academia, Academic research, SMEs, corporations, industry and equipment manufacturers, content and service providers. In the online world smaller entities can innovate without the need of large infrastructures and it is therefore even more important to support SMEs and create innovation policies that put SMEs into the driving seat of European growth. To complete our value-chain into a powerful Innovation

chain, we are in the process of involving and partnering with innovation catalysts including:

**Education:** business schools, to complement our high quality academic members and together help design curricula to improve entrepreneurial skills

**Access to Finance:** Venture Academies and Business Angel communities, to bridge funding gaps and bring together SMEs and other NEM innovative companies with VCs/BA. A much wider exploitation of some of the currently available European funds should be pursued; among others: risk-sharing financial capacity, structural funds, and cohesion funds.

**Broader Innovation:** Innovation forums, Executive Coaching Professionals and Associations, to help corporations and their executives think through and deliver business model innovation. The concepts of “Open Innovation” and “Viral Innovation”, where research, technology development and implementation of technology results (overall new innovation concepts within the Innovation Europe policy) should be exploited to their maximum extent.

**Large Scale User Trials:** test-beds and living labs, to test innovations in larger scale experiments and reach a broader European citizen base for acceptance testing.

**Social Innovation:** not-for-profit organisations that facilitate and support social innovation, social entrepreneurs and citizen organisations, to use NEM technologies for societal challenges.

**Design:** not-for-profit and other organisations working between art, design and technology, to facilitate product and service design and improve user acceptance

***Action 1:** Building EU Innovation Partnerships through NEM and our Innovation catalysts. We believe that NEM together with our innovation catalysts can greatly contribute to EC's efforts to set up Innovation Partnerships and we are looking forward to EC's response and to playing a pro-active role in making Innovation Partnerships happen.*

### SME support and improved targets

Support for better access to private funding, though important, needs to be balanced by easy access to public funding and research programmes, particularly for SMEs and start-ups. Our NEM SME group has identified four targets specific to SME Innovation, during early think-tank debates. These help deliver faster innovation and better support innovative SMEs in Europe: 1) create research programmes suitable for SMEs and simplify participation rules and governance (faster, simpler research funding procedures and support at national/regional/EU levels) 2) stimulate and assist SMEs to participate in larger EU

R&D cooperation initiatives such as European Technology platforms and public-private partnerships 3) take a wider view of SMEs, to identify cross-sector programmes and open innovation models across global value-chains and 4) share best practice between researching and non-researching SMEs.

***Action 2:** Improve access to public funding and research programmes for innovative SMEs. We are committed to improving these four targets and would like to bring the above recommendations to the EC and support its efforts to foster innovative SMEs and the conditions that allow them better access to funding.*

### Proactively engaging with the EU to build Innovation Chains and Partnerships

We are in the process of creating a cross-ETP innovation workgroup, to combine best practices and facilitate Innovation Partnerships that use a systems approach to deliver cross-sector innovation.

We also believe that the cultural, art and design sectors are key catalysts in building innovative products and services and increase user acceptance. We are pleased that design and the need for a European Design Leadership Board have been identified. We recommend that this is extended to include actors such as artists working on NEM technologies and creative media industry players, and organisations that facilitate the interactions between art, design and technology.

NEM can help engage these communities with our members and together with key stakeholders from non-profit and social entrepreneurship sectors in an inspiring and results driven way.

***Action 3:** Use ETPs to build a systems approach to cross-sector innovation.*

*We would like to bring these recommendations and approach to the Digital Agenda and we wish to play a leading role in connecting Technology Platforms into a powerful innovation partnership. We look forward to EC's response and together with the European Commission to help create Innovation Partnerships that will speed up delivery of global solutions to Europe's societal challenges.*

## IV. Market, societal challenges, education

### Market and business opportunities

The Networked Electronic Media market is moving very quickly, driven by new technologies such as smartphones,

3DTV, web tablets, but also new forms of content as well as games.

In this new situation, business models also need to change. We have already seen in the recent past the emergence of Over The Top players (Google, Facebook, Yahoo, ...) we will obviously see new comers in this huge market. Fibre networks as well as LTE will be deployed in a few years, giving opportunities for new applications (cloud, xAAS, ...) which will in turn give opportunities for new comers. This is a great opportunity to accelerate innovation in the NEM area but there is also the need to work on the value chain and on the position of existing stakeholders.

**Action 4:** *A need to set up specific activities within NEM and ask for specific research topics in the next work program addressing new business*

We can also see that people are ready to pay-per-use, but are less and less interested to buy a licence - this will also drive future business models. In the NEM area, people are creating more and more UGC and professionals are more and more using this content to build their services (news, TV shows,...). People will be interested to use simple services to get a financial return under any circumstance.

**Action 5:** *A need to develop a standardised micropayment service in order to offer customers the possibility to monetise content exchange with anyone.*

The Internet has become a fundamental service infrastructure for everybody and equal access to it remains to be a fundamental prerequisite for its success. Future media is highly linked with to question of net neutrality as far as most services in the Internet will, in future, use media and content. Everyone should have access to:

- Culture, cultural heritage,
- Education,
- Public services,
- Health services.

The realisation of net neutrality is key to NEM application development; everybody should have access to information whatever its connectivity and the device used.

However, it should be possible that the QoS should not be equivalent for everybody depending on the contract and the location. Network operators should allow any content to be carried on fair and equal terms, including services provided to their own respective downstream businesses and should not make judgements on what is or is not appropriate to carry on their networks. However these operators should be able to offer and charge for, on a fair and equitable basis, additional capabilities to enable

differentiated service levels (such as guaranteed quality of service).

