“Networked and Electronic Media”
European Technology Platform

www.nem-initiative.org

Strategic Research Agenda

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Networked and Electronic Media: Strategic Research Agenda
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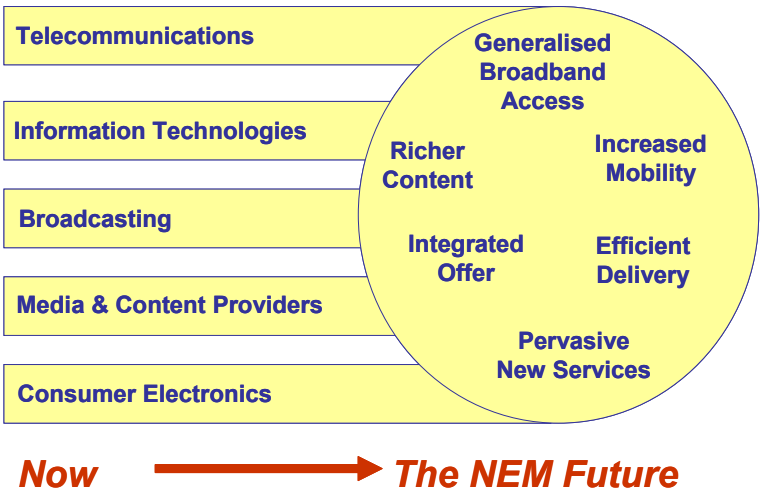
The NEM Initiative is extremely grateful to the numerous individuals who contributed to this Strategic Research Agenda. Up to date information on individuals and companies contributing to NEM may be found at www.nem-initiative.org.

1. Executive Summary

This document is intended to highlight European industry's views on the research priorities that are required in the next few years so that Europe can truly become a worldwide champion in all domains related to "Networked and Electronic Media" (NEM). Numerous reports show that investment in research is critical in creating new products, services and solutions that can be widely deployed worldwide in the future. This is the basis for the reflections that are being investigated by all NEM European Technology Platform stakeholders.

This version of the NEM Strategic Research Agenda is considered as being the first "reference" document. It has been built up mainly with a bottom up approach which has taken into account numerous contributions from many actors in the field, whether large companies, SMEs, and academic institutions. As such, it is already gathering many ideas. But more ideas and a better definition of a full roadmap may still be required. The NEM initiative is counting on this version to keep on raising interest from all those interested in the domain and who may have not contributed yet.

The **convergence** which is currently starting to happen between various industrial sectors such as telecommunications, broadcasting, information technologies, media and content providers, and consumer electronics, will eventually lead to **the birth of a new sector**. Frontiers between telecommunications and broadcasting are already starting to blur as on the one hand e.g. telecommunications operators are providing access to television channels in addition to access to the Internet and to phone calls (what is called "triple play"), and on the other hand e.g. satellite broadcasters are starting to offer interactive services such as pay-per-view and video on demand in addition to accessing traditional TV channels. This trend will only continue at an even faster pace in the next few years, enabled by a number of new and innovative technologies that will become more and more widely available. The ambition of the NEM European Technology Platform is that this new sector include first rank European industrial actors and that the technologies that will be used worldwide will be based on European standards, enabling the products, services and solutions from European companies to lead the market and benefit to all European citizens and businesses.



Technological research and the consequent development of products, services and solutions are at the heart of NEM actions for the future of Europe. There are big challenges ahead of us that need to be tackled. Only a comprehensive gathering of all European expertise in the domain, as the NEM European Technology Platform is doing, will bring efficient responses to those. It is the ambition of this document to contribute to identify the key research topics that will help to answer to those challenges.

The **first Chapter** of this Strategic Research Agenda addresses **Service and Applications**. It is NEM's view that the final goal of convergence is to provide better services to the citizens. Therefore the R&D priorities of this agenda must be considered in the perspective of improved or new services and applications for the benefit of users, should they be private consumers or organisations.

Although is always difficult to identify the applications that will be successful several years ahead; some **future scenarios** have been drafted highlighting some aspects identified as key elements of services that digital convergence will enable. Consequently, that chapter lists a few **challenges** where NEM can have a real added value by bringing together European forces. Those are

- **Enriched personal Communications**: in the frame time considered by this SRA, the trend of communications to become multimedia will be reinforced, taking benefit of the many possibilities offered by broadband IP based networks. New combinations of services will be imagined addressing groups of users. Communications will really address users, taking into account and updating their preferences or locations.
- **Personalized service creation**: Individuals will become more and creators of applications and not only consumers. Communication will therefore become more symmetrical as the users will exchange more and more self produced content assisted by relevant creation and retrieving tools.
- **Digital cinema and electronic content delivery**: an emblematic illustration of the convergence between media, networks and consumer industry is the accelerated pace of all media industries including film producers towards all-electronic technologies. This will give birth to various types of systems for the distribution of contents over networks, changing drastically the traditional consumers' approach.
- **e-Application:** ubiquitous networking will obviously favour all types of services that can be run at distance. There can be expected that new types of e-applications will take benefit from the high speed of networks and the enriched representation of information.
- **Pervasive Gaming**: the development of networked gaming is strongly linked to network capabilities in terms of throughput and reaction time. With mixed virtual reality, that business which emerged from the IT industry is now joining the media arena. The expected future network performances will influence the development of more and more innovative and sophisticated gaming concepts.
- **Advertising for new media content**: another very innovative application is advertising, which plays already an important role in the internet business. With the availability of more digital contents on all distribution media, new advertising businesses will emerge, making use of the capabilities that will be offered by all digital technologies in terms of picture processing.

That list is obviously not exhaustive, and will welcome new contributions.

The **second Chapter** of this Strategic research Agenda is concerned with **Content** related technologies.

It has become quite common to emphasize that without content whatever advanced network technology offer has no value. In the coming years, it is expected that more and more content will be created by the end users.

- That digital content will be exchanged within the family but also within groups resulting into **some convergence between personal communication and content** and will add to the content created by the professionals.
- To support that exponential growth, tools will be required to **produce** and exchange that content according to **Open formats**, and **Content protection** will become crucial.

- On the other side, when accessing content, all sorts of **content adaptation** and **personalisation** to the consumer's preferences and context will be performed requiring specific tools.
- The users will be faced to an enormous amount of information accessible in various places. Without assistance .it will become impossible to retrieve the relevant content from media libraries, which stresses the importance of **metadata** and **semantic search engine** technologies

NEM Services and application require the ubiquitous presence of networks. The **third chapter** addresses **Network Infrastructure and Delivery Networks.**

Network is something that the end user should not see in normal operating conditions. To reach that performance with the demanding NEM constraints, the current network technologies have to be improved. The topics below have been identified as strongly contributing to the realisation of that goal.

- **Network architecture**: The main challenge of the coming years is the increasing number of multimedia devices requiring advanced composite services. Network technologies must provide an answer to that challenge in terms of network organisation, throughput, efficient resource usage, capacity to extend service provision to new Body Area Network, Car Area Networks, etc.. in sustained decrease of cost conditions.
- **Network based intelligence for end to end service control**: the NEM applications will trigger an increasing number of sessions and flows. To support those applications with the relevant QoS, more intelligence will have to migrate to the periphery of the network, close to the users. Many issues must be solved to implement that new network based intelligence up to deployment.
- **Seamless service provisioning**: in order to perform seamless services on a variety of networks with different technologies and especially different architectures, a cross-network model must be developed and implemented.
- **Network planning and optimisation**: efficient deployment and operation of a new network technology is a key factor of the adoption and final success of that technology. Tools have to be designed to plan the multi technology networks for NEM services, taking into account the dynamic adjustment of network parameters that could become a demand of those services.
- **Security and privacy**: the universal adoption of on-line digital services stresses the need for security provisions in order to prevent any intrusion within the private user areas.
- **Ubiquitous multimedia networking**: in order to provide the adapted connection or content to the users whatever their location, some combination of network technologies with location awareness, automated profiling and content transcoding has to be considered.

Key elements of new services are **Terminals and User devices** which are the subject of the **fourth chapter**.

- Convergence of audiovisual, informatics and communications will trigger **Home multimedia devices** combining more and more complex IT functions (for instance high capacity storage and high computing power) with network interfaces and demanding human interfaces such as HD display capability. Among those devices the "Mobile" terminals will require more and more of the above features with severe constraints on size, weight and power consumption.
- Other types of home devices are **Gaming terminals**. It is anticipated that those devices will become key in the integrated world of NEM. At present those terminals have a proprietary status, but the development of open middleware could help to overcome that issue.

- A particular role within the home is devoted to the **Residential gateway**, which is not properly a terminal but has a privileged position within the home network. As a mandatory element of connected homes, it will be in the position of supporting many services to the consumers.
- A response to the complexity of functions that a single device has to incorporate is the concept of **Virtual distributed devices**, which in fact is the application of networking to the many terminals that everybody carries on himself. In this area almost everything has to be designed and a high level of innovation is expected in this area.

In this document, many technologies have been considered as key building elements and are not specific of the areas listed above. The **fifth Chapter** addresses **Enabling technologies.**

Those technologies are those which will enable the NEM vision to happen. They include many topics among which those listed below.

- A special attention is drawn on **Right related technologies** (DRM, watermarking, etc..) which have been identified as critical at various stages of the value chain
- Technologies aiming at retrieving information (**search engines**, **metadata**, **semantic** web): faced to the explosion of content accessible onto the (home and public) networks, the user will have to find its way to find the information he is seeking.
- **Representation of content** (media formats, but also 3D representation, augmented or virtual reality…): this is a prerequisite for digital communications. An important and successful effort has been performed in this field in the past, but new types of contents are now coming up as 3D and virtual reality which require to keep a high level of research in that area.

Beyond technology, there are other critical aspects that also need to be tackled. One is the **European regulatory landscape**, which may does not allow innovative solutions to be broadly deployed. Europe, being a union of 25 independent Member States (and soon probably more), tends to have various regulations that are in line with national priorities. Although this is perfectly understandable and even required in some cases, the big challenge ahead of us is that this does not prevent European technology to be widely deployed in all European countries. The existing regulatory bodies should take into account that the convergence of these sectors is accelerating and should make every possible effort to support and promote the broad adoption of European technologies and standards.

Another critical issue is **interoperability**. Applications and services that are and will be more and more available to all citizens and businesses will use various types of infrastructure to transport voice, images, and more generally all types of data: telecommunications networks, whether fixed or mobile, using various technologies; cable; satellite; etc. In addition, the user will have access to such services via a multitude of terminals, such as TV, PC, mobile phone, PDA, as well as new multimedia terminals that may be fixed e.g. in the home, nomadic, or mobile. Therefore interoperability between all these terminals and the various transport networks needs to be ensured. This is the only way to prevent a monopolistic situation to occur, which may be detrimental to European cultural diversity and European independence. **NEM intends to be an effective instrument to support and promote appropriate regulations as well as interoperability in the area of Media and Telecommunications at large.**

2. NEM Research Priorities

NEM has identified several aspects requiring research in order to make the vision happen. These are grouped them in 5 priorities, which are presented in the following in detail. Each priority focuses on certain aspects of critical importance. And an indication is given what the NEM projects might want to address

From a consumer centric perspective it is the service which provides benefits to the consumer. Applications enable him to use content and services. Thus the NEM vision may condensate in very different new types of services and applications. These services require an underlying technology – a so called service platform and infrastructure.

Services require content, and thus offering a broad set of services will generate massive increase in content. This will imply a need for advanced content management technologies.

This platform is addressed in the research priority dealing with the developments of networks. Not only planning, but also optimizing the operation is critical in an environment, where networks are no longer sued for dedicated services. Moreover, the number of access networks in increasing. Many types of wireless and wired networks ranging from personal area networks, local networks, access networks and core networks will have to interoperate and be managed. The investigation should include QoS issues, ease of configuration and service provisioning, and network and service management.

Terminals are critical for actually using services. With a change of the infrastructure and user behaviour new types of terminals will have to emerge.

With increasing complexity of the services and the network infrastructure supportive intelligence is needed, either in the network or even in the terminal. Based on the roles and actors (business) the intelligence may be distributed across the networks asking for intelligent “communication” mechanisms.

2.1. Services and Applications

People want to reach other people (communication), seek all kinds of information (e.g. news) and entertainment media, using any kind of devices transparent of underlying networks, easily, efficiently, securely, with fun, any time, any place! To accomplish this vision, future ubiquitous broadband networks will orchestrate an enriched user experience and future convergent service platforms will deliver any application and content managing a single customer profile.

The business model of broadcasters, telecom operators and service/content providers will become convergent regarding audiovisual technologies. New business models must be built on the basis of open service interoperability, seamless end to end services architecture, in such a way that e.g. digital television services can be accessed in a transparent way. Digital cinema will open new possibilities to exploit the internet and the convergence of technologies to provide new delivery channels and opportunities for distributing/accessing EU films.

Architectures for new delivery models need to be worked out, such as e.g. peer-to-peer services, multipoint-to-multipoint sessions for virtual environments, new approaches for service distribution proxies, nomadic use of services across fixed and mobile networks. New services like video surveillance are gaining more and more usage. This requires simple but very elaborate tools for creating new services and applications. The new applications that will emerge in the NEM vision will impose new requirements with respect to the infrastructure and push the learning spiral of broadband network technologies and services.

It is envisaged the development of suitable, user-friendly, accessible schemes (economically affordable and operationally accessible for users including people with disabilities) of “non-linear” content. Users should have access to any content, anytime and anywhere which will satisfy their needs and demands. Also requirements set for multilingualism driven by the European environment need to be included.

Development of schemes to ensure regulatory rules and applicable policy are respected with regard to protection of minors and other policy rules (advertising, etc.).

Looking from today into the future, one can imagine only a small set of services and applications such a service infrastructure will enable. In the following a few examples are given, of what one can think of today.

2.1.1. Future scenarios

2.1.1.1. e-Applications

There will be a plethora of new eApplications deployed in the future. eGovernment will rely on a large number of different eApplications, such as, eSocialSecurity, eTourism, eHealth, eTax, eVoting, and others. eInclusion is something that the whole European community needs to be part of.
Below, eLearning is singled out as one example of such eApplications that will ease the life of the future citizen, decrease the amount of time and funds for commuting, ensuring the necessary flow of relevant information, and enhancing the role of democracy.

Definition

e-Services delivery platforms enable the provision of services via all kinds of networks available to the consumer. Internet technologies will most likely be an important component. New e-Learning applications based on eServices, as has been stated in the i2010 initiative, will play a major role in the development and true adoption of the Knowledge Society.

Objectives for medium term-2010-and longer term-2015+

The new e-Learning solutions will be driven by the following scenarios:

- Personal environments will be populated by personal communication and computing devices, accessories, wearables, implants. eLearning services will be adapted to the user's individual situation, location and preferences.
- Business environments will benefit from eLearning solutions creating a competitive advantage for European business and will facilitate especially SME´s exploring new markets.
- Mobility and ubiquitous access will be a key challenge for in-field job training needs.

State of the Art

Nowadays eLearning standards are being developed by four main organizations: AICC, IEEE, IMS, and ADL (Advanced Distributed Learning Initiative of U.S. Department of Defense and its partners). Their current Sharable Content Object Reference Model (SCORM) provides the framework and detailed implementation reference that enables content, technology, and systems using SCORM to "talk" to each other, thus ensuring interoperability, re-usability, and manageability. Universities experiment with eLearning as the military is doing as well. Still, a comprehensive system and structure is missing.

Topics to be addressed

eLearning demands high bandwidth broadband, it calls for new high quality graphical environments, it stimulates the introduction of new and innovative services in digital content and software.

eLearning services also require interoperable networks, such that the content could be accessed through different channels in a seamless fashion by the end users. In addition, widespread broadband access implies for the user an overflow of information.

In this way, intelligent agents and other smart service discovery mechanisms are needed to allow users to have a personalized media experience. A user should be able to search for content he

likes without dealing with different access networks (like UMTS, DVB-H etc). Further research on semantic preferences at the various levels is needed.

Key issues to be solved

Creating eLearning services must be very simple. Suitable tools and design guidelines must be developed.

Related to the eLearning services, a key issue is the seamless interoperability and use of any kind of devices.

Other issues to be considered are those relating to intellectual property rights, especially digital rights management, and interoperability.

eLearning imposes cultural changes in the training process within organizations. It is needed to be integrated with the company knowledge management policy.

Some actions can be done from the Public Administrations to educate people in digital skills, fostering the take-up of on-line public services, including education; and supporting multilingual & multi-media archiving services through a digital libraries initiative.

2.1.1.2. Pervasive gaming

Definition

Pervasive games are "games that are always present, available to the player. These games can be location sensitive and use several different media to convey the game experience."

Objectives for medium term-2010-and longer term-2015+

A more technological description for pervasive games is that they refer to the seamless integration of network technologies and the provision of mechanisms for the gamer to interact with gaming applications and platforms, and virtual or physical game elements without the need to understand the underlying connectivity and technical networks. Within the pervasive game domain the user is always connected in multiple ways, via multiple devices.

As technology advances remove the largest constraints for terminals and transmission, there will be a growing range of multimedia personalized (including on the move) forms of entertainment and new games emerging.

State of the Art

One of the key factors in gaming applications is the ability to rapidly deliver game events among the various players over the network. Highly interactive applications like massively multiplayer online games (MMOGs) are extremely sensitive to delays in event deliveries. However, classic solutions for the delivery of fresh information over nodes of the distributed game system are not adequate for the support of fast-paced distributed games. There are also slow update online games, such as some real-time strategy (RTS) games, or others that will tolerate up to ten second latency spikes. Examples of these would be Planetarion and the MMOG ToonTown.

There are examples of novel gaming ideas such as the famous location-based game BotFighters, examples of using a camera for tracking the movement of the phone or GeoGaching. Both of these are examples of using technology that is already now available in a novel way and thus creates new kinds of gaming experiences.

SecondLife is another example of a popular game in which people can have a second opportunity to live in a different way as they are. Moreover, people are making real money trading virtual objects and properties they own in this virtual world.

Topics to be addressed

Special attention needs to be given to the interoperability issues in the new videogaming terminals for home and portable devices. Convergence issues in gaming need to be solved so that users can

play online together with any device anytime anywhere. For this to be realized, multiplatform content development and development of open standards – perhaps even in open software – is crucial.

Real-time action online gaming is a highly interactive application often characterised by strict requirements that usually cannot be accomplished by the traditional Internet protocols. The increasing potential swarm of MMOGs players imposes the use of highly reliable, responsive software solutions able to hide latencies and overheads that may affect the usability of games over the Internet.

In case of an intense traffic in the network or in the case of excessive computational loads, the responsiveness of the system may be jeopardised. Proficient architectural solutions and synchronization algorithms for MMOGs should be able to face both these two situations in order to preserve a high level of interactivity and an identical contemporary view of the game state among all the nodes in the system.

Key issues to be solved

The implications of the rising importance of interactive entertainment on the media culture are still hard to grasp and, above all, mainly unexplored. Gaming may substitute other forms of entertainment, so it may have a negative impact on other passive media consumption. However, some cross-media games (e.g., coupled to an ongoing TV-show) may enrich the user experience.

Games are also an application which requires much from the underlying transport networks. Studies show that it is a rare case when the players of fast-paced shoot-'em-up games do not suffer from network latency or latency variation. This affects greatly the gaming experience and has called for many proprietary solutions to emerge, and dedicated networks to be built. The standard Internet protocols are not designed to cope with the demands, but the game design aspects can alleviate many aspects of this challenge. Also the availability of flat-fee pricing will increase the number of players substantially.

Another key issue, and a driver for the success of pervasive gaming, is to provide the users with the ability to personalize their game experience depending on their circumstances and environment. Additionally, it is widely said nowadays that 'content is king', and as such the pervasive gaming environment must support the ability for users to create content on the fly, and so change game dynamics in real time.

Network effects dominate the online gaming industry the perceived value depends on their users. The chances of network-based gaming are already widely realized in other regions of the world (e.g., Korea). The dominance of other world regions in this sector has to do with their bigger internal markets, closer relations to hardware manufacturers and other factors. European gaming producers may have a good chance if gaming platforms are based on standards.

2.1.1.3. Advertising for new media content

Definition

Advertising has been an important source of revenues for media companies. In the new media era, digital and interactive media creates new opportunities and challenges for this business. New forms of cross-media advertising (TV shows + SMS) are emerging and campaigns can be more specifically targeted to content on-demand consumers (marketing one-to-one).

Objectives for medium term-2010-and longer term-2015+

Digital adverts can be easily copied and made suitable for different platforms and media channels. Campaigns can more easily be created for multi-channel media and the overall categorized visibility rates controlled in an easier way. There exist flexible concepts to increase the reach of ad campaigns but seamlessly adaptable to fragmented user groups or even individuals. Ad insertion is much more elaborated, e.g. by concepts for replacing scene content automatically or prolonged ads. There is no differentiation of ads for the internet and ads for broadcast.

State of the Art

Ads in broadcast are special clips inserted into a program, with the effect of interrupting the program. Alternative forms place products directly in the scene during production. In the Internet ads are placed along with the regular text in the WEB-page, or utilize the “popup window” technology. Spam must be seen also as a form of ad campaigns.

Topics to be addressed

New and often cheaper forms of advertising are being developed and taken into use. Video broadcasts may be superimposed with virtual advertisements overlaying the camera view, products are strategically placed in programming, news, which are nothing more than attempts to draw attention, are leaked to the media, seemingly strategic digital material is left at public places to be found, adverts take the size and shape of Internet jokes that are willingly and extremely efficiently spread by the users.

Audience measurement is crucial for the broadcast sector, and digital broadcasting can facilitate the automation of the measurement functions. This leads to much cheaper audience and reachability studies, without the need for audience panels and soliciting information from them.

Adding contextual and situational information to the recipients' status will allow for far more accurate advertising than is possible today.

Key issues to be solved

At the same time, the easy transport of advertising has lead to the explosion of content being pushed at the users. Unsolicited information, or spam is flooding the email boxes and technologies to counter this have been taken into use. New forms of spam are also emerging. Spim is spam over instant messaging, where textual messages are being pushed to instant messaging users, when logged on. Spit is spam over internet telephony, and is formed of robot or manual advertising calls to VoIP users.

Legislation may already have set boundaries in some of these cases, but most often lags behind. Also, new techniques often test the boundaries of existing laws and force the regulators to take a stand, or revisit the scripture. The fact remains that all the possibilities offered through technological advance, can never be taken into account by the legal advance.

The main technological progress required refers to the user control over information received. The user needs to be able to determine what is suitable for intake. Blocking unwanted advertising is a basic need. This can be accomplished by several means. E.g., developing filtering technologies, or allowing only selected senders’ messages through and establishing ways to trace the messages back to the original sender.

2.1.1.4. Enriched personal communications

Definition

We communicate with a person, or people, not only via voice call numbers, IP addresses, or similar identifiers. An enriched personal communication system provides the best way and mode to communicate with a certain person or group, regardless of the situation.

Objectives for medium term-2010-and longer term-2015+

Like all primates, humans are inherently social animals and social networking is a basic need. Humans generally have many different layers of social networks surrounding them. Group communication helps staying in touch with these social groupings. The communications sphere of a person needs to provide for mechanisms for easily adding, deleting and modifying these groupings.

The success of any service or application will depend on how users rate its usefulness and how intuitively and easily services can be used. In businesses usefulness will be measured in organizational efficiency and profitability. Generally speaking many present applications have been

created from boundaries set by technology and with minimal user interaction. In the European context there are also questions like multilingualism, different social background and disabilities, differences between the technological infrastructures which needs special attention. Demography and individual user age will also have profound influences on the usage and perceived usefulness of services.

State of the Art

When thinking of future services it is easy to gloss over the existing ones which have stood the test of time. The most obvious example is the telephone! However although exceedingly mature, voice communications has not reached the end of its use or development. While cordless and mobile phones have freed us from being tied to the vicinity of a fixed point they have not negated the need to hold the earpiece and microphone close to the face. What if we could hold a discussion with a remote party while totally unencumbered. An objective is to develop intelligent microphones and loudspeakers tracking the position of the user throughout his home or office and optimizing their characteristics accordingly.

Videoconferencing and video-telephony are services with a long history of failure, caused on one hand by the immatureness of the technology (e.g. insufficient bit rate to provide good quality pictures) and on the other by the missing social acceptance (typically, no-one likes his picture being recorded just after getting out of bed).

Topics to be addressed

When a person's availability change, there needs to be a simultaneous update of the records that the person's context group refers to, when establishing communications. Public and private authorities, such as the social security office or the employer, who may wish to enter into a dialogue with a person, need also to be taken into account.

Users can also be grouped according to their capabilities to act. Temporarily or permanently lowered sensual or physical capabilities may warrant applications and services to adapt to the situation. Were this information available in the secured profile of the user, the adaptation could be automatic, at least for the software part.

Another goal would extend the above to multi-party discussions. Today's telephone conference calls frequently leave the users struggling with a huge dynamic range between the strong and weak signals, and with the very restrictive context (e.g. it is very difficult to interrupt a speaker, background noise just at one participant's location often makes mere listening an agony).. The goal would be a multi-party open audio system which if the user closed his eyes would be indistinguishable from having the other speakers in his own room.

Research and development on new services and applications should in the future be more focused on user requirements, user acceptance, simplicity and intuitive usage. The trend towards converging networks, mobility, IP-based traffic which sets special requirements for security and trust and the need for global accessibility will on the other hand make it even harder to reach the goals for the infrastructure, networks and terminals.

Key issues to be solved

All this implies that increasing efforts should be put on technology development, but on the other hand special attention needs to be put on sociological, psychological and usability research to ensure a maximal and efficient usage of new services and applications

The continuing evolution of display and network technology results in an ever wider divide in capabilities of devices, be it mobile or stationary. As a result to maintain the usability, content and or applications will have to adapt to the environment where it is used. Ideally, processing of the media and applications to adapt to the capabilities of devices and displays should not be at the end point. It should be inherent to the media stream or application to be represented within the capabilities of the devices while maintaining the usability at the same level.

2.1.1.5. Personalized service creation

Definition

Enabling individuals and consumers to create personal applications is seen to be of extreme importance for the future landscape. There is an inevitable change going on, facilitated by broadband availability and driven by the need for communicating and experience sharing, for individuals to become prosumers (a prosumer is a person who is simultaneously a producer and a consumer).

Objectives for medium term-2010-and longer term-2015+

In the medium-term perspective emphasis should be put on developing open interfaces with open software solutions to enable easy applications development. In the long term perspective a modular approach should be developed which would enable everyday users to easily configure their own applications by using graphical or other easy to use interfaces. The system or service platform would configure the applications.

State of the Art

P2P networking, blogs and podcasts have already enabled the creation of user communities around a multitude of topics. This has changed the media consumption patterns, the user creates their own content to be shared with the others.

Open software is another example of users collaborating in the development of new applications. Many P2P applications and services have begun as software written by an ordinary user. The software has been found useful and it has proliferated with unprecedented speed. Utility and price are important adoption factors for users.

Evolution of open services and systems suggests us that every provider will be interested in allowing other services to use service and applications developed by him, preserving their user experience with independence of the final service that invokes it. Nowadays, content aggregation / syndication into a single web page is the common way of integrating “service/application components” into a personalized common user interface.

Topics to be addressed

Core aim is to define an abstract language that allows new services to send objects between them without any operation made by the service integrator. Thus, all of these interchanges could be executing at the client side, minimizing all data traffic due to delivering data to the server.

Merging this new philosophy with Web 2.0 and all related asynchronous techniques like AJAX, will enable a new generation of UIs where the communications between client and server will be reduced a lot. This issue allows the release of network resources for other applications.

Key issues to be solved

The new service paradigm when everything will be in an electronic form and available over the internet will pose new challenges to legislation and the regulatory environment. Especially peer to peer communications have brought about severe challenges to the music and film industry for example. The revenue growth of the music industry has been hit. Quite obvious are the digital rights management issues, which have been a hot topic for several years. So far it seems that measures to counteract this trend have not been very successful.