**Action 6:** *Net neutrality is an important item of discussion within the NEM community, NEM could help through position papers to help regulators to take the right decisions.*

## Societal Challenges

### Acceptance of technology by society

The global evolution of people's perceptions regarding networked electronic media technologies (devices, services,...) leads us to a vision of future media:

- More immersive: 3D, holographics for entertainment content as well as video-conferencing and games should take advantage of these new technologies.
- More personalised: people having access to more and more information and access to the right information at the right moment, need more generalised context awareness and information profiling. In addition, information is becoming obsolete very quickly, so there is also a need to propose information rating services.
- More collaborative: people are used to communicate and share content through social networking and to work more and more in a collaborative way. This implies that a combination of content sharing and interpersonal communication services becomes necessary.
- Anything, anytime, anywhere on any device: People use several types of devices depending on location and personal context. There is a need to be able to provide any service on any type of device, whatever the connectivity.
- All these services should obviously be in line with people's behaviour :
  - People are attracted by new technologies which answer a need (e.g. iPhone, DVB-T, ...)
  - People are becoming Green and will use services which lower energy consumption
  - Elderly people are TV centric in the same way as young people are smartphone centric
  - Wireless technologies are accepted best from a usage point of view but are badly accepted from a health point of view.
  - Future high bandwidth connectivity (FTTH and LTE) will boost NEM applications and will be widely used in Europe
  - Digital Home complexity will need high level Customer Relation Management in order to help people to configure their home network

- Privacy is a key factor that need to be addressed from a technical point of view as well as from a regulation point of view

**Action 7:** *NEM ETP could be used to simplify and hide the technology for the user. All the technical complexity should be hidden so that users are able to experience new innovative services without any technical knowledge.*

### Link to Grand Societal Challenges

Our European society will face some huge societal challenges in the near future and obviously NEM should help in these fields. NEM is user centric and should take into account the Grand Societal Challenges mainly in:

- Global warming: Due to air pollution (industry, cars, home heating, ...) and increasing levels of atmospheric CO<sub>2</sub> causing an increase in overall global temperatures, which will have a major impact on our future life (storms, rising sea levels, increasing desertification, ...)
- Tightening supplies of energy: Fossil energy will be less and less available; there is a need to find some new resources, but also a need to save energy.
- Water and food: Due to the enlargement of the world population, it is and it will be more and more difficult to have sufficient food and water for everybody.
- Ageing societies: Owing to medical advances, people are living longer and there will be need to help people to stay at home.
- Public health, Pandemics: It is in our basic instinct to live longer and longer, medicine is making great progress but there are always new viruses arising that need great efforts in research but also in public infrastructure which are more expensive and difficult to fund.
- Security: Citizens expect that their environment, which now includes communication and internet as well as their physical safety, will be secure and well protected. This is especially important now that the opportunity for cybercrime as well as physical crime exists.

The Main interest for NEM is Smart culture and knowledge and content: European culture is very rich and European people are so creative that we will be soon overwhelmed by information and archives. With search engines becoming more and more powerful, there will be a need to assist people with content management including helping people to "clean" their information wherever it is stored.

As influential technology platform in networked and electronic media, NEM forms a crucial part of the ICT's

hyper-sector and represents an important critical mass for European research in this field. Consequently, NEM should also contribute to:

- Global warming through new immersive communication applications to avoid travelling
- Ageing society through new multimedia applications helping elderly people to stay at home and to keep in contact with their relatives

How can we ensure content/information availability and the meeting of responsibilities/obligations of companies (public services)?

- In our future society, most interactions with public services will be done through the Internet
- Public content will increasingly comprise of multimedia and should be accessible in any situation
- People should be able to join any public service using synchronous and asynchronous communication services instead of queuing
- Information rating: information still stays on the net even if it is obsolete
- Language translation: one content, many local publications

**Action 8:** *NEM ETP is user oriented and should lead think tanks on culture and edutainment and also contribute to Energy savings as well as to services for the ageing society.*

### Regulatory aspects

People expect their political leaders to protect them, to the greatest extent possible, against the multiplicity of everyday threats. There are numerous fields where good regulation is applied to the benefit of the citizens. Standards for healthy food or medicaments are implemented and monitored by pertinent inspections as well as enforcement of rules for safe driving or working. With respect to the IT sector, individuals as well as companies expect secure data storage and protected data transfer. Personal, company or governmental data should not be accessible without prior permission by the owner of the data. This is a basic request, the fulfilment of which represents the fundament of acceptance and success of the IT technology: No trust – no business!

**Action 9:** *NEM is helping to implement data security and personal privacy when dealing with digital data. Pertinent research is solicited and position papers will be developed that work on the fair balance between data protection and the business opportunities available with the advent of new IT services.*

## Education

According to Section III of this document, and related to “Innovation”, NEM is creating an innovation partnership geared around the grand societal challenges. Among those challenges, education is a basic pillar and starting link of the innovation chain. Without a solid, comprehensive and stimulating educational period, NEM will not evolve as Europe expects it to, neither in speed, nor in quality or number of researchers.

### Are students prepared for the future?

It is recognised worldwide that higher education is a great national asset, contributing to the social good, and empowering the economy. According to the recognised study by EDUCASE about “The future of higher education” of 2010, education is one of the main drivers of change and evolution for any country, and conditions its innovation and development capabilities in medium and long term planning.

Following Marc Prensky’s naming ideas, our current students are “Digital Natives”. They were born and have grown up surrounded by technology. They are used to receive up-to-date information, they prefer graphics to text, and they are used to hypertexts and random linking searches, multitasking and parallel processes. They do better and over-perform when they work in groups, interconnected. They do not need to “learn” the special “language” of current technology, language that the “Digital Immigrants” (not “natives”) need to learn, in manuals and user guides that the Digital Natives scarcely look up. This new profile of students needs new teaching procedures, new ways of communicating knowledge that take into account more participation, more self-search, and learning by practice.

NEM imply technology with a fast obsolescence cycle, and with a special need for actual professionals in specific ephemeral fields participating in the teaching activities. As a consequence, the students should be more deeply involved in the day-by-day activities of companies, to experience the dizziness of the idea-design-implementation-selling short cycle. Therefore, new teaching procedures and Masters programs should be launched or updated to cope with the current needs, and appropriately prepare our students for the future.

But this new education should also be sustainable, in terms of costs and environmental impact. The new teaching mechanism should be designed to preserve the social, economic and environmental ecosystem.

The future shape of higher education will be influenced by new structures and new business models, enabled by information technology. But currently, many are driven by cost, access, or novel approaches. The engagement and stimulation of students should be achieved through constant interaction, problem solving, and reflection. The educational experience is increasingly connected, experiential, flexible, and driven by individual preferences and

needs. Social networking tools enable connections and collaboration, whether social, scientific, or civic, and should be considered as a basic tool for human relationships and knowledge exchange. In addition, international mobility and sharing of experiences and learning procedures clearly benefit both students and professors. The current international networks of students will become the future international networks of researchers.