The issue of the protection of minors has raised concern and several techniques and legislative measures have been implemented. It is, however, quite clear that these measures are based on how things used to be. With the advent of internet-based applications and services where legislation easily can be circumvented by cross-border IP traffic this has shown the shortfalls of legislation and regulation as they are now implemented.

2.1.1.6. Digital Cinema and electronic content delivery

Extensive content digitalisation and pervasive availability of interconnected broadband digital networks will open the way to new delivery channels to the customers. The traditional entertainment material which is currently distributed to users through physical reels (for cinema professionals) or DVD's (for the general public) will migrate to non physical delivery systems. This will be a major change for a large part of the content industry (for instance film producers and distributors) which will have to reconsider their business models with new generations of theatres, but also with on-line contents. Moreover the emergence of the internet as another channel to provide content to the consumer will make possible new usages of contents (with more flexibility) but will also introduce the network operators as another stakeholder in the content distribution arena.

Definition

Depending on the actors and the type of public considered, electronic content delivery can take several aspects.

- A major evolution concerns films for public watch in theatres. This is Digital Cinema, a B2B application in which a series of actors which were not confronted to digital networked technologies will have to change drastically their know-how, based on trusted exchange of physical media, and adopt an ICT based approach, with file transfer over open networks, software and electronic billing.
- Television over IP: the addition of a TV service to the traditional interactive services already operated on networks is obviously a new channel to reach the end consumer at home. But conversely to traditional broadcasting, that technology brings also many capabilities in terms of interaction with the content and access to a large (and non-linear) offer.
- But some electronic content delivery mechanisms (and businesses) can also be imagined to take benefit of all the components (including memory) available at the users' home or in the network, and/or based on the assumption that most users will be connected, even sporadically, to some high bandwidth wireless networks.

Objectives for medium term-2010-and longer term-2015+

Although it is always difficult to anticipate the ways the consumers will appropriate future technologies, a general opinion is that the move towards electronics distribution of contents will be ubiquitous in the years 2010-2015. This will imply a radical change of the delivery paradigm during that period, which will imply strong technology evolutions (decrease of physical media, increase of network throughput, severe requirements on security), but also the development of new service concepts which will make use of network capabilities in terms of ubiquity, storage and interactivity.

State of the Art

Nowadays early deployments of various electronic content delivery systems are under progress in several countries. Digital Cinema has started in the US and some specifications have been issues by the DCI consortium (initiated by the major film producers) but the digital projector is still an expensive component. Television over internet is perceived by some operators as a business answer to the income reduction that will result from the migration of telephone over IP. Such services include some VoD capabilities, but TV over internet remains principally "another media to broadcast TV". Various other ways of digital content distribution systems are also considered here and there. However, this is only the first step towards an extensive deployment of those technologies which will participate to the concept of "content available everywhere, at any time".

Topics to be addressed

In order to massively deploy new distribution technologies relevant standards must be stable, broadly accepted, and the technology must be available at reasonable price.This implies:

- The definition (or the extension) of standards addressing content distribution architectures and their integration within the telecom infrastructure (as one of the many services enabled by an open multimedia service platform),
- The development of low cost components for digital picture processing and displays according to the type of applications targeted (servers, codecs, projectors for theatres, offices, homes),
- The development of innovative content delivery architectures combining networking and storage in order to enable new business models (push model, video podcast etc…)

Key issues to be solved

The migration of Content delivery to digital networking has to face Digital Right Management and piracy issues. Another issue is the amount of investment that will be necessary for that migration, especially when radical changes such as Digital Cinema are considered. But also, because in many cases that migration will imply the increase of business stakeholders, some clarification of the business models and of the role of each actor will probably be required.

2.1.2. Service related technologies

2.1.2.1. Tools for content discovery

Definition

In a near future world where content on demand is available everywhere from many providers, finding appropriate content for the user needs (discovery) becomes of the utmost importance. Imagine the Internet without any search engines; it would be very much harder, if not impossible, to find information.

Objectives for medium term-2010-and longer term-2015+

Discovery can be both of specific pieces of content and also packages of related content. The discovery engine should have some intelligence, remembering previous choices selected and using that information to steer new searches. The normal, current use of discovery is for a search to be conducted, followed by the subsequent download of the information being sought. This is the way most people expect discovery to be used.

However an alternative view is that the search could be based on an example or based on searches one has made previously (based on a profile that could be stored in the network rather than locally - network-storage of profiles has the advantage that it is available from any client device…) or on some consensus view.

State of the Art

Digital TV channels provide a service called Electronic Program Guides (EPGs) which are only compiled by the service provider. In a EPG, each piece of content has a single descriptive metadata prepared by the content producer or owner. NEM must enable the situation where the viewer has a choice of EPG and metadata sources leading him to a piece of content. Such descriptions may come from 3rd parties. Independent TV guides, like TV.com also offer information and user recommendations about TV shows.

Traditional search engines, like Google, have evolved to offer audiovisual search engines (see Google Video) which is now the world's first open online video marketplace, where you can search for, watch and even buy an ever-growing collection of TV shows, movies, music videos, documentaries, personal productions and more.

Topics to be addressed

Thus there could be two classes of audiovisual search engines with different requirements on network bandwidth. The library metaphor would have more information with little additional presentation surround, whereas the bookshop metaphor would have less basic information but with more surround (i.e. flashy formatting). There are implications on network usage patterns for these two scenarios - the library is search-intensive, whilst the bookshop is likely to be more multimedia-based, and therefore consume more download time.

Standards for metadata describing content should be developed, based on the work done in MPEG7. New ontologies for audiovisual content classification should be defined to be used by audiovisual search engines. Discovery services should be also integrated with PVR and other audiovisual equipment either at home or personal portable devices.

Semantic search algorithms should be integrated in audiovisual search applications.

Automatic generation of metadata is a topic that still needs attention. Especially to open up archives of existing (not to say older, and non-digital) content in an economical way, the processing of content and creation of metadata should not involve too much hand-work.

Key issues to be solved

There are obviously digital right management issues to be solved, especially when content is paid for.

New business models will emerge; the real value could be more in the service rather than in the content itself.

2.1.2.2. Multimodal interactivity with remote environments (telepresence)

Definition

Telepresence services provide a virtual environment for humans to control devices, robots, etc., in a hostile or remote real environment. In a telepresence system the human uses (head-mounted) displays and body-operated remote actuators and sensors to control distant machinery.

Objectives for medium term-2010-and longer term-2015+

Telepresence is the experience of being fully present at a live real world location remote from one's own physical location. Someone experiencing transparent telepresence would therefore be able to behave, and receive stimuli, as though at the remote site.

Experiencing presence and telepresence does not depend so much on the faithfulness of the reproduction of the physical aspects of external reality as on the capacity of simulation to produce a context in which social actors may communicate and cooperate" (Mantovani and Riva 1999).

Two main targets may be pursued:

- business application for remote communication and collaboration (e.g.: pipeline video inspection for maintenance and repair, distance learning).
- tele-operation through specific devices (eg: subsea work in deep waters, hazardous situations, remote surgery)

State of the Art

Research on Multimodality and its applications is now efficiently launched in cooperative networks (NoE Similar), academic laboratories (MIT MediaLab, Center for Human-Computer Communication (Oregon)), and companies (Siemens, Philips, Nokia…). Multimodal interactivity with remote environments is a great challenge in respect to the growing needs in efficient remote collaboration wihtin multi-site companies. It is worthy of a particular focus.

Topics to be addressed

For an efficient remote interactivity, among numerous topics to be addressed are:

- Mutual awareness: new devices and software (audio, video, tactile) reproducing for the attendees a natural peripheral awareness of the remote site.
- 3D interfaces: 3D visualization and 3D interaction

Key issues to be solved

Issues to be solved:

- Network latency: Multimodal interactivity needs to have an immediate and secure feedback.
- Displays: few haptic and tactile devices are available.

2.1.2.3. Remote Management

Definition

The home network is becoming more and more sophisticated, capable, and complex. The range of devices available is growing exponentially, as is the effort that is required to install and manage them. Remote management of home networks will become increasingly important, as will the ability to manage a user's network remotely.

Objectives for medium term-2010-and longer term-2015+

As new devices are installed into a network, there should be some form of dialog between the device, the access gateway and the network or a controlling entity in the network. This exchange of capabilities will not only allow the access gateway to manage the device in the home network but also allow the network to manage configuring services and requirements for that device. There are likely to be two modes:

- Normal Monitoring.
- Failure Fixing - when something goes wrong and detailed information is required.

In the latter case, the quantity of information flow changes and the symmetry of the connection is likely to reverse. (eg VNC screen-scrapes of user screens sent to a remote diagnosis centre.)

State of the Art

Remote management is used in businesses today. There are systems that will allow for remote software updates, data synchronisation, system configuration, policy enforcing, screen capture, and even remote use of the hardware. This functionality is fully in place for fixed connections, but wireless functionality is quickly catching up.

Topics to be addressed

NEM needs to explore the new business opportunities and potential new nodes in the value constellation. While the ideal case is that everything works automatically optimally, it is foreseen that homes will require functionality similar to that in the business world when dealing with the complexity of the home appliance interconnectivity and interworking. Personal area networks and personal networks will outnumber the business networks, and will require a similar amount of security than the business networks of today.

Key issues to be solved

Many of the main issues to be solved are technology related. Obviously there is need for development of service platform concepts ensuring interoperability between devices and gateways, ensuring secure communications, taking care of authentication and dealing with payment and billing. Remote management with new access methods to the home environment with

interconnected terminals and devices will raise new security issues and thus these questions need to be addressed.

2.1.2.4. Micropayments

Definition

Micropayments are small, usually one off, payments made for a given piece of content or service. They allow for billing for small amounts collected centrally and then distributed to the appropriate content/service provider.

Objectives for medium term-2010-and longer term-2015+

Rules to control how Micro Payments are applied can be complex, particularly in the case of acquiring rights to a complicated set of content, especially if that content is dynamically reconfigurable. Micro Payments act as an enabler for people to buy or sell services which otherwise they might not bother to buy (or to charge for). Micro Payments are components of larger services, rather than a completely separate service. So, a future network might implement Micro Payments as a core part of its basic capabilities, and thus potentially make any data transfers subject to charging, if required.

State of the Art

The availability of a micro-payments system is a critical element. Systems do exist already, but are not yet widely used. The flat fee "all you can eat" model is on the other hand gaining more acceptance mainly due to growing competition between service providers.

Topics to be addressed

The micropayments system must be easy to use, secure and trusted by users, auditable and low cost to run. When an individual payment may be only a few cents the overhead of processing that payment needs to be an order of magnitude smaller.

Key issues to be solved

Legal issues and strong opposition by money management authorities (banks, etc,).

2.2. Content

The media industry consists of a **value chain producing, storing, adapting, aggregating, delivering, and consuming 'content'**. NEM considers content to be understandable information made available to a user at any stage of the value chain. This definition of content **includes both the 'essence'** – the data representing text, audiovisual services, games programs etc. that is the object of the value chain – as well as **the metadata** that describes the essence and allows it to be routed, processed, selected, and consumed.

Content is the key driver of success at the consumer level, a critical innovation factor in the whole system. In NEM's vision, the media industries will become increasingly interactive, so **consumers will also be generators of content** (see also the section on). Thus the value chain will be increasingly interlinked and convoluted. Therefore, it is important that Research and Development effort is applied equally to **content production**. The creation of content has a technological side, which should not be underestimated; this is especially true for the development of interactive entertainment. R&D resources should be applied to areas such as script writing, formats, graphical design, set construction, direction, production, postproduction, interaction, consumer participation, etc.

Another trend of the future as seen by NEM is that **any content** from **any source** will be available **anywhere at any time** – via natural interaction – on **any interactive platform**, in **any format** desired by the user, which implies that a specific attention should be paid, beyond physical delivery networks, to content adaptation and personalization and selection processes.

At present, most content is produced by a craft process. Normally, the user either has to make an appointment (through a broadcast schedule) to consume content or has to buy the physical medium supporting the content, for replay on specific equipment (DVD player, portable cassettes player etc.). Download of content over networks is still in its infancy, and beset by problems of rights management and format conversion, non-compatible software etcetera.

To achieve NEM's vision, the following technologies are needed, for instance:

- More economical and more easily usable tools for content capture, including automatic metadata capture (e.g. indexation)
- Easily usable tools for editing content - including interactive content - on consumer IT equipment (i.e. state of the art consumer PCs)
- Seamless handover between disparate networks
- Content adaptation to the target device (e.g. from e-cinema to the screen of a portable device)
- Content personalisation to the user's preferences or context
- Assistance to select content
- Rights management that treats all users fairly

The issues that may prevent the realization of the vision are **not primarily of technological, nor even economic nature**. They are concerned with **usability** and the **legal aspects of rights management**. Usability issues could limit the vision to a minority of technophiles; and rights management tools could be used to prevent dissemination of content rather than to encourage it. Of course the ability of some technologies to implement the vision has to be checked. For instance automatic translation might help to overcome the barrier of language differences, but it is still far from clear whether acceptable machine translation is even possible in theory.

2.2.1. Private and public content production

Definition

The mission of the NEM platform, as far as content is concerned, should be to facilitate the **production of new audiovisual content** - entertainment, news, education, and public service - that takes the maximum advantage of the new capabilities of networked electronic media in order to integrate all citizens into the Information and Knowledge Society.

Objectives for medium term-2010-and longer term-2015+

The production of **interactive content will become the most important element** of content production. Content produced by organizations for public consumption will ask for contributions from individuals; and individuals will wish to personalize and adapt content produced by others and to make it available to third parties.

State of the Art

Collaborative tools already exist for text production (e.g. Wikipedia), and computer programs can be refined through collaborative 'open source' procedures. Broadcasters use pictures and video from members of the public, particularly in news and entertainment programmes (e.g. funniest homevideos). Some broadcasters make content available to the public for creative use under the 'creative commons' procedure.

Topics to be addressed

The main requirement is the realisation of more **economical and more easily usable tools** for content production. One example emerges in the gaming industry, where there are barriers to market entry similar to those of early film or television. The costs of creating new products and prototypes are much higher than in other media sectors. It is therefore **crucial that content developers have better access to technology** that enables them to create content and implicitly opens the way to distribution channels.

Domestic tools for content capture are already almost indistinguishable from professional tools; the focus should be on **tools for content manipulation and editing that run on domestic IT equipment**. (e.g. state of the art consumer PCs).

Above all, such tools must be intuitively usable - this will require trials with large user groups.

Key issues to be solved

The main issues will be concerned with **usability and rights management** rather than with the technology itself.

2.2.2. Open content format supported by commonly available tools

Definition

The open format for content is the **way to describe** the dynamic or static **data**, the components used to **render these data**, the interactions between the components and the mechanisms to **adapt the rendering** of the content across various networks, devices and user contexts.

It is important to note that in some contexts 'open' implies a standard accessible to all but with conditions (which may include royalties) on its application. In other contexts, 'open' implies 'open source' and therefore freely usable in all applications.

Objectives for medium term-2010-and longer term-2015+

Within the NEM context this format Is regarded as **relying on open** (and, if possible, open-source) **standards** that are **widely used and shared** between large communities of the whole content publication chain. The format should **allow dynamic adaptation and scalability** through **multi**

publishing platform and should be common to the widest range of public and professional production tools. Standards must be interoperable, for instance by standard software plug-ins.

State of the Art

Today, most of the solutions for content rendering are based on a textual description language that is often XML-based and a rendering engine on the user device. However, except for XHTML that is the format used on the web today, **most of the upcoming formats** (XUL, MXML, XAML, etc.) **are not compatible** and need specific rendering platforms. MXF and AAF are used in the audiovisual production industries, and a portable content format (PCF) has been developed for interactive applications.

The institutions that constitute the MPEG community have invested important resources both in the development of the MPEG-21 standard, in order to ensure the interoperability of contents, and in the MPEG-A initiative (Multimedia Application Format), which includes a clear business orientation in order to define the specifications adapted to the functionalities required by the industry.

SMEs dominate the field of content creation, and tend to be moving towards open-source software standards.

Topics to be addressed

The ultimate goal should be to have a **new generation open format** to replace or subsume all the current formats listed above, whether the publication chain is based on a Rich client or a thin client.

That format should embed as **much semantics** as possible and be human readable following the approach that was a key criterion for the success of XHTML.

The **open-source approach** should be encouraged because it is more flexible, but it needs a new business model. Open-source standards must be maintained and improved continuously just as proprietary ones.

Projects understanding this requirement could develop a new business model for Europe, facilitating the maintenance of open-source software.

Key issues to be solved

The main issues foreseen are the **standardization process** (different interests from software vendors regarding their production tools and players) and the **performance of the whole multi publishing chain** as a consequence of the scalability and adaptation features required by such a format.

2.2.3. Content adaptation

Definition

Content adaptation is the ability to **tailor content to the current circumstances** of the user. The adaptation required is determined by the capabilities of the terminal(s) and equipment available at the user's current location, the capabilities (such as bandwidth) of the communication networks at the user's disposal, and the physical circumstances of the user - who may, for instance, be visually impaired. Obviously, such adaptation shall be transparent to the end-user, so that he/she does not need to know all the technical parameters that may be of influence. Content adaptation is related to content personalization, which is concerned with tailoring content semantically to the user's requirements.

Several different forms of content adaptation may be identified:

- Selection of the most appropriate content version among a set of statically pre-prepared versions;
- Scalable formats, where higher quality or more complete versions are built up by adding to lower quality versions and the components relating to the appropriate quality level can be selected;

- On-the-fly production of new content versions (dynamic downscaling, format transcoding, merging of different media channels, …);
- Dynamic binding to the resources and service components that best fit the currently applicable context.

Objectives for medium term-2010-and longer term-2015+

Real convergence will give seamless and transparent access for all users, whatever their circumstances, to multimedia information by means of any terminal through any network whatever the network and terminal characteristics. The **final promise is to supply services** that are easy to use and better **adapted to what the user needs by providing information in the right format**. Finally, content editors should easily be able to support content adaptation during the production of content. The vision is to achieve autonomous **on-the-fly adaptation, with no human intervention**: adapters should be capable of self-description, and a pervasive support infrastructure should take the appropriate context-based adaptation decisions, without affecting the design and implementation of multimedia servers and client applications.

State of the Art

Today, very little content adaptation is performed by the publication platforms. Some features are supplied in the field of multi device management and media adaptation (especially on still images) but these adaptations are very light. Some broadcasters make low-resolution versions of content (particularly News) available on web pages, and broadcast content is being adapted for the small screens used in mobile TV trials. Video content may have components to make it more accessible to some users - subtitles for the hard-of-hearing, sign language interpretation, and audio description for the blind or partially-sighted - and these components sometimes can be selected optionally by the viewer.

Traditional protocols and commercial support solutions to multimedia streaming cannot guarantee context-dependent sessions and session continuity. They need to exploit real-time content adaptation techniques such as dynamic downscaling, format transcoding, and merging of different media channels.

Several international research efforts are focused on the design and implementation of middleware infrastructures for content adaptation. Most of those proposals tend to adopt an adaptation approach based on static content selection; some research activities have already addressed real-time content production; only a few research efforts consider dynamic binding to resources and service components.

Topics to be addressed

The ability to **repurpose encoded audiovisual media formats** is an important research topic with impact not only in the coding field but also with impact in current streaming architectures.

- A major action here is related to the adaptation of scalable media under development.
- Further research is required on the development and implementation of algorithms and transcoding systems, the real-time management of the network and device capabilities (e.g. UA Profile), and the computation of a delivery context to provide the best version of the service.
- Traditional protocols and commercial support solutions to multimedia streaming cannot guarantee context-dependent sessions and session continuity. They need to exploit real-time content adaptation techniques such as dynamic downscaling, format transcoding, and merging of different media channels.

Key issues to be solved

Application-level middleware infrastructures should **monitor context changes** (characteristics of exchanged multimedia flows, user preferences, connection/bandwidth availability …) to autonomously and effectively adapt service delivery, to decrease the complexity of designing and implementing adaptive multimedia services.

It is fundamental to enable **automatic content adaptation** based on proper service composition and dynamic re-configuration of bindings to resources and service components. In particular, middleware infrastructures should facilitate component description/discovery and automate context-dependent dynamic binding to suitable resources, by also guaranteeing streaming continuity during transient re-configuration.

Finally, current **standards and frameworks** for session management have to be **extended**. The Session Initiation Protocol (SIP), lacks context awareness and therefore is not suitable to dynamically adapt mobile multimedia services: the need for standard extensions to fit the requirements imposed by the wireless Internet (wireless access localities integrated with the traditional wired Internet) is starting to be recognized.

2.2.4. Content personalisation, context awareness, ambient intelligence

Definition

Content personalization is the ability to **tailor the content to the end-user's preferences** (e.g. content consumption in the past) as well as the user's context (location, current connectivity, mood, etc…). Personalization is a means of meeting the customer's needs more effectively and efficiently, by making interactions faster and easier.

Objectives for medium term-2010-and longer term-2015+

A topic related to personalization is **content adaptation** which will "physically" (as opposed to semantically) **adapt the media resources to the context** of the user including the available bandwidth, the resolution of the terminals being used, etc. (see previous section). Furthermore, content personalization is closely related to knowledge management, data mining and to indexing. Another related issue is the **location of content** such as gaming software, adapting content to the needs of a local market not only in language but also in terms of cultural references.

User experience personalization to be effective when they are receiving highly relevant content available exactly when they want it - any type of media available at anytime and in the most efficient way. Not just limited to on-demand TV, video or music, but life experiences – education, self-awareness, community, immersive reality, multi-player games and shopping. Advanced content delivery systems need to exploit information about the environment in which they are working.

This 'context awareness' is much more than location awareness alone, or merely the immediate situation. **The vision is to have a middleware infrastructure capable of collecting all context metadata** from clients, servers, involved resources and the environment in general, and of transparently deciding the most appropriate content customization operations, with no impact at all on the design and implementation of multimedia clients/servers.

State of the Art

There are a number of personalization software products available. Profiling engines are generally composed of three modules:

- User profile: creates a user profile based either on explicit (the user declares his/her preferences) or implicit (with data mining process) information.
- Assessment of interest: contents are ordered in a list. Each document has a value associated that represents the interest of the user for that content.
- Presentation: contents are organized and then sent to the user.

W3C Composite Capabilities/Preference Profile (CC/PP) is currently the most widespread standard for the XML-based description of user preferences and device capabilities. Open Mobile Alliance (OMA) adopts a CC/PP-based profile, i.e., User Agent Profile (UAProf), to describe mobile terminal capabilities1. By focusing on content description, various XML-based standards were designed to cover different aspects, such as content authoring, e.g., DC by Dublin Core Metadata Initiative

[1] UAProf has broadly spread as the de-facto standard for cell phones profiling

(DCMI), content description of complex audiovisual data, e.g., MPEG7 by Multimedia Picture Experts Group (MPEG), and content delivery and protection, e.g., MPEG21 also by MPEG. Also, IST projects started to conduct research in that area, e.g. ePerSpace Project, which objective is to provide an open platform able to give access to any content provider using a common user profil management. After standardization this solution could have potential for industrialization.

Topics to be addressed

The first objective in the field of personalization is the development of a **system that is aware of the user's situation (**location-based information, mood). Such a system will interpret the contextual information in the light of preferences previously declared by the user or choices previously made to supply appropriate 'tagged and targeted content'.

A **support infrastructure** should be able to properly aggregate data about the context, in order to distil a context view at the proper level of abstraction depending on who/what is in charge of taking decisions on the basis of that view. Sometimes, those context data should be migrated, possibly proactively, with the client they apply to, depending on client movements during a multimedia service session (roaming, horizontal/vertical handoff, etc.- possible interaction with the research efforts by the eMobility Initiative).

It is possible to identify two differentiated incremental steps of progress, involving different topics and issues:

- Designing and implementing a support infrastructure that facilitates the work of multimedia service developers/providers by providing an integrated programming interface for both retrieving current context and commanding content customization;
- Designing and implementing a support infrastructure that autonomously takes content customization decisions on the basis of automatically collected and aggregated context information.

Key issues to be solved

Beyond the technological issues, collection, storage and use of the data needed for personalization involves **challenges in the field of personal privacy.** If early personalized services are perceived as not useful, or as an invasion of privacy, public reaction could prevent this area of work from achieving its promise.

2.2.5. Convergence between personal communication and content

Definition

Users wish more and more to share content within a community of people in order to enjoy together a specific period of time and to share reactions to the content. At present, this is difficult except by the users being physically present in the same place as the content – for instance at a theatre, sports ground or concert hall. NEM could offer solutions that allow people to do that remotely. One of the solutions is to make convergence between personal communication and content a reality offering to several remote users the possibility of access to a common piece of content and to react to it as they could do during a physical meeting. That could be done through an integration of content distribution and personal communication.

Objectives for medium term-2010-and longer term-2015+

A first objective would be to study and propose solutions able to offer to two users the possibility to watch a TV programme (for example a football match) with an overlay of video communication, or an audio channel. Such a service needs integration of two streams, one coming from the content provider, one coming from a communications provider, and the solution has to be standardised in order to ensure interoperability. Study of such 'first generation' solutions would stimulate ideas for new forms of content exploiting this convergence.

As a longer term objective, NEM should study and provide solutions able to allow a community of users to share any content (movies, music, photo, games ...) and react to them with the other

people as they could do in a physical meeting. That service has to be able to run on any types of device whatever is the situation of each participant (at home, in the car, on the move, at the hospital, in the plane ...).

State of the Art

At the time being there are some projects and prototypes such as *AmigoTV* offering proprietary parts of the solution (for example, only voice communication supported) which could be used as a basis of a European solution.

For broadcast content, some such services already exist, through chat rooms on the broadcaster's website - which may be mediated by the broadcaster.Mainly, though, current services offered still use different devices for consumption of content (e.g. the TV) and the interaction with others (e.g. the mobile phone or PC).

Topics to be addressed

- Community content platform able to broadcast TV program or any multimedia content to a community of people
- Community communication and presence platform able to establish audio and video communication between the different participants
- Innovative user interface able to combine content and communication services

Key issues to be solved

- Overlap between advertising and overlaid video communication
- Standardised solution able to be used on any type of devices

2.2.6. Content summarising

Definition

Content summarising consists in **generating a condensed version** of a given audio-visual document, program or full channel broadcasting providing an overview of the most relevant information or events of interest present in the content.

Objectives for medium term-2010-and longer term-2015+

Summarization possibilities strongly depend on the nature of the content itself: news, sport, musical programmes, etc. The most useful summary will also strongly depend on user's expectations: information, emotion, etc., context of use: at home, in mobility, limited accessibility and handicap, and preferences. Technologies capable of generating such adaptive summaries, with possible trans-modality conversion, are to be researched. Target services concern video summary distribution in diverse contexts: fixed & mobile TV and VoD, video conferencing, video surveillance.

State of the Art

Currently, video summarizing begins with intelligent decomposition into shots followed by either key frame selection for each shot, or frame mosaic-ing. Further analysis can be performed such as shot grouping into scenes for movies, event detection in sport programmes or facial recognition of key personalities. Keyword detection in the audio track, or in on-screen text, or in an accompanying subtitle track, can also be used to enrich the information. This additional processing still **needs to be greatly improved to achieve operational usability**.

Topics to be addressed

Summarizing is **strongly dependant on indexing** (see below). Specific topics to address include in particular **flexible knowledge-assisted content analysis** that is also to progress and

generalize so as to enable **easy summary generation for most types of content** from a limited set of core technologies.

Key issues to be solved

The key issue for this topic is technical: almost all recognition techniques **must progress a lot** in order to achieve the minimal level allowing using them in operational services.

2.2.7. Content indexation (automatic generation of metadata)

Definition

Indexation means **generating search keys enabling efficient retrieval of content** in both relevance and speed respects. Some keys simply consist of textual metadata handled by classical database management systems. Some others need specific handling.