### New models for education

As students become more diverse and as learners’ needs expand across a lifetime, more flexible models for education are emerging. Online learning and accelerated programs provide greater flexibility than traditional campus programs. To promote international exchange, transferability of credits from one institution to another becomes necessary, as time-to-degree increases and lifelong learning grows.

The creation of this new educational model requires collaboration across organizational and national boundaries, bringing together the collective intelligence of people from different backgrounds including education, corporate, and government. New educational programs should be created, with new profiles and fields of expertise, following (and promoting) the innovation strategies of the NEM companies.

New professional profiles, including Graduate, Master and Doctorate programs should be identified, involving the whole set of actors in the definition of the contents: Industry, European Technological Consortium, Stakeholders and Universities. The basic target is to obtain new professionals with a deep knowledge of the wide NEM sector, its needs, closer to the market, with a special emphasis on the needs of innovation and creativity, to promote the development of new systems and new services, according to the social evolution. The active involvement of all actors is crucial, and the international mobility of both students and teachers is essential to avoid endogamy, to create partnerships at different levels and stages of the process, and to reach a real networked educational framework.

**Action 10:** *To identify new educational programs for the future NEM professional, with the involvement of the whole NEM community. Innovation, creativity and international mobility should be embedded in the new profiles.*

## V. Detailed recommendations for future research topics in FP8 ICT

This chapter provides detailed information on the most important research lines identified by a web survey amongst NEM members that was published on [www.nem-initiative.org](http://www.nem-initiative.org) in March/April 2011. The results of the survey show that the most important individual topics

relate to Social Networking and Content Creation: *Creative communities (including distributed content production)* received 100 % of all responses to be highly relevant or relevant, with a large majority on highly relevant, and so did *“Smart Content”* whilst *“Capturing of true 3D, holographic and augmented reality A/V environments”* scored a total of 97 % under the same conditions.

Other highly rated areas of interest relate to *“User satisfaction”*, *“Networking and Delivery Infrastructure”* and to topics under *“Content search and media presentation”*. Less highly rated were the association of the scores with the area of *“Technology drivers and enabling technologies”*.

On a higher level, a large majority of the respondents agreed that R&D in FP8 should, above all, help to “Hide complexity – simple to use” (68 %), “Free end-users from hard and software maintenance” (53 %) and “Make the user the master – not the device” (64 %). These are some examples; the total list giving all top scores of the survey is given in **Annex A**.

On the basis of the responses obtained, the Research Areas were grouped into five categories (by order of priority):

- Media -related applications and business models
- Content Creation
- Networking and delivery infrastructure
- Content search and media presentation
- Technology drivers and enabling technologies

These categories correspond with those listed in the “NEM Strategic Research Agenda 2009” (SRA-2009)<sup>2</sup>.

This Chapter is organised according to these categories. At the end of each Section, a list is given that summarises the identified research topics for FP8 within the ICT/NEM domain.

## V.1 Media-related applications and business models

Applications are fundamental to the networked media industries, and a good business model is essential to a successful application. New technologies will make new applications possible and change business models, making some obsolete and enabling new ones. Social networking has become part of our everyday life, and the web is gaining increasing importance as a common service platform. New sectors of human activity, which so far have existed outside of a networked economy, will be based on networked services. People increasingly expect a good quality of experience.

Consequently, applications and business models are proper subjects for an R&D programme in networked media. As already indicated in the 2009 version of the

Strategic Research Agenda, it remains the responsibility of research to prepare for the emergence of a renewed and creative economy based on new connected applications.

### V.1.1 Social Networking and Media Sharing

Humans love to communicate. In fact, once the fundamental needs of food, security and shelter are met, it is arguably the greatest contributor to meeting the higher level psychological needs of self-actualisation, acceptance and self-esteem. It gives us meaning through our relationships to others, and sets us apart as a species. The many and varied modalities of communication that technology enables bear witness to this as the need to communicate re-expresses itself over and over again. It runs like a golden thread from the humble telephone call, through IM to Facebook, Twitter and beyond.

A natural characteristic of large scale communication is the formation of communities. Each of us belongs to many communities; and online, these communities can become increasingly dynamic and transitory. A content theme or channel has a dynamic relationship with the community which gathers around it and which can contribute to the content generation itself. This trend will be even more important in the digital generation who are adept at handling interactions across multiple communities (whilst making use of multiple hardware and software platforms).

To support innovation in this rapidly moving area, research is needed across a broad range of technologies and disciplines:

**Content Evolution** - Social network content is predominately text, image and video-clip based. Will this expand to include long-form and near-synchronous media consumption? What is the impact of the ‘content social window’ on this, and what are implications on network architecture?

**Content-mediated communication** - Understanding the psychology of social network usage and the interplay with content will provide a powerful roadmap towards new and exciting services as communication and content services become increasingly intertwined and interrelated. These ‘Conversational Content’ applications are providing a form of convergence and underpin the rich and creative, and often subtle, ways in which people express themselves and communicate with others through the use of content.

**Collective Intelligence** - The fact that users currently annotate and comment on content through tags, ratings, and preferences, and that these activities are performed on a regular basis, gives social media data an extremely dynamic nature that reflects topics of interest, events, and the evolution of community opinions. Aggregated information from social networking sites becomes a source of valuable insights into emerging phenomena and events and enables real-time monitoring and extraction of actionable knowledge. Research is needed in real-time,

<sup>2</sup> <http://www.nem-initiative.org/fileadmin/documents/VisionSRA/NEM-SRA-070a.pdf>

large-scale information extraction and data mining from the noisy social media exploiting the combination of content, spatio-temporal, and social context to enable a deep understanding of events, patterns, and situations emerging from data.

**Online Communities** - How do online communities form, grow or wither? What are the critical success factors and how can technology support these?

**Communications modalities** - Increasingly we switch communication modality to suit our needs. Research is needed to broaden the role that ICT has in supporting and facilitating new communication modalities and to enable the business models that may emerge as a result.