Objectives for medium term-2010-and longer term-2015+

The main aim is to develop **advanced automatic analysis and recognition** tools and systems for audio visual content (photo, videos, music) capable of **generating highly semantic metadata in a very fast and reliable way**. Target services include audiovisual delivery over fixed and mobile networks (TV, VoD) and all associated functionalities (intelligent PVR, summarizing or content adaptation), personal content management, professional content management including video surveillance and video conferencing applications.

State of the Art

The lack of proper indexing and retrieval system is rendering useless most of the huge collections of digital multimedia content that are available. Only a few indexing techniques can be considered as mature and effectively deployed: audio and video segmentation, image and music identification, detection of recurrent shots (eg: news anchor) and speech-to-text transcription in very favorable conditions.

Topics to be addressed

For almost all recognition techniques (vocal, person, object, event), stress must be put on **relative independence to content type and recording/capturing conditions**, essential for reliable and effective use. Knowledge-assisted complex scene understanding is an ambitious but natural goal for more advanced functionalities. **One-pass multiple entities recognition is also a fundamental topic to address** to maintain acceptable processing complexity.

Key issues to be solved

All other recognition techniques **must progress a lot** in order to achieve the minimal level allowing using them in operational services.

2.2.8. Innovation in creative formats

Definition

Recent experience has shown that take-up of new digital platforms is strongly driven by the availability of new services. Users will not buy into a new platform just because it's new or digital. The new networked electronic media will **make possible new forms of content** that will help to drive take-up; and the new forms of content will shape and orient the technological development.

Objectives for medium term-2010-and longer term-2015+

Particularly among the young, new media are more often used than traditional broadcasting media to get information, entertainment, and learning. The role of the media, a critical role in democracies, must be updated and directed to maintain their level of social influence and relevance.

NEM's vision is a **convergence between the traditional broadcasting media and new media**. Consequently interesting and attractive new content can be produced that takes maximum advantage of the capabilities of new media while retaining the universality of traditional media. And related content will be available on all platforms, produced as a single package and designed to exploit all media.

State of the Art

Interactive elements are being introduced into traditional broadcast media in some countries, but **often only to offer extra text services** (programme notes for a concert, recipes for a cookery programme ...).

Topics to be addressed

New formats of content must be designed to bring about this convergence. Those formats must be able to embrace the new capabilities of networked electronic media and which adjust to their various platform configurations: mobile phones, Broadband, interactivity on DTT, and so on.

TV scripts and their guides of style, for example, will not be the same for traditional TV than for video content products shaped for 3G phones. A whole new set of expression codes must be developed for the NEM and for the integration between NEM and traditional Media.

Key issues to be solved

Rights regulations must recognise that the media industry moves towards NEM, thus helping create a true market for future NEM-friendly content.

Workplans must include **creativity in content formats**, and evaluation guidelines must ensure that it is equally rewarded with technological creativity. Talent must be brought to the NEM arena. The people who are at the origin of compelling and successful TV and radio shows, and electronic games, must learn about the capabilities of the New Media and start developing product and material for it: script writers, producers, journalists, graphical designers, conductors, etc... Managers in the whole audiovisual Media industry must be see the need to embrace new media as new distribution channels for their content, while their companies and professionals start to produce at industrial levels for the new formats that will be specific of NEM.

2.2.9. Semantic searching for content

Definition

Discovering content can be defined as the act of which a user or an agent finds a description that fulfils certain user criteria. The primary goal in content discovery is always to **find the most suitable content** among all the possible ones (the semantic technologies will play an important role in the intelligent discovery of contents).

Objectives for medium term-2010-and longer term-2015+

The search engines, nowadays, accept key words as input and generate as output a list of objects that contain these key words. The quality of the results depends on the classification of the list.

A **semantic search** has two main advantages compared with the traditional search: It accepts questions formulated in natural language and the result of these questions is the fragment of information that is sought.

Semantic searching attacks the overload of information. It may have the potential of revolutionize the way in which we search digital information. It changes the paradigm of "search" to "content selection".

State of the Art

Nowadays there are some semantic search engines like

- TAP (TAP is a distributed project involving researchers from the Knowledge Systems Laboratory at Stanford, Knowledge Management Group at IBM Almaden and W3C's Semantic Web Advanced Development Initiatives)
- Conweaver (semantic search engine recently developed by the Fraunhofer Integrated Publication and Information Systems Institute - IPSI), etc.
- Semantic Web and enabling standards: XML, RDF/RDFS and OWL.

Topics to be addressed

Semantic Search of audiovisual content: MPEG-7 and TV-Anytime are well-accepted standards for the description of audiovisual content. They both provide capabilities for specifying structured metadata descriptions of both the audiovisual content and the user preferences regarding audiovisual content.

2.3. Network Infrastructure, Delivery Networks

Many issues have to be investigated on network infrastructure in order to make the vision of NEM happen, including the multi-technology integration issues and the convergence of broadcasting, telecommunications and consumer electronics in the home and extended home environments. This convergence has to be implemented while preserving network security and the quality of service end-to-end. The network integration should in particular span mobile broadcasting (HSDP, MBMS, 3,5G etc.) and other digital broadcasting and high-bandwidth network solutions (DVB, DMB etc.).

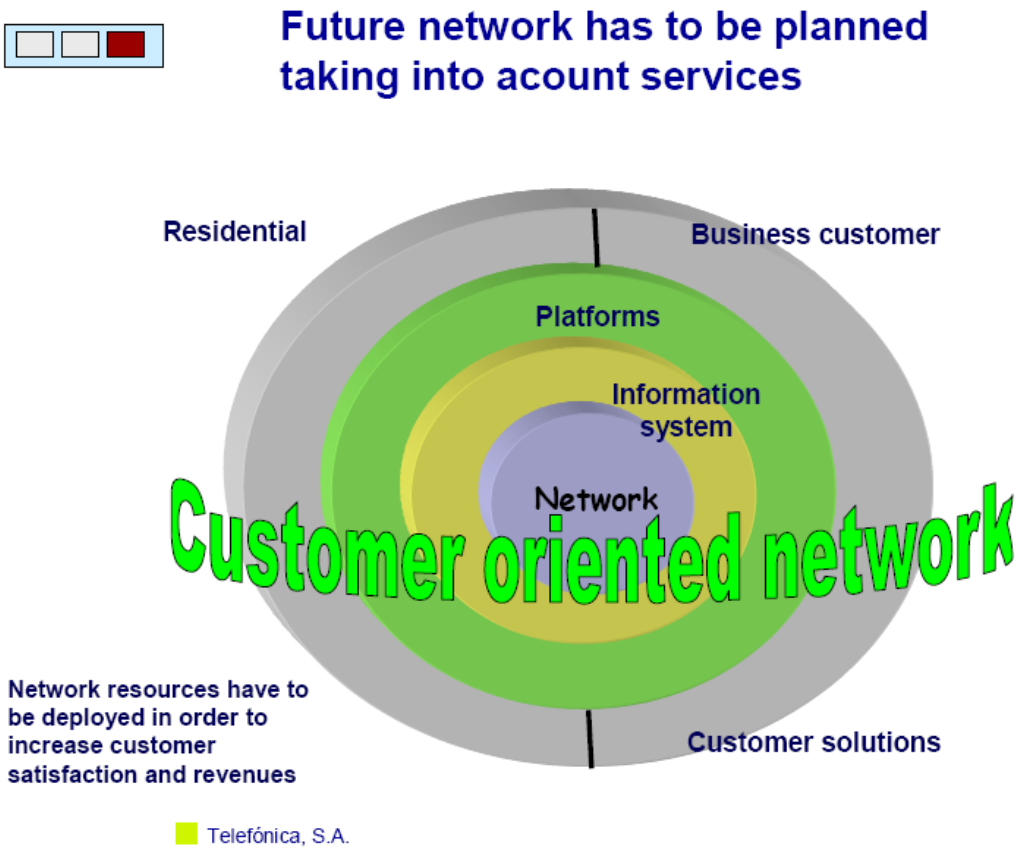
Additionally, the future network will be centred on a real-time, self-configurable, open service infrastructure that not only supports all services but also controls a single IP optical backbone and provides on-demand provisioning of resources. Although the new network will be based on IP, it will be a multi-service networks with multi-operator Quality of Service (QoS) aware connectivity and billing capabilities. This novel network will enable operators to offer flexible bundle of multiple services with a superior level of quality largely superior.

Today, the mobile, voice, data, video and IP networks are separated, in most cases sharing only the transport infrastructure. There is little or no service interaction, resulting in e.g. multiple customer profiles, multiplied operational costs and missed opportunities for creating more integrated services. A high upfront investment is required every time a new service is introduced, since end-to-end network build-out is needed before any revenue can be generated.

The future network will accommodate seamless end-to-end multi-media communications across a complex combination of network constituents such as personal area networks, body area networks, home networks, fixed access networks, mobile access networks, metro networks and core networks. This will involve interactions of multiple types of consumer devices and services via a broad variety of both wired and wireless access technologies, and result in an increase in the number of sessions with multiple flows per session, and in the bandwidth demands. The complex business relations between the multiple players in the value mesh will impact the network architecture evolution.

In the future, an innovative service platform enabling this diversity of multimedia applications and services over heterogeneous access will be required for seamless and cross-platform and cross-operator integration management of the involved technologies, such as seamless, hardware-independent integration of different network technologies, flexible coupling of a diversity of services and service providers and their link-up to technologies, and structures for realisation of services supporting seamless network access and flexible service coupling.

The future network thus is a complex ecosystem to be designed taking into account all actors. The network is formed by the convergence of many players: network operators, service providers, terminal suppliers, IT suppliers, content providers, service aggregators. That part has to be addressed as well as the End-to-end QoS in order to provide a solution compliant to the customer needs (QoS vs. price) and fitting the future business plan.



2.3.1. Network Architecture

Definition:

Network architecture is about the organisation and structure of networks. In the context of NEM the scope spans from the core network to body area networks. As a network does not consist of just connected wires, the understanding is, that physical connections, interfaces, and protocols are included as well as operational aspects such resilience, reliability, SLAs, QoS ,etc.The “network infrastructure” provides certain functionality necessary for the operation of end user service, which is not part of this section.

State of the Art

The legacy telecommunication networks feature various flavours of wired and wireless access, plurality of switching layers (ATM, IP, SDH, Ethernet…) and protocols with a low level of collaborative interactions. While voice networks and core networks can offer high grade service quality, today’s IP network architectures focus on best-effort reachability among cooperative users, which results in a primitive control and management infrastructure with tightly coupled decision making logic and data plane. The evolution towards IP-centric or even “all-over-IP” networks has just started. The number of access network technologies attached to core networks in continuously increasing as the number of different operators does. Negotiating SLAs between network operators is common, although laborious and inter-network service offerings require extensive contract negotiations.

Today, it is assumed that host computers were connected to the edges of the network. However, host-centric assumptions are not appropriate in a world with an increasing number of mobile devices. The edge diversity constraint, i.e. the feature that allows for nomadic use and session

continuity in a converged (fixed-mobile) environment, is planned for integration into the network. Moreover, the first concepts on higher layer service intelligence in the access network are being explored. On the other hand, architectural innovations must enable to create, deploy, and evaluate novel network architectures based on both electrical and optical technologies.

A technology evolution example is given by the Internet access technology. A large part of the broadband subscribers in Europe are connected today to Internet via an ATM based ADSL modem or DOCSIS based cable modem. New access network architectures based on Ethernet are being defined, e.g., DSL Forum WT-101, IEEE 802.3ah EFM. Moreover, an end-to-end QoS architecture for the fixed access network is under standardization (e.g., ETSI TISPAN) and multi-service and multi-provider capabilities in Ethernet networks is defined and demonstrated in lab trials (e.g., IST MUSE). In the mean time, triple play is getting a commercial reality, while the aggregation part of the network is upgraded with Ethernet links. Mature VoIP solutions are gradually taking over the traditional voice communications. While a majority of the subscribers will have access to the triple-play services via ADSL2+, cable or Wimax, new high bandwidth first mile solutions such as VDSL2 and GPON for FTTH have reached a maturity that allows operators for a commercial rollout.

Target (objectives / aims):

Main challenge for the upcoming multi-media ready broadband [DKI1]networks is to address the usage revolution coming with the emerging new world of composite services and increasing number of multimedia devices. Main services that are driving this trend are Music, TV Broadcast and VoD, High-Speed Internet, online gaming and home services, VoIP and videotelephony. A future-proof multimedia-ready network infrastructure shall be designed to provide sufficiently high-speed access for these services (or at least be able to adapt services to the network characteristics) with a high end-to-end reliability and enhanced session management without constraints regarding the user's location.

Key Issues to be solved:

The efficiency of the network architecture has to be improved in order to allow more cost-efficient user connectivity in this dynamic environment. This development will be mainly market-driven by the reduction of operator revenues in conjunction with limited financial margins of the customers. Also, the required bandwidth per user will increase due to new contents and new service offers, and due to increased user mobility, services capable of handling multiple-access, and enhanced simplicity of service usage itself. The increase in bandwidth demand will result, besides network management challenges, in an enormous increase of core router throughput >10 Tbit/s and metro network throughput of >100 Gb/s. The network infrastructure faces, therefore, serious challenges, from improving the security and robustness of its core packet delivery service, to accommodating an explosion in traffic and in the number and diversity of devices that connect to it, to enabling a new generation of multimedia and other applications.

More sophisticated network-wide objectives such as dependability, policy, traffic engineering, security, ease of management, cost effectiveness, middleware interaction with the in-home and out-home networks etc. also call upon to meet reduced operational complexity and, specifically, incorporating more point solutions into the control plane atop a tremendous heterogeneity of networking technologies and domains that are present essentially for historical reasons.

Topics to be addressed

Paradigm shifts resulting from increasing the overall scale and operational efficiency of the inherently multi-domain networks depend on an integrated advanced infrastructure that is substantially beyond what we have today. Indeed, requirements called for by the expected increase in multimedia applications include:

- Layer-spanning network planning and optimization for more modular and flexible optical networks including a largely automatednetwork management.
- Dynamic network transport mechanisms coupled with network control admission mechanisms to manage the network resources with a maximum of efficiency and prevent congestion and/or service deny. More efficient usage of network resources by dynamic configuration capabilities and backup capacity for increased reliability

- Studies have to aim a sustained decrease of cost of transmitted Gbit/s/km, by reducing CapEx with improved performances (minimum use of 3R regeneration, improved distance, increased capacity potential and lower transmission technologies cost), and to tackle management of upgrades and capacity increase for a reduced OpEx, i.e. flexibility for upgrades, with 40G/10G compatible lines, automatic adjustments for new wavelength connections. Some of the necessary components are not available at the moment and have to be deployed.
- Network architecture and solutions must be tailored for multimedia applications and related traffic. The research needs to focus, for instance, on creating all optical nodes and subsystems integrated in an all-optical transport network. These nodes and subsystems support the hybrid integration of existing and new optical technologies and devices, such as allowing optical packet switching and optical burst switching, with the consequent increase in speed and improvement in the performance of communications. The progress in this field will stimulate a revolution in the features provided to the end user and new business opportunities for the European industry
- Networks require rationalization for affordable bandwidth transparent to the service user. This requires both hardware agility and embedded protocol and algorithmic intelligence to optimize bandwidth usage. The network must be capable to provide dynamic connectivity (point to point, point to multipoint, multipoint to multipoint) with guaranteed QoS to support unicast, multicast, and broadcast traffic taking into account user expectations on application performance. This requires investigations on network architecture and technologies for optimization of the traffic delivery, integrating service differentiation on parameters relevant for the multimedia users, including service continuity in case of failure. IETF is specifying the GMPLS protocol suite with the capability of controlling different switching technologies. GMPLS is a valuable tool for improving integration of networking technologies at the control plane level.
- Dynamic network transport mechanisms coupled with network control admission mechanisms to manage the network resources with a maximum of efficiency and prevent congestion and/or service deny.
- Technology-independent solutions for home network elements to inter-operate among them and with the telecom networks and services. Facilitation of common use of network features in different systems, e.g. by standardisation of inter-work with all in-home technologies, wired & wireless (incl. Radio and fixed wireless links)
- Integration concepts for novel Peer-to-Peer network and middleware technologies for Next Generation Networks (NGN), with the potential to dramatically reduce OPEX, and potentially providing high robustness, scalability and flexibility. The direct content exchange between peers is a serious threat to the existing business models. It has raised legal issues (e.g. content piracy) for the users. Some of the research issues for peer-to-peer networking are:
  - Employ Peer-to-Peer concepts to implement classical networking functions (fully distributed approach with implicit scalability and robustness) relying on flexible middleware models.
  - Investigate new functions (i.e. gateways) for inter-operation of P2P with NGN/IMS networks, and the new business models possibly involved.
  - Provide a controlled environment for peer-to-peer networking that ensures the rights of the content owners.
  - Protect peers from malicious users, hackers, denial of service attacks, spam.
- Network support of Community Networking. A community is a group of people that share some common interests (e.g. neighbourhoods, sports clubs, fan clubs, and schools). Community networking is concerned with electronic information exchange about these items of common interest within the community. This could be electronic news letters, own or third-party content with the appropriate rights management, discussions and more. Some of the issues for community networking are:

- Management of the community and its members;
- Community specific content generation and distribution
- Support of privacy within the community
- Study of network architectures and standardised, open and secure interfaces to a multiplicity of further networks in order to enable extended service provisioning, including Body Area Networks (BAN), Car Area Networks (CAN), etc, spanning a virtual personal area networks (VPAN),

2.3.2. Network based intelligence for end-to-end service control

Definition

The network infrastructure integrates functionality such that all kinds of services can transparently be offered to the consumer, wherever he is. Moreover, the control and monitoring of such services is possible end-to-end, including the control of QoS. This requires elaborate technologies as sessions and services must be monitored, adapted, seamlessly rerouted, billed, and so on. And the aspect is included, that such intelligence may be distributed across the netire network.

Target (objectives / aims)

The aim here is to develop new network control concepts to accelerate the introduction of next-generation marketable services. This would allow to broaden current business models for service provisioning and exploitation, which in turn will facilitate the provisioning and cost-effective deployment of new, more intelligent, more context-sensitive and more personal services across network boundaries. Sophisticated services can be operated efficiently only if the network infrastructure itself provides the necessary intelligent environment. The network on the whole must become an automated and collaborative medium that is formed by tightly coupling data, control, and management planes. For example, the provisioning of – possibly distributed -- network-based intelligence e.g. for end-to-end service control is an essential prerequisite for the delivery of high-quality services over heterogeneous integrated networks infrastructures as outline in the previous section. Bottom-line, a service-centric network is needed, which could be interpreted as integrating a “service plane” in the network architecture.

The future network is a complex ecosystem in which an increasing number and variety of actors “want to live”. The network is formed by business agreements of different kind between the players: network operators, service providers, terminal suppliers, IT suppliers, content providers, service aggregators. That part has to address as well in order to provide a solution compliant to the customer needs (QoS versus price) and fitting future business plans. The future multimedia-ready networks will be an innovative service-aware construct formed by the convergence and integration of several players and technologies that enable an increased diversity of multimedia applications and services.

State of the art

Today’s networks use the traditional architectural segmentation of network types in core, access and user-equipment domains, whereby the core is responsible for handling user requirements in terms of switching/routing, bandwidth/QoS reservations, authentication and accounting, and the access network infrastructure is typically limited to allowing connectivity of the user equipment to the core. Furthermore, existing access infrastructures follow a “monolithic” approach whereby systems are vertically integrated and exhibit low flexibility and customisability. In this context, network services and even applications offered by “third party” providers are dependent on, and mainly implemented at the core of the network.

Key issues to be solved

Many issues have to be investigated on networks in order to make the vision of NEM happen. The many applications triggered by various home devices will not only generate an ever increasing bandwidth demand, but also a growing number of sessions and flows. In addition to the increasing

transport capacity of the core network, this imposes new challenges and processing requirements for the access and edge nodes in the data plane, control plane and management plane. Higher layer intelligence will migrate in the network closer to the end user to solve the scalability and improve the flexibility. Novel network technologies also represent potential new security threats that need to be addressed. Applications will use real “multi-media” with multiple streams per session. The flow awareness will provide new means for more sophisticated QoS and accounting support by the network than today´s models. Application awareness will be embedded in the network to efficiently handle many streams and provide value added services. This will provide the network operator with capabilities to interact with and control the services end-to-end and add more value than pure bit-transport.

The network infrastructure faces, therefore, formidable challenges from improving the security and robustness of its core packet delivery service over accommodating an explosion of access modalities to the network to enabling a new generation of multimedia and other applications. These challenges of designing new network-based intelligence and following them through to deployment include:

- To research the migration of higher-layer intelligence in the access network closer to the end-user. On one hand, to build in the ability for network operators to potentially interact with the delivered multimedia services and add more value to pure transport oriented services. On the other hand, to cope with the ever increasing number of multimedia sessions with multiple streams per session.
- To research novel residential, access and edge network elements and network architectures to cope with the increased operations complexity, terminal diversity, session volumes, and evolving business relations – and seamless session handover.
- To research advanced QoS strategies leveraging the increased service-awareness of the network, together with advanced traffic engineering capabilities. Research, for instance, on the inter-domain routing protocol, making the inter-domain routing layer much more stable and more robust against ‘poisoned’ constellations.
- To research more sophisticated functions to provision, authenticate, authorise, and account the different devices and services.
- To research measures to cope with the security threats that new networking technologies bring.
- To research end-to-end solutions covering networks, systems, terminals, and applications in which users are also content broadcasters and service providers (unicast and broadcast).
- To research constructs, that complement the management and control planes, to create and maintain high-level knowledge of the network, its usage, and its behaviour, and to integrate, reflect-on and draw interferences from that knowledge. In particular, dynamic reconfiguration capability is included to achieve optimal resource exploitation, while enabling multi-layer traffic engineering (MTE), that combines functions in the various layers to optimise performance and QoS.
- The convergence and integration of technologies, which will trigger new services and applications, will call for even more standardisation efforts. These efforts will not only be more numerous, they will require much more effort to deal with the complexity and diversity of the eco system.

Topics to be addressed/ Definition of the topic

The networks evolve towards the transparent transport of all kinds of data, thus enabling to implement all current services (data, voice, video, phone, monitoring, surveillance, alarms, etc.) into a single infrastructure. The market evolution for IT, Telco, and media / broadcast services and applications increasingly calls for integration schemes of new players and roles into the value chain, and to account for their participation in service realisation and provisioning. Operators and service providers require new concepts to implement new cross-platform business models and domains in a fast, flexible and effective way. A first step in this direction is provisioning of fixed mobile convergence, so that the multimedia service can be delivered across networks of different

provider and/or different technology networks. In the future, an innovative service platform enabling a diversity of multimedia applications and services is required for seamless and cross-platform integration management of different technologies:

- Seamless, hardware –independent integration of different network technologies including cross-platform integration of services (mobility management, QoS, security,…)
- Flexible coupling of a diversity of services and service providers and their link-up to network technologies
- Concepts for management of networks for end-to-end service provisioning (advanced management tools)
- New, more integrated approaches for end-to-end provisioning of resilience, QoS, and support of end-to-end service level agreement (SLA) management
- Structures for realisation of services supporting seamless network access and flexible service coupling, service discovery, mobility and selection
- Support of High number of sessions and flows, high capability of media processing
- Conditional Access and Content Protection schemes, support of VoD protocols
- Support of Digital Rights Management (DRM)
- Updating of firmware in the end devices and network resources.

2.3.3. Seamless service provisioning

Definition

Services of all kinds can be used regardless of the underlying network infrastructure. Moreover, there is no service interruption in case of changing network accesses. The services is provided seamless. The necessary support functionality – so called enabling services – may be part of the network infrastructure itself or part of the terminal. Essentially, the service components are distributed across the infrastructure and the business models define the location of the enabling services.

State of the Art

Today, there is no unique converging networks model architecture for delivery of communication services, e-media, and entertainment content. Existing models are mainly based on the client-server paradigm. Explosion of P2P, RSS Syndication or Blog acceptance shows that the user of the global network (Internet for the time being) is becoming also an actor of content creation, as well as an actor of the delivery. IMS or TISPAN initiative aims to provide model & architecture for service delivery. Today, the network environment is featured by a fast migration to IP/(Gigabit) Ethernet based networks. The 3GPP IMS domain is one example. With Voice over IP and video applications over telecommunication networks, this technological trend is complemented in the fixed network as well. However, most of current networks were designed to support only one or a small set of dedicated services.

This leads to problems in deploying new services. Either the infrastructure is not suited for it or the underlying infrastructure is too specific for using standard components. Today, the operator faces the challenge to reduce the complexity of business processes. In particular network operators try to minimize investments as well as operational costs. Consequently services must be introducible fast and must be available to very broad audience. This is a very difficult problem in today's architectures because the business process layer is forced to interact with a phletora of underlying systems and databases, resulting in a very complex development and interaction process. In addition, the platforms already deployed in each architecture silo are frequently based on specific non-standard interfaces. It is extremely difficult to evolve each component to take advantage of cost reductions or new technology. Operating services across different access networks is just at the very beginning. Existing examples besides voice are email or messaging.

Today, various service architectures stemming from the telecom and IT worlds exist in parallel (e.g. CORBA, Web Services, Parlay, J2EE, OSGi). Due to this architectural heterogeneity, services providers are obliged to develop and test their services offers for several platforms in parallel, which prologues time-to-market and increases development cost.. Furthermore, such services are not well adapted to the (mobile) user requirements and are note useable across networks, and cannot adapt according to dynamic user context.

At the end of FP6, the technological fundaments of service delivery will be based on technologies such as XML, WSDL and SOAP and Universal Description, Discovery and Integration (UDDI), complemented with miscellaneous web services standards. Main standards organizations and interest groups are World Wide Web Consortium (W3C), Organization for the Advancement of Structured Information Standards (OASIS). In communication networks, re-usable software components will adhere to open standards from the 3G Partnership Project (3GPP), the World Wide Web Consortium (W3C), the Open Mobile Alliance (OMA), the Open Systems Alliance (OSA/Parlay) and the Liberty Alliance.

Target (objectives / aims)

Currently, commercial networked applications are delivered to end-users through a service provider together with a limited set of partners. It is to be anticipated that in the 2010-2015 framework, services must be created and delivered to end-user much faster and constituents of an application (the service components) will come from a larger community of partners. Services are to be delivered seamlessly to end-users irrespective of the underlying network infrastructure (fixed, mobile) or end-user environment (home, car, office). Service logic will be highly geographically distributed (ubiquitous sensor networks and actuator networks). The end-user experience will be highly individualized based on user context, role, preference, behaviour.

It has been outlined that the constant evolution of services creates a growing variety of ingress traffic both in volume and nature for all actors, incl. the Telco area (operators, manufacturers or service providers). Consequently, networks become more and more complex and have to deal with different natures of traffic and different access networks. On the other side, the network has to get more and more transparent to the service and application. Deriving from this context, the Next Generation Networks (NGN) concepts have been developed to give the network operators the capability to face this evolution and satisfy the customer service demand. Basically, the key concepts of NGN architectures are:

- a services control independent of the bearer resources
- open and standardised interfaces between the services control and the resources control.
- As a result, these new architectures provide more flexibility regarding support of new services and optimise network resource use.
- High-quality basic services with multi-usage components as building blocks (ID-management, context-related functionalities for melioration of other services)

Obviously, NGN and seamless service provisioning match well, in particular for the reasons that the NGN architecture should:

- support all types of services (data transfer, real time multimedia);
- allow abstraction of the access network
- provide generalized mobility including incl. seamless roaming and handover;
- allow a multiplicity of actors to share network infrastructures;
- be open (standard interfaces and protocols);
- guarantee QoS;

- Possibly satisfy needs of operators and service providers who are either incumbent or new entrant.