**Devices** - How can devices and user interfaces continue to evolve to facilitate easier media sharing across new forms of content and new models of interaction? How will online social behaviour translate to the TV with more participation and interactivity through second screens?

**Business models** - Intelligent ICT supporting micropayment, context-aware ad-insertion, personalisation and recommendation will enable broader monetisation of user-generated content and disrupt existing industry value-chains. Beyond the traditional business models, more recently some blended models like freemium are emphasising the distinction between fundamental and premium services.

**Action items for inclusion in future ICT research:**

*Evolution and future impact of social networks ('Conversational Content' applications, online communities, new communication modalities (new forms of content, new models of interaction, etc.)*

*Simplified devices for social networking*

*Support of future business models through micropayment, context-aware ad-insertion, personalisation and recommendation, and enable broader monetisation of user-generated content*

### V.1.2 User Satisfaction and Quality of Experience

The user satisfaction with a service is mainly based on three criteria:

- The quality of experience of the service
- Smart user profiling
- Customer support

Quality of experience (QoE) is what is perceived by the user, who will consider it alongside price in evaluating the value of the service. Network operators measure quality of service (QoS) in terms such as bit error ratio, number of erroneous seconds, delay, and service availability. Although these parameters are easily measured, they have

little meaning for the user. New content distribution services will first need to equal the QoE of their existing counterparts (i.e. artefact-free, no freezing and fast zapping times) and also offer new features often using interactivity or other new features (e.g. time-shifted viewing, access to more content, 3DTV with a feeling of presence).

The huge variety of communications alternatives will lead to different requirements per customer, whose needs will also be dependent on parameters like their time, place and mood. To introduce new services successfully, the networks of the future should learn from the way the users are communicating, what services they are using, where, when, and how, and adapt accordingly while ensuring user-friendliness and simplicity.

Therefore the research question is how the quality of experience can be measured to give results that are helpful in service development.

#### Smart user profiles across all services & devices

It is increasingly difficult for users to find pertinent information in a reasonable timeframe, unless they know exactly what they are looking for, where and how to get it. There is a need for an Internet based filtering system that helps users by having integrated user profiles (i.e. identity and preferences data...).

Today, such user profiles together with personal data are collected and managed by several service providers (e.g., Google, Facebook, Twitter). In turn, these providers derive and offer personalised services (including personalised advertisement). However, people are concerned about what information is gathered and stored by whom. In addition, users are also increasingly bothered by the fact that they hardly have any control over their own private data and how this data is shared with additional (third) parties. Nevertheless, collecting profile data is essential for tailoring personal offerings and can thus be beneficial for users as well as content and service providers at the same time. Yet, users have an obvious interest in protecting their privacy.

Research efforts should address new concepts of meta-profiles or inter-linked profiles. The new profile schemes should allow, inter alia, for:

- Simple management of which information is shared with who;
- Anonymisation of shared personal data were desired;
- Utilisation of merged information from multiple sources – e.g. for improved recommendation systems;
- Protecting the service providers' interest in being able to exploit personalised information without jeopardising user privacy or sharing valuable collected data with third parties;

- One-stop-shop management of profile and personal data;
- Privacy-conserving real-time context and preference capturing such as the user's mood, current interest, device capabilities and network connection.

In this respect, there is a need to develop service enablers and open APIs that fulfil these requirements to enable simple user-preference capturing and information filtering under the control of the user.

### Customer Relationship Management (CRM) - Customer Support

Users could have trouble with devices, services or want some additional information. For that purpose, industries have set up hotlines and support services able to answer any requests and this is part of user satisfaction. Devices and services are more and more numerous and it becomes more complex to understand the real needs and issues of the users.

#### **Action items for inclusion in future ICT research:**

*New metrics to assess user satisfaction*

*New mechanisms for user profiling and instant support*

*Mechanisms able to evaluate the user network configuration (Personal Area Network or Home Network).*

*Note: A type of dashboard presenting remotely the user configuration to the hotline should be standardised at minimum in order to offer to the user flexibility regarding the service provider. Some standards are appearing such as TR069 but there is still research to do in order to achieve that goal.*

## V.2 Content Creation

In the SRA 2009 document, 'Content' was defined as 'understandable information made available to a user at any stage of the value chain', including both the 'essence' – the data representing text, audio-visual services, games etc. that is the object of the value chain – as well as the metadata that describes the essence and allows it to be searched, routed, processed, selected, and consumed. Additionally, the usage rights and intellectual property status of content must be clearly known, otherwise content (and its associated metadata) may not be used in a professional environment.

According to the NEM Initiative's understanding, all content is potentially a 'multimedia application'. In producing multimedia applications, all components should be integrated from the start – interactive components should not be thought of as 'add-ons'. The information exchanged between inanimate devices in the 'internet of things' might be considered to fit the above definition, if the

devices are thought of as 'users'; however, this section concentrates on content creation for human users.

Until recently, content creation was the preserve of professionals and was very much a craft process. In the future content will be much more widely produced by other groups too, and the production industry will have to evolve to reflect this change.

### V.2.1 New Forms of Content

New forms of content are considered to be highly relevant to the future ICT research agenda, which is not surprising, given the considerable interest from both consumers and producers of content in finding new ways of engaging with each other through the medium of digital content. Two aspects of the new forms of content should be considered, that of smart content on the one hand, and the need to capture true, 3D, holographic and augmented reality audio-visual content on the other. Smart content has the potential to revolutionise the way that interactivity can be used and implemented, with content carrying its own intelligence and interacting with network nodes as well as display devices.

Although not everyone sees 3D and augmented reality as being core to future content creation, the very breadth of this question invites a wide range of viewpoints. The use of stereoscopic 3D is becoming widespread, yet effective presentation of true 3D content is still awaiting viable 3D displays, whether based on holographic techniques or other multi-viewpoint technologies. There is also the question of how 3D content is captured, and although there is no huge appetite for addressing the question at this time, it will surely become a key issue once 3D display and immersion technologies make the next big leap. There is a clear need for concerted research effort into these technologies in order for the full application potential of new content to be realised

#### **Action items for inclusion in future ICT research:**

*Ways to improve A/V immersivity, and its associated devices and services for capturing and processing*

*Improved technologies for capturing and displaying true 3-D content*

### V.2.2 Representation of Content

The Media Internet supports both professional and amateur content producers and is at the crossroads of digital multimedia content and Internet technologies. It encompasses two main aspects: media being delivered through Internet networking technologies (including hybrid technologies) and media being generated, consumed, shared and experienced on the web. The Media Internet is evolving to support novel user experiences such as immersive environments, including sensorial experiences



beyond video and audio (engaging all the human senses), and experiences that adapt to the user, the networks and the services.