These aspects have to expanded to

- interoperation of heterogeneous networks
- vertical handover between network technologies
- service management across networks

To sum up, users should be provided with personalized services, over several mobile (and/or fixed) accesses, whatever their location, thus enabling generalized multimedia mobile services in broadcast and telecommunications network co-operation areas. Additionally, users should be provided with service provisioning tools for consumer-generated services and content.

Key issues to be solved

- developing integrated service provisioning control platform (e.g. like IMS but across all network types)
- include personal area, body area and home networks in the service provisioning concept
- develop handover and roaming mechanisms to seamlessly operate services for consumers on the move, e.g. when changing the access network or the personal usage context.
- Design and implementation of network operations and management functions with traffic monitoring and engineering capabilities
- Merging of the various service architectures stemming from telecommunications and IT worlds (e.g. CORBA, Web-Services, Parlay, J2EE, OSGi).
- New service conception employing open standards and re-useable modules (e.g. user management, billing, universal network interfaces)
- Usage of user profiles and user context to enable personal services at a large scale, while protecting the user's privacy and ID,
- Interoperability of services across network and operator boundaries
- Allowing the user to play an active part in the global delivery system, e.g. by providing provisioning tools in order to enable provisioning of consumer-generated services and content.
- Dynamic composition of services from possibly a large number of finer grained services of which behaviour and characteristics depend on context, proximity, time.
- Data management solutions as data will be related to the user and service will be omnipresent and typically spread across multiple data sources (Network Elements, applications) and even multiple parties (Network Operator, Service Providers).
- Service middleware for highly distributed networked environments where service logic interaction between loosely-coupled fine-grained service is triggered through advanced messaging mechanisms.

Topics to be addressed:

- Concepts of cross-network service overlays building an abstraction layer towards services and applications across the different access networks, core networks and operator domains,
- Application aware network. This involves research on automated, secured discovery and provisioning of network services supporting scalable content delivery in a multi-domain, multi-operator context for end-to-end service across heterogeneous networking technologies and administrative domains. Multimedia applications have also to be able to automatically communicate to the network their requirements in terms of QoS (application-

middleware-network cooperation/integration). Beyond connectivity, the network could embed service-supportive functions such as virtualization of resources (servers, storage …) to provide more efficiently content delivery. An open and standard architecture has to be designed, enabling multi-operator service trading and fair value-added chain

- Transparent convergence and interworking of networks. This aims at allowing content delivery over converging and interworking networks and interconnected devices, through consistent and efficient internetworking (fixed-mobile, mobile-mobile), seamless delivery of multimedia content whatever the network and usage model (mobility, rates, etc.), autonomic interconnection of networked multimedia electronic devices and interworking of resultant network with legacy networks. For example, one issue that arises when integrating networks is that the bridges between networks need to be aware of all the different neighboring networks, so that communication from one server to another is possible. This would require some sort of communication between the bridges, possibly using some handshaking protocol, so that the bridges are constantly aware of all the other bridges. The awareness of other bridges becomes increasingly important when bridges are mobile. Moreover, the bridges may use different transmission data rates and therefore some congestion control mechanism is required. Another issue is that each bridge should be able to deliver data reliably to the other bridges, in order to avoid degradation of data quality in the network. Also, how to find the most efficient route from server to client is another important aspect when integrating networks.
- To design future-proof network infrastructures sharing rationalised architecture models and integrating mutualized-based components, while leveraging IMS-like concepts and standard open network interfaces, to keep offers open to partners and competitors when and where technically possible.

2.3.4. Network planning and optimization

Definition

As heterogeneous networks will be handled more and more as one entity with different flavours the planning of networks and the optimization of the network infrastructure as a whole becomes important.

State of the Art

For current mature mobile networks, as GSM/GPRS and WCDMA, planning solutions have been developed to cover the main problems of initial deployment of networks (automatic cell planning solutions) and spectral management aspects (automatic frequency planning solutions). However, most of the GSM (only voice) optimization tasks have been conducted, so far, manually by operator's engineering staff. With data capable networks (GPRS and WCDMA) and the usage of new data services (web browsing, mailing, gamming, etc.) the complexity of network optimization has dramatically increased making more and more difficult an efficient manual optimization more and more difficult. For planning and optimization of broadcast networks mature planning tools exists already for a long time. Experience exist both for classic roof-top antennas (stationary TV), but also for portable (DVB-T) and even indoor mobile reception (radio) . However, new broadcast services on mobile devices (as Mobile TV) put new requirements to the design goals. (mobile indoor along with optimal utilization of bidirectional links in mobile cells). Besides, networks will present new characteristics that may need also new technologies as for planning and optimization, e.g., traffic engineering is currently done in a static manner.

Target (objectives / aims)

With the objective to let the media devices internetworking-operate in a transparent way with the one another, the wired network infrastructure needs to be tailored to that usage. Network planning solutions aims to efficiently design and plan for deployment of networks, while optimization solutions try to improve performance and capacity of the network as the environment and traffic demand evolves.

The planning and optimization of 3G/4G (especially the radio network) and WLAN/WMAN is very complicated and faces many challenges. Traditional planning methods require experienced planners to manually select and configure network elements. As there are many network elements with many parameters to configure, it is very unlikely to find the optimal network configuration using a manual method. Approaches and tools that can automate 3G/4G/WLAN/WMAN planning and optimization are urgently needed by the mobile communications industry.

When it comes to really convergent network infrastructure the rounting of traffic may be either on fixed but also over wireless networks. Thus a comprehensive planning and optimization tool is needed, which takes into account the dynamics of traffic.

Objectives for medium term-2010-and longer term-2015+

Efficient deployment and operation of new fixed and wireless network technologies is a key factor in the adoption and final success of such technologies. Network operators will require (as they require for current technologies) planning and optimization solutions which enable an efficient exploitation from both the economical point of view (network infrastructure) and the technical point of view (spectral efficiency). Deployment and operation of the network is currently a demanding task, whose complexity is expected to grow in the future due to the increasing performance required by both the users and the operators. With current emergence and foreseen explosion of networked devices, media types, usage of telecommunication (global mobility especially), traditional solutions reach their limits in term of flexibility and dynamicity. In this scenario, it is necessary to develop specific technologies that take into account the new needs for network performance, but also the new characteristics of such networks.

Topics to be addressed

- Current network planning has to deal with an access and aggregation network than cannot cope with the increasing service traffic as well as the core network does.
- Flexibility and dynamics, in conjunction with development of new offers (content production, services, networking, etc.) means development of distributed planning and optimization.
- It is necessary to research on new propagation models for new radio technologies in order to build accurate radio planning solutions
- It is required to research on new solutions for optimization of antenna parameters (location, tilt, azimuth, power, frequency, etc) so the overall performance is maximized
- New dimensioning solutions for the new network architectures need to be investigated in order to permit and efficient deployment of the networks
- Other area of research will be monitoring of Quality of Service received by the user in new services as input for optimization, Service Level Agreement assurance, etc.
- All work should take account of the need for efficient use of the radio spectrum and of the changing regulatory models, such as spectrum trading, that are being adopted to encourage efficient use of the spectrum

Key issues to be solved

- Tools for simultaneously plan heterogeneous wireless networks, taking into account different deign goals
- Planning tools which can cope with the increasing dynamics of network transport mechanisms coupled with dynamic network control admission mechanisms (traffic engineering)
- An important research area is the dynamic adjustment of network parameters for performance improvements to adapt to network and demand changes, which could derive in need of distributed optimization systems.
- Specialised network planning and optimisation tools for home wireless and wireline networks, but including body area and personal area networks.

- Planning tools which can handle the situation, that consumers get more and more content providers..

2.3.5. Security and Privacy

Definition

Services and its content must be provided securely to the consumer, potentially even between businesss partners. The privacy of each actor in this environment, namely the end consumer must be guaranteed. The infrastructure components must be secured against hacks, intrusion and miss-use like DoD.

The universal adoption of on-line digital services and contents is highly dependant on the ability to provide consistent solutions for the security of networks and services, and the protection of privacy.

State of the Art

Privacy public awareness has been raised by recent events leading to the discussion of its limitation, in line with the worldwide security efforts. Likewise, the huge increase of spam and spyware on Internet is challenging consumer trust on service and content providers, and how they protect and use personal data. Privacy is more and more an important factor for the success of current and future rich content-oriented services. Being considered a fundamental Human Right within European Union, privacy represents the right for a citizen to be left alone, free from surveillance or interference from other individuals, from organizations or even from the state. Despite the fact that everybody seems to care quite deeply about privacy, some reports state people won't pay for it, while other reports draw the more reasonable conclusion that people will not pay for things they don't understand.

State-of-the-art solutions such as firewalls and virtual private network solutions do not provide flexible and scalable solutions. Firewalls protect a network from unauthorized access and perform traffic filtering but provide nothing or little in order to protect data transfer. Virtual private networks are good in access control and protecting data transfer but do not guarantee seamless access (without implying a serious work load on network administrators). Access control generally relies on access control lists that are difficult to manage when multiple domain are involved. Additionally, virtual private networks support confidentiality and data integrity, but do not implement non-repudiation of communication events or business transactions. Network-hosted security solutions and concepts for the public telecom networks are largely missing today.

Objectives for medium term-2010-and longer term-2015+

Security is an important aspect for network and service providers, but also for the private networks and users. Enhancements are essential in the security and privacy domain, namely:

- Users should gain secure access to public networks and services;
- A user should have the capability to gain secure access to devices/services in its private networks from the outside;
- Networks should be protected from malicious users, hackers, denial of service attacks, spam without constraining the usability of networks and services too much;
- For ease of use (improved user experience) a single sign-on for all or a set of services should be provided;
- The privacy of the user has to be protected

With ubiquitous services and networking any security and trust enabling solution has to be adaptable; this basically comes from the fact the numbers of users, devices or administrative domains are a priori unpredictable. Consequently, requirements as well as administrative and management issues are diverse.

Topics to be addressed

The above-mentioned simple facts lead to technical and regulatory enabling challenges that need to be fully addressed at the R&D level, delving with aspects such as:

- Security architectures, scalability, interoperability, secure processing, and lawful basis.
- Security enhancement also on Optical Network level, namely through research on topics such as OCDMA (Optical Code Division Multiple Access), and Quantum Cryptography.
- Joint ventures integrating players from all relevant domains (e.g. providers of operation systems, application vendors and security service providers for threat analysis, targeting the joint definition of protocols and interfaces for effective network-oriented ICT security concepts.
- Effective concepts for infrastructure protection by traffic analysis and intrusion prevention employing a modular design in order to rapidly integrate new security aspects.

Key issues to be solved

Privacy is a very complex issue, but the right tradeoffs need to be investigated, so that working legislation, mechanisms and systems can be put in place. Networked electronic media services will attain customers trust by introducing measurable privacy on the systems, restricting access to private information and preventing unauthorized observation of communications and associated sensitive data flows, sometimes even concealing identity, while allowing the relevant user information to be exchanged and the selective reveal of credentials and attributes, so that services can implement sustainable business models.

2.3.6. Ubiquitous multimedia networking

Definition

Ubiquity in multimedia networking means that a global network must be always available and immediately tailored to the desired media by the users. It is a communication environment that allows accessing multimedia services independently of the moment, the place or the way it happens.

This topic encompasses various aspects of flexibility and self-adaptation of the networks. From a situation where user and devices do what they can with what is offered, there is the need to reach a situation where the network does what it can to provide what is expected. From a technological point of view, ubiquitous multimedia networking involves technologies to determine user context & terminal capabilities and technologies to deliver all kinds of services adapted to the resulting scenarios. Thus it is related to automated profiling, location awareness, content transcoding, efficient mobile MM transport and enhanced interactivity, among others.

Objectives for medium term-2010-and longer term-2015+

Services will be available and will be offered to all users, adapting to their profiles and device characteristics, as well as to the access networks being used. The user should be able to benefit from the services e.g. while shopping, being able to select other items, compare prizes or check the latest trends.

Target topics are:

- Multimedia-ready, standards-based and pervasive service platform, allowing for the discovery, personalisation and composition of components in order to instantiate pervasive services.
- Enabling components providing the core functionality (service discovery, composition, rules and event management, user context management, personalisation, security and privacy), allowing for enabling components supplied by 3rd parties.
- Enabling components extending service provisioning into a virtual personal environment consisting of e.g. home network, body area network, car network etc.

- Ambient Service Frameworks consisting of interconnected service providing platforms (service provider platforms, home services platforms, …)
- Integrated tool suites for easy and cost efficient service developments and a wide range of applications for consumers and professionals in order to provide benefits for the end-users, operators and service providers including 3rd parties.
- Ubiquitous multimedia networking and immersive communications in virtual, augmented and mixed reality environments. The networks have to be able to accommodate flexible business models which evolve and introduce changes. For this target, a number of requirements have to find technological solutions:
  - Virtual environment must be developed with integrated security and associated network and services user profiles, allowing to be able to adapt themselves to the network and the terminal and hiding the involved network complexity from the user.
  - Any change has to be “seamlessly” done without user intervention
  - Higher flexibility is needed
  - Bandwidth on demand
  - Connectivity on demand
  - Quality of Service on demand.
  - Bandwidth, quality and connectivity
  - Networks have to be open to third parties by introducing clear differentiation between service, transport and control planes.

State of the Art

The current state-of-the-art in networking, services and system concepts summarized below poses a large number of obstacles to fulfilling this mission:

- The family of Mobile IPv6 related protocols and other more recent solutions suggested do not solve all the technical problems related to mobility and its combination with broadcast.
- The combination of numerous individual solutions, such as in the IETF, produces new problems because combining these protocols and algorithms severely increases system complexity.
- There is an urgent need for a user-friendly optimisation across layers ranging from the network to pervasive services for users who want easy access and are not interested in the underlying technologies.
- The provision of service pervasiveness exposes the serviced mobile user's context, resulting in the need for a new class of solutions for privacy and security.
- Pervasive systems add a further dimension to the network and service infrastructure, resulting in new, and as yet unsolved, configuration and management problems.
  Solutions to these problems would require operators to bridge a significant technology gap in both the infrastructure and the support for services.