The huge amount of content that is being created requires new architectures able to manage the assets in more efficient and intelligent way. This automated management includes the ability to automatically annotate the content and create additional metadata, from three different perspectives:

- From the semantic annotation point of view, the ability to understand and automatically modify the linguistic constituent elements of any type of archived document.
- From the classic perspective of the automatic pattern recognition field, applied to any type of audio-visual content. For example, making use of Computer Vision techniques and Audio Recognition approaches.
- From the fusion of the two previous points, generating semantically structured descriptions of the content, ready for both low and high level search and the manipulation of the assets.

Handling of these vast amounts of automatically generated information will require research into new natural interfaces that are easier and closer to the human way of expression. Natural language will replace complex syntax for the composing of queries, allowing for simpler-to-express but complex-to-translate high level search and management instructions, including natural ways of describing video and/or audio, images or sounds.

**Action items for inclusion in future ICT research:**

*New content annotation procedures*

*More natural human-machine interfaces (e.g. for the search and manipulation of content)*

**V.2.3 Tools for content creation and manipulation**

Recently new ways to capture and create content have emerged, not only from the professional side but also from the user. It opens new research challenges but also opportunities for developments.

First, the industry is evolving from the creation of just audio-visual content to the capture and processing of scenes. This is not only because 2D is going to be replaced by multi-view capture and 3D modelling, but also because new types of sensors capture additional data such as the depth of objects, human body detection, the motion of objects and the scene environment. Challenges such as the capture, alignment and fusion of all this data are some of the issues to solve.

Similarly, some areas of technology areas that are currently separate will converge to provide new ways to create content. For instance computer-generated imagery (CGI) and natural video will converge to using similar 3D modelling to ease mixing real and synthetic video. User-generated content (UGC) and professional content are also converging insofar as the tools available to the professional world become gradually available to the amateurs (for extended content creation, artistic effects or the imagination of the creators with respect to interactivity and immersivity).

In addition it is not just about the signal, or essence, of the content. It is clear that more and more meta-data will be associated with the signal ranging from signal-based meta-data (information on the signal and its capture) to cognitive metadata (e.g. the description of the scene, actors...) and even to the users' metadata (e.g. information on the user, how he consumes content...). Automatic or semi-automatic tools are thus necessary to generate this meta-data, but also solutions to keep and check the integrity throughout the production workflow with appropriate privacy and security guarantees.

Finally, it means that new content representation formats will be required, generic enough to cope with all type of content with extended colour, extended spatial resolution, extended temporal resolution, more views and associated metadata. This format should also be able to adapt to any production and post-production facilities and equipment, but also to all kind of expected rendering devices (from 2D immersive theatres to 3D holographic viewing).

**Action items for inclusion in future ICT research:**

*New content annotation procedures*

*More natural human-machine interfaces (e.g. for the search and manipulation of content)*

*Capture, alignment and fusion of content data collected through multiple sensors or created by 3D models*

*3D technologies that integrate natural video and computer generated graphics*

*Development of automatic meta-data generation and meta-data privacy protection during the production stage*

*Development and standardisation of representation formats including all parameters (colour, dynamic range, 3D, resolution, metadata...) and their associated rendering devices*

**V.3 Networking and delivery infrastructure**

The requirements for this area have not changed significantly since the last version of the NEM SRA in 2009. In the NEM domain, networks underlie all the services and applications. But in normal operating conditions the user

should not have to configure the network to suit an application and should not even need to know how the signal is routed. To achieve that goal, current network technologies need much improvement. The size and complexity of the internet is growing very fast, both in terms of volume of traffic and the numbers of users (not only human users but also inanimate devices). Human users increasingly demand services that are real-time, simple, secure and personalised. Accommodating these requirements presents the main challenge for the future internet.

### V.3.1 Intelligent Delivery

Intelligent delivery of content in general and of video in particular, is an important topic for research as this will impact the majority of the future traffic over the Internet.

With the breakthrough of countless media services on the Web, media consumption patterns have changed. Watching television programmes (on a TV set or on a PC) is often accompanied by the usage of other Web-based services. The full integration of TV and Web content however remains a big challenge from a content and application side, but also from the delivery side: A rich set of tools is required covering management and delivery of the actual AV content, metadata handling and enrichment, as well as seamless synchronised delivery to different devices (including second-screen devices)

**Delivery-centric network architectures** that extend or go beyond today's content-centric networking investigations: besides the identification, retrieval, caching, and securing of named content, the timing constraints for the delivery should also be taken into account as a focal element in the overall architecture, especially for video. Depending on the video encoding techniques used, the network can perform trade-offs between quality and latency, reaching an optimal QoE for the end-user. A related research challenge is a comprehensive network quality concept which could include e.g. smart quality agents in multimedia networks with algorithms for real-time monitoring and control of the service quality.

**Intelligent adaptation of the content flow** to the underlying transport and momentary congestion status of the network, be it wire-line or wireless: today's adaptive rate video delivery mechanisms mostly rely on intelligent client decisions. In the future, an additional intelligence component in the network, and the necessary communication semantics and protocols between intelligent clients and network elements can further optimise the adaptation and delivery process.

**Cognitive video delivery** by further extending the adaptation capabilities with a learning component, and other elements of cognitive networking, will allow the delivery process to improve over time, based on high level policies and reasoning processes.

Finally, the **Interworking between content search and discovery** with delivery capabilities and constraints can provide interesting opportunities for research as it can combine the "what" with the "how" of the delivery process.

#### **Action items for inclusion in future ICT research:**

*New ways to share intelligence among terminals, network and delivery servers*

### V.4 Content search and media presentation

Content is plentiful all over the internet, often in a distributed form. Making this content searchable and accessible is still a major challenge. High scores in the survey were given to making content searchable and manageable. Topics named were 'Automated semantic annotation' on the content creation side and 'Cognitive content search tools' as well as 'Effective Recommendation Systems' at the content consumption side.

Authentic, true-to-original media reproduction including Virtual Reality is still a major topic for future research. 'Seamless mix of real and virtual content' and 'True-3D/holographic reproduction of A/V content' are issues still unsolved.

For efficient and user-friendly media consumption, more informative user interfaces are needed for future applications. Key concepts here are Interaction and interfaces for 3D content, Adaptive human-machine interfaces, and Speech control of devices.

Content search and media presentation is complemented by 'User number measurement and user behaviour logging'. However, according to the survey results, "Real time and total audience measurement" need to respect the 'Rights to private data'.

#### V.4.1 User-system interaction

One challenge for future research in new media concerns how to make users and systems interact better in order to enhance, on the one hand, the users' experience with the system and on the other hand the system's overall performance. The importance of such a topic is revealed in the survey by the fact that all respondents find the topic relevant (and a net majority of them rate it as highly relevant).

To **enhance the users' experience with the system**, future research on user-system interaction should be **focused on the needs and desires of users**. Users are no longer passive consumers of content; they expect to be able to select, to rate, to find related information and to contribute to the content that they are consuming. From a technological point of view, the aim of future research is to

provide hardware and software that are at the same time both powerful and simple to use. Such technologies should help users interact with the increasingly wide range of devices that give them access to content. A particular challenge concerns the development of **3D technologies**. 3D is a major source of enhancement of the users' experience, notably in terms of immersivity. The development and adaptation of interfaces to 3D is, however, still to be achieved.

Interaction between user and system can at the same time further **enhance the system's overall performance**. Such performance is notably increased when media content is adapted to every individual user. Hence, future research should aim at increasing the systems' ability to adapt to users, i.e. through more personalised content or access to content. **Finally research in the field of user-system interaction** should go beyond the crucial technological and user aspects. Future research **should consider** the impact of such innovations on the economics of media industries, and conversely **how well-fitted business models can foster media innovation**.

**Action items for inclusion in future ICT research:**

*Development and adaptation of interfaces to 3D devices and tools*

*Increasing systems' abilities to adapt to users and enhance user-system interaction (e.g. more personalised content and access to content)*

#### V4.2 Authentic, true-to-original media reproduction including Virtual Reality

The Future Internet will not only become pervasive in the sense of the number of connected devices; it will also carry all sorts of media with unprecedented quality. Forecasts predict that in less than 5 years 80 – 90 % of the carried payload will be A/V media.

Immersiveness is dramatically increased by quality improvements: For images and video, we will see panoramic or giant images and movies, higher dynamic range, ultra high resolution, 3D beyond plano-stereoscopic, multi-view or free viewpoint video. And within the audio domain there is Wave Field Synthesis, Ambisonics and Multichannel Audio, all of which will boost the credibility and "reality" of media rendering.

The physical realisation of virtual objects through 3D printing technology has the potential to add a completely new and tangible facet to media reproduction.

Pervasiveness, on the other hand, brings the content to the user and into their context. Dynamic and scalable content coding, integration of media into browsers through HTML5 and adaptivity that considers location and

device characteristics are all important ingredients for making media even more pervasive.

**Action items for inclusion in future ICT research:**

*Technologies for transport, coding and rendering (e.g. content-centric networks, spatial and ultra-high resolution sound and video, scalable and hierarchical coding, rendering of audio and video over the device continuum)*

*True 3D (holographic) reproduction of A/V content (Applications and services: Digital Cinema, Giant Image and Movie Browsing, Scalable Rendering, Browser-based media applications, 3D integration into browsers)*

*Affordable 3D printing technology*

#### V.5 Technology drivers and enabling technologies

Business requirements are a major factor in driving innovation. But there are also broad policy and societal concerns that shape the direction of technology development, often in areas wider than networked media. A set of enabling technologies can act as a foundation for the functionality of the entire end-to-end chain. This section describes the work needed to satisfy those concerns and develop the enabling technologies.

##### V.5.1 Data security and personal privacy

Services and their content must be provided securely between all users. The infrastructure components must be secured against hacks, intrusion and misuse. The privacy of each actor in this environment must be guaranteed; but, under some conditions, as established by law, the network must provide the possibility to trace illegal behaviours of connected individuals or service providers.

The universal adoption of on-line services and contents is highly dependent on the ability to provide consistent solutions for the security of networks and services but also for the security of user data and the protection of privacy.

On-line, networked social behaviours such as social networking, image sharing, and shared on-line entertainment allow the collection and management of information concerning a personal data and person's activity and behaviour. This could generate data security and personal privacy problems; but equally it could provide new elements for construction and enrichment of proper online identities. The important issue is related to user control and awareness of what data are collected and possibly available for ubiquitous, user-friendly, and personalised services. Consequently the implementation of a balanced and consistent European data privacy legal framework is very important for preserving personal privacy while enabling development of new personalised services. A

recognition that much of the current Internet infrastructure is governed by non-European regulation or norms is vital.

**Action items for inclusion in future ICT research:**

*Seamless user control over privacy and identity management*

*New enhanced technologies for protection of user and usage data*

### V.5.2 Identity management and AAA (authentication, authorisation and accounting)

The user's identity is a token for gaining access to all of the media services and terminals. Such access normally involves some kind of identity management, particularly authentication, authorisation, and accounting (AAA).

**Authentication** refers to the verifying of a person's claim to holding a specific digital identity and is accomplished via the claimant's presentation of an identifier, possibly with corresponding credentials; it can be pure hardware (e.g. smart card with memory), it can be pure software (e.g. secured storage on one or on distributed servers) and it can be used in combination with personal knowledge (e.g. pin-codes) or biometrics.

**Authorisation** is about granting or refusing of privileges to an entity for accessing specific services or resources.

**Accounting** refers to the tracking of the consumption of certain resources by users and is commonly used for management, planning, charging.

In order to enable ubiquitous, context-aware and personalised services, authentication, authorisation and accounting (AAA) systems should be able to provide:

- User-centric privacy mechanisms, easy to use, effective, revocable (by all parties) allowing users to control privacy protection and, possibly logically separate their identity and their activities on the network from the charging process.
- User-centric and cross-network means and mechanisms for applying and enforcing policy and charging rules;
- Privacy-preserving digital identity, trust and reputation models and frameworks regardless of the type of network and service the user is currently engaged on;
- Integrity/identity of payments (particularly for micro-payments by means of personal devices) and other business related issues; without confidence and trust no viable business is possible;
- Seamless and user friendly handover even between different administrative domains and

heterogeneous access networks (with reduced handover delay);

All the aspects and solutions related to authentication, authorisation and accounting (AAA) must also take into account issues like scalability, dependability, and resource management.

**Action items for inclusion in future ICT research:**

*New enhanced methods for identification of persons and related personal things (making use of the features offered by the emerging Internet of Things)*

*Ensuring the interoperability of identity management among different services and applications*

### V.5.3 Personalisation/profiling: Smart user profiles across all services & devices

Networked media services evolve such that that users expect the service to be available on a variety of devices, integrated with other favourite services (such as communication, social networking, shopping) and based on personalised experience. Personalization allows services and content to be tailored automatically to the end-user's preferences (explicit or implicit) as well as to the user's current context (device capabilities, location, connectivity, social and emotional situation, etc.). Such advanced networked media services include strong user involvement in an immersive, personalised *and* collaborative environment across all services & devices. Providing networked media service continuity over lifetimes, across different service providers and devices as well as preserving privacy and protecting security will be essential for the next generation of "cross-domain/cross-device/cross-provider but personalised" service.

The challenge is to make it easy and useful for users to access the massive quantity and diversity of services, information, content, available on the Internet; different application domains such as news, images, music, movies, social and professional networks, transportation, personal (haptic/medical, etc.) sensors, personal things, etc. This challenge is about building "smart user profiles" that require:

- Novel reasoning technologies for more advanced data analysis and personalised (even cross-service) content recommendation as well as common data models and APIs for data exchange and integration across different sources;
- Social and Semantic technologies bring the necessary data understanding that can enhance services to be more responsive, personalised and social, and better adapted to the end-user individual interests and needs;
- Mechanisms for synchronisation and exchange of data regarding user behaviour and usage of ser-

vices; the update of the Internet-scale repositories is the key enabler for seamless service provisioning and the challenge comes in acquiring the user behaviour and preferences automatically and in near real time;

- Service data and systems analysis at Internet scale e.g. methods, approaches and technologies for analytics of huge amount of data and complex service systems in near real time, identifying usage patterns, user preferences and needs together with complex interoperability and performance requirements, thanks to continuous mining and analysis of Internet-scale data;
- Increasing usability, user-centricity and user control over trust, privacy and identity management across multiple domains, service providers and devices;
- To include, in the European data privacy legal framework (mentioned in V.5.1) a data analytics segment for user data and service usage data.

**Action items for inclusion in future ICT research:**

*Methods, approaches and technologies for the analysis of huge amount of data on Internet scale*

*Reasoning technologies for more advanced data analytics (e.g. social semantic technologies)*

#### V.5.4 Power management technologies – energy saving in/by ICT

In accordance with recent activities on energy savings world-wide, it is possible to identify main technological drivers for energy savings which could be of interest for the NEM community in respect to provision of corresponding energy saving services as well as implementation of low-energy consumption technologies and services. The identified opportunities can be divided into the following groups:

- Direct services for energy saving and optimization (smart grid and energy management in home/buildings)
- Indirect services to support energy saving in economic sectors with typical high energy consumption, such as logistic and traffic as well as manufacturing,
- Implementation of low-consumption networking technologies
- Standard communications e-services reducing the energy consumption
- Enabler technologies and service platforms supporting the creation of low-consumption services

Research contribution from NEM community in the area of energy saving can be expected in the following areas:

- Provision of wide connectivity for implementation of the smart metering services at homes and buildings and to support implementation of Smart Grids and new green logistic and traffic systems. Here, the related connectivity issues should not be considered isolated from the delivery networks at large, which includes transfer of various types of media content. In particular, appropriate delivery reliability, quality (in term of delays and required bandwidth), and security will be of particular importance in the future common delivery network for both energy related and the media services.
- Creation of services and service platforms to support energy saving as well as establishment of the e-services should also be considered in the scope of creation of "standard" media based services, where features necessary for the media services provision could include requirements from the energy saving side, in order to establish a complete service offer and improve competitiveness of the media services on the market.
- Development of new advances communication services that consume less energy than existing ones.
- Coaching using multimedia means
- Note: In the areas mentioned above, there exist already several basic technologies but the integration of all these heterogeneous technologies still need a lot of work. To realise this, it is necessary to construct and deliver novel architectures for Future Content Networks and for Future 3D Media technologies, enabling a number of applications that require the simultaneous tele-immersion of multiple persons into virtual worlds, or even more challengingly, into physical worlds. Augmented immersive environment could be created by the mixing of virtual and real A/V data and the reconstruction of "real" environments. NEM is supporting a specific research objective and a specific budget in the next program for such a subject.

Multimedia technologies such as 3D, virtual, object and content aggregation can be used to help people to understand how they can optimise their energy footprint. For that reason there is a need to define how object information (sensors, cameras) could be merged with multimedia content. The format of such information has to be standardised in order to avoid incompatibility and to assure users that any object users might buy are compliant with such a service. This standardisation activity has to be done with EPOSS in order to ensure that the format supports all the needs of these multimedia applications.

**Action items for inclusion in future ICT research:**

*Connectivity for implementation of the smart metering services at homes and buildings (to support the implementation of Smart Grids and new green logistic and traffic systems)*

*Creation of "standard" media based services (to support energy saving as well as the establishment of the e-services)*

*New advances communication services that consume less energy (e.g. for Coaching using multimedia means)*

**V.5.5 Machine-Machine Communication**

M2M communication is an abbreviation for machine-to-machine communication, a broad concept describing a set of technologies that support either wired or wireless communication between machines (either mechanical or electronic devices) without any kind of human intervention. An example of M2M technologies might be some elements (sensors, networks and middleware) that monitor traffic in a city and communicate the information to a city control center in order to optimise the traffic flow and avoid congestions.

The M2M communication might be, therefore, used to create enriched services such as telemetry, remote management of vending machines, remote control, remote monitoring, tracking of objects, road traffic control, maintenance, smart metering, security systems, surveillance, logistic services, fleet management, connected cars, e-Health, services linked to the smart city concept and many others. M2M will be a first step towards the Internet of Things, a world where every single object will be interconnected to the network.

In general terms, M2M communication will be a core element of a wider generic, modular and flexible platform that will give value to the real world interaction by making "things-machines" available, searchable, accessible and usable by the set of multi-domain applications. Those platforms will be in charge of extracting and adding intelligence by a further processing of the gathered large amount of data stemming from each of the machines from within different environments (transport, infrastructure, citizens, water, energy, points of sell, goods, meters etc.). Such platforms will also allow service operators to offer complex services built up from multiple elements from different originators, offering valuable commercial opportunities for service differentiation.

Intelligence built in to objects worn or carried and objects in the environment will allow these objects to come together on an ad-hoc basis to create temporary service platforms.

**Action items for inclusion in future ICT research:**

*New ways of federation in order to create, in a simple-to-use form, a combination of temporary services/resources, interconnected via the Internet.*

**VI. Conclusions and implementation guidelines**

As a starting point, the key drivers for the compilation of this NEM Position Paper on Future Research Directions were:

***Working to the benefit and well-being of European citizens.***

***Helping our society to reduce and eliminate the digital divide in Europe as far as possible.***

***Assisting in realising the key themes of the European Union's Digital Agenda and of the Innovation Union communications.***

***Enabling the EU Media Industry to play a leading role in the creation of a smarter and more sustainable planet.***

Starting with an analysis of the future societal and business opportunities in the wider IT sector, and taking into account Europe's cultural diversity as an asset that we inherited from our ancestors, this document describes briefly a series of ten Actions considered necessary in order to achieve these illustrious goals. Clearly, new ecosystems and progressive educational strategies have to go hand in hand with research and large, medium and small companies in the NEM field.

The NEM stakeholders and authors of this Position Paper are firmly convinced that public initiatives, such as the European Commission's ICT Framework Programmes, form a powerful and effective instrument to profoundly foster European research, development, and innovation activities while addressing the bigger picture of sustainable growth and societal challenges. Consequently, this document represents a high-level view for themes which NEM considers to be relevant for the EU Framework Programme 8 "Horizon 2020".

## VII. Annex A - Result of the NEM Survey on most important Research Topics

### NEM research topics relevant for FP8 ICT Research

<p><b>1 Media-related applications and business models</b></p> <p><b>1.1 Value web</b> Web as public service platform Virtual meetings</p> <p>* <b>1.2 Social networking and media sharing</b> Social community control and reputation</p> <p>* <b>1.3 User satisfaction and quality of experience</b> Smart User profiles across all services &amp; devices</p>	<p><b>4 Content search and media presentation</b></p> <p><b>4.1 Automated semantic annotation</b></p> <p>* <b>4.2 Authentic, true-to-original media reproduction including Virtual Reality</b> True-3D/holographic reproduction of A/V content Seamless mix of real and virtual content</p> <p>* <b>4.3 User-system interaction</b> Interaction and interfaces for 3D content Adaptive human-machine interfaces Natural language processing (speech control of devices)</p> <p><b>4.4 Effective recommendation systems</b></p> <p><b>4.5 Smart advertising embedded in content</b></p> <p><b>4.6 User number measurement and user behaviour logging</b> Real time and total audience measurement Audience research whilst respecting the right on private data</p> <p><b>4.7 Cognitive content search tools</b> Intelligent search adapted to human ways of thinking Intelligent aggregation of search results (e.g. ontology-based)</p>
<p><b>2 Content creation</b></p> <p>* <b>2.1 New forms of content</b> Smart content Capturing of true 3D, holographic and augmented reality A/V environments</p> <p>* <b>2.2 Representation of content</b> Modelling formats Scene-based content description Automatic rich metadata extraction</p> <p>* <b>2.3 Tools for content creation and manipulation</b> Content capture (Including 3D content) Metadata driven content databases Standardised production middleware Content manipulation Content adaptation Content scalability on the move Content management systems (including for distributed production)</p> <p><b>2.4 Overcoming human language barriers</b></p>	<p><b>5 Technology drivers and enabling technologies</b></p> <p>* <b>5.1 Data security and personal privacy</b></p> <p><b>5.2 Rights management</b></p> <p><b>5.3 Federated virtual devices</b></p> <p><b>5.4 Open federated services and platforms</b></p> <p><b>5.5 Contextual awareness</b></p> <p><b>5.6 Location</b></p> <p>* <b>5.7 Identity management and AAA</b></p> <p><b>5.8 Micro payment</b></p> <p><b>5.9 Personalisation/profiling</b> Smart user profiles across all services &amp; devices</p> <p><b>5.10 Charging and payment</b> Real time and total audience measurement</p> <p><b>5.11 Middleware</b></p> <p><b>5.12 Assisted Living</b> Bio-sensors and multimodal sensors</p> <p>* <b>5.13 Power management technologies - energy saving</b> Energy efficiency of networked electronic media Influence of networked media R&amp;D on energy efficiency of other sectors New batteries/energy technology</p> <p><b>5.14 Spectrum economy</b></p> <p>* <b>5.15 Machine-Machine communication</b></p>
<p><b>3 Networking and delivery infrastructure</b></p> <p>* <b>3.1 Intelligent delivery</b> Context/content aware networks Internet governance technique Intelligent traffic management (including temporary usage of "white spaces") Smart access nodes</p> <p><b>3.2 Quality of service</b> Intelligent P2P services</p> <p><b>3.3 Network architecture</b> Ubiquitous and seamless connection Hybrid Distribution Broadcast/Broadband</p> <p><b>3.4 Home and extended home networks</b></p> <p><b>3.5 Green network design</b></p> <p><b>3.6 Support for Cloud services (incl. cloud gaming, archiving, computing, etc.)</b></p>	<p><b>6 Overall</b></p> <p>* Hide complexity – simple to use</p> <p>* Free end-user from hard and software maintenance Make user the master – not the device</p>

\* \* \* Topics for which the NEM Community sees a specifically high importance in FP8. Results derived from the open survey performed in April/May 2011.