Topics to be addressed

Self-adaptation of the network of the needs is the key topic to be addressed. That also means that the network logic and interworking is made transparent to the user, who only needs to ask for the media he wants.

Self adaptation of the network must be built on top of the set of enabling technologies. Issues such as IP-oriented services vs. non-IP oriented ones and seamless fixed/mobile MM delivery must be tackled. In some cases, there are several technologies to help to provide the same goal (DVB-H vs. 3G MBMS/HSPDA, DMB, MediaFlo). It will be necessary to review the technological “tools” from

the point of view of ubiquitous MM networking. Research will determine the need of missing technological solutions.

Other topics include:

- Open standards, platforms and technologies
- Management models and simple and transparent use of the services, independently of the networks that are supporting them.

Integrated terrestrial-satellite mobile broadcasting networks for the provision of multimedia services to mobile and personal terminals, including mobile TV and digital radio, also need to be investigated. Topics to be addressed in this field include:

- Study of software architectures for the support of mobile broadcasting services received through hybrid networks such as S-DMB.
- Study of mechanisms for guaranteeing Quality of service in mobile fading channels, for example through high level coding techniques.

Key issues to be solved

In order to create a mass market for new digital services, a foundation set of ubiquitous standardized networking in Europe must exist. Key action is the establishment of standards for announcing, publishing, querying and accessing data of key localized and personalized information services for the usage by value-add applications (e.g. further processing and user interfaces). Examples are storm, earthquake and other safety/security warnings, news on local, region, country, EU and world scope, government announcements from city, region, country and EU administration to residents, traffic situation, public transportation timetables and routing, event information (cultural events in the city). Convergence of networking technologies, especially for home automation, security and health devices as well as common device access protocols, standardization of device profiles and common concepts for device management are necessary.

Interworking of networks has done a giant step with IP whole adoption. Global reachability is close to be solved (especially with IPv6) but there is now the need for ubiquity objective to tackle interworking of network usages, especially when mobility (user, device, group, network …) is involved.

Even if there is a widespread agreement on turning to user-centric MM delivery, the needs and strategies of operators and content providers may tip the balance to choose one research strategy or another, or choosing a technological approach or another.

Other issues include:

- Security mechanisms, simple and reliable.
- Service models offered on a ubiquitous fashion.
- Billing and management models.
- Use complexity that can put the users apart.

2.4. Terminals, User Devices

Terminals have a key position in the multimedia value chain, since they are the means for the consumer - who finally pays for it - to use the proposed content, services and applications. At the same time end user devices represent a mass market, and the trend should be to an increase since the demand on multimedia is itself high.

Two important areas have to be addressed. The first one applies to "fixed" terminals that play a central role in the home, called “set top box” or media centres, but also gaming consoles etc. These will have to support more and more IT like functions, such as HDD storage, high computing capabilities, network and peripherals connectivity. They must support advanced applications, increasing codec complexity, increasing rendering capabilities such as 3D for gaming, while keeping the end user relieved from the burden of "PC" management. They will also have to absorb HD capabilities for large displays. The second one is the rapidly raising demand on small mobile terminals. These will have to combine some capabilities listed above with issues such as low power consumption, low size and weight, robustness. There is a tendency, that the mobile devices are used also as quasi-stationary devices in the home.

Convergence of audiovisual and informatics will trigger new kind of terminals so called media player, renderer, center, … which will be able to support several types of services (communication, content access, device control, etc). In addition people will have more and more devices at home and there is a need to share those devices between the different application and services. Thus, interconnecting terminals in a user friendly way and interoperability are two corner stones which become mandatory.

The new terminals have to be equipped with significant intelligence: new operating system in devices while on the move, PC should be used extensively in the portable and “wearable’ sphere, terminals will have to be personalized. There will be a multiplicity of devices: i-pod, PDA-telephone, new large TV, personal prescriptor, personal assistant for a personal life profile.

The plethora of different multimedia devices raises the question whether the trend is towards integrated multifunctional devices or multiple device ownership. There is a clear tendency of integrating mature and proven technologiy, such as combination of basic mobile phones with MP3 players, FM radio, digital cameras and gaming features. However, in all of the media devices categories there are successful single function devices, e.g. iPod in MP3, Canon Ixus in cameras, Nintendo GameBoy in gaming and even small portable FM radios still have niche markets in sport and outdoor use. On the other end there is set of integrated devices that resemble the future vision of technology driven convergence. These devices typically combine potential winner features on top of already successful technologies, e.g. Nokia DVB-H mobile phone, Sony PSP gaming with UMD movies and Microsoft Windows Media Center PC’s.

The technology integration plays significant role in both device areas – fixed media centers and small mobile terminals. The consumer decision is ruled by what is the main use case, what other devices the customer already has and might want to connect with the new device, how much the technology novelty drives purchase decision and, finally, how complicated feature lists an average shopper understands. A winning device typically answers two key demands: 1) the technology provides clear benefits either replacing older solution or bringing novel meaningful functionality and 2) there is content available.

But there is another development possible. As the number of devices increases and the intelligence moves into every component, along with body area networks, one can very well imagine that future devices are a composition of elements a person carries with or has in its reach. This might not happen short-term but very well in the time scope of NEM.

2.4.1. Gaming terminals

Definition

Gaming terminals are hardware for the end user for interactive entertainment software. Like in other multimedia devices, there is home based game consoles (e.g. PC, X-box, PlayStation, Game Cube) and portable game devices (e.g. GameBoy, PSP, N-Gage). The game terminals can be stand alone devices with only local single player or group gaming features. The biggest growth area past 10 years has been connected terminals, with integrated communication features to allow multiplayer gaming over local or global network, especially via the Internet.

A game terminal offers user audiovisual experiences, visual/non-visual stimulus and interaction methods to react the game events. The combine effect creates immersive environment, where user projects himself into the game world. The quality of the game experience is often measured on how well the game manages to user focus. The immersion is partly resulting of different technical features, but the game story has a significant role in creating a good gaming experience. Thus, it is not possible to judge a game terminal success by evaluating single features. More important is whether the game device offers user high quality experiences and lures game developers to utilize device features to create game play and stories.

The audiovisual experience is measured with objective and subjective image and audio quality. In the game devices the visual quality is measured by the screen capacities as well as the graphics capabilities of the terminal. The games us real-time 3D graphics and the processing power determines more the capabilities of the terminal than the screen size. In the home game terminals the processing power is high enough to create realistic looking real-time graphics with numerous special effects and the physical screen size can be as large as the user wants. In the portable game terminals there are more restrictions coming from the processing and power consumption as well as the physical restrictions in the screen size. On the other hand, the smaller screen size allows more efficient use of the limited processing power as the number of pixels is limited. The development in the graphics power in the portable devices is following home game terminals rapidly and the demand for better screen quality is rising also in portable domain.

In the audio quality the physical restrictions are not as high, but the processing power is needed for real-time spatial audio and audio effects computing. In portable devices audio experience has a stronger impact in short term due the limited visual feedback. The audio quality is more critical for the overall experience to compensate the visual feedback and there are no physical limitations.

The visual and non-visual stimulus initiates the actions generated by the game events. Visual stimulus is used more, but there are also direct or indirect cues coming from music, audio, vibration, etc. The stimulus is integral part of the game experience and the cues are embedded into the general game audiovisual experience. The game enjoyment greatly depends on how well the game presents the cues and presents the story continuation. A good game does not necessary need latest 3D graphics to be an enjoyable experience.

The interaction devices are critical part of the terminal as they provide user possibilities to react to the game events presented via audiovisual feedback. The game interaction methods are mainly measured via usability factors. A good interaction tool enhances the game experience, but even excellent game controller does not save poor game or story. Novel interaction methods can have driving role in creating new game styles or ideas. The good examples of this are voice recognition, which enabled the karaoke style singing games, or pressure sensitive carpet, which was created for the dancing games.

Objectives for medium term-2010-and longer term-2015+

Game terminals will become one if not the key terminal in the integrated world of networked electronic media. The integration of the sectors TV, internet and games will happen most likely first on game terminals. This has consequences for standards, formats and genres. The biggest and most underestimated effect of this development will be the impact on the content itself.

Game terminals have a proprietary status. This has not only an impact on issues like cultural diversity, freedom of expression and information etc.. This has also major technological implications for Europe. European companies for content creation will have a small share in the consoles portfolios.

With the increasing importance of game terminals for networked electronic media Europe is in danger to loose completely track to the key technologies of the future. This has not only economic implications, but is also of political and cultural importance.

The reasonable European solution, the European game console, is hardly possible at all. It is not sure, that a fourth vertical console system is ready to be part of the market. End terminals are effectively sold by far under their real production prices in order to win market shares for the platforms.

A European console would face the problem of low market prices and reluctant acceptance as it is not the standard. A thorough analysis might come to the conclusion, that a European console is too risky and at the given speed of technical development not likely to be the best option. In return Europe might be forced to accept, that for a long time it will not be able to master the technology of end terminals in the networked media environment of the future in the households.

Substantial investments in middleware and tools could be able help to master the multiplatform problems from the content producer's point of view. The idea is to create middleware – based on open source solutions – that could be seen as a standard ending point of possible game developments – the middleware would take care of integrating and porting these creations into the specific hardware.

The emphasis of the strategic software decisions might be in favor of open software. Open software can help to advance quicker as the creative communities do not have to spend cash on licenses. Important is a system which assures interoperability of open software solutions aimed at the creative industries.

Technological and legal obstacles are to be overcome to place a game on a game terminal. It is not sure, that financial support alone can help in this situation, but these questions have also a regulatory dimension.

Add-on hardware for the existing game platforms can also create ground for substantial niche market, for example new innovative input methods give possibility to create new game styles or genres. Same way possible innovations in output methods and open connectivity solutions for different platforms open possibilities to create terminal independent game services. The creation of add-on technology alone is not sufficient to create differentiation from EU, but combined with software and service creation there is possibility to create new content business. However, the game platforms are proprietary technology and game development is governed with tight licenses. The creation of independent add-on technology could be supported with standardization and open approaches to keep the ownership of the new game technologies in EU or in public domain.

State of the Art

The game terminal business is divided by three major players, Sony, Microsoft and Nintendo, with some smaller players in the field (e.g. Nokia, Gizmondo, some PC manufacturers). The PC game business has still solid market share compared to the game consoles. Due the modular nature of the PC business, there is no single market owner for the PC based game terminal category.

The home game consoles are in order of market share PlayStation (Sony), X-Box (Microsoft) and Game Cube (Nintendo) plus the solid PC game business. The typical life cycle of the devices is five years and the competition with new features happens more or less within this timeframe. Currently Microsoft has just started shipping new X-Box 360 platform, which will be soon followed by Nintendo (Revolution) and Sony (PS3).

The portable device market has been dominated by Nintendo with GameBoy-series. Recently there has been more competition with Nintendo DS and Sony PSP. The mobile phones have entered the portable game terminal market in general via JAVA games and the potential player number is higher than any of the dedicated game consoles. However, only Nokia N-Gage can be listed as game console and the current announced strategy is to integrate the console features in more phones rather than continue with a single portable game console.

Although not comparable in it experience, games on mobile phones are an important feature. The consumer seeks entertainment wherever he is.

Topics to be addressed

Biggest challenges in the area of user terminals for gaming applications are the constraints on the terminal performance and screen size. These constraints will remain also for gaming on the move. The performance of a high-end gaming on the move device is one generation behind the state of the art gaming consoles and this seems to be true also in the future. The biggest gaps currently are on the computational power, physical screen size, key pad size and network latencies. On the other hand mobile devices offer features that are not widely available for traditional PC or console devices, such as, location information, always-online connection with true mobility, digital camera, voice capabilities and awareness of the surrounding environment (e.g. temperature, humidity, brightness). In the future, voice could replace some functions (e.g. communication) that is the keypad is needed for.

Social and multiplayer gaming opens new possibilities for terminal technologies. In home environment the main areas are to provide access to multiple communication channels at the same time, e.g. game communication and voice-channels. The game terminal is a natural place to combine different communication channels into one seamless experience. In portable terminals the additional topic is gaming in public or semipublic areas, such as café's, lounges or meeting rooms. The common theme is how a portable game terminal can connect to the external peripherals available in a particular public space. For example the ITEA project "Nomadic Media" studied the use of public screens for ad-hoc social gaming and remove the limitation of screen size by capturing an available screen for shared use. This kind of gaming increases the social nature of gaming, but in technical domain there is a need for new architecture for terminals and connectivity.

Key issues to be solved

There are number of emerging technologies that are likely to create impact on the future of game terminals, especially in mobile gaming.

Near eye displays can provide a change to the display size challenge in portable devices. The physical size of the display panel is small and the perceived virtual image via optics match a screen size of 30 to 50 inch. The development of LCD screen technology enables building of small and lightweight optics with very high pixel density, which enables high enough resolution for the virtual display. The major breakthrough is the improved optics to form the virtual display image. The previous generation of virtual displays from the end 1990's was approximately size of a alpine ski goggles and weighted approximately 200g to 300g. Next generation display will be more close to a pair of sunglasses and weight is around 100g. This provides similar comfort as wearing pair of glasses.

Context awareness, especially sensor networks, will enhance the mobile gaming experience. In consol game devices sensors are used mainly for direct input and game manipulation, for example Sony EyeToy camera or motion sensors in Nintendo Revolution. The use of context awareness does not bring too much added value, as the usage location usually remains the same. In mobile game devices the context awareness is a natural extension as the time as well as space of game play changes constantly. In addition the direct input has more options as the sensors can detect real movements and not only game related pseudo actions as in console gaming. In mobile game devices the use of sensors needs to be used as a game element, but the game device will always set the design limitations. The optimal game device in future needs to be modular to support adding extra game technologies or upgrading existing technology capabilities.

The list of attractive game technologies include e.g. GPS for positioning, motion detector (accelerator sensors, gyroscope, compass), direction (compass), cameras, microphone, light sensor and short range radio (RFID or similar) for proximity detection. The winning combination will

not emerge only via excellence of the technology, but through hit game titles that make compelling use of certain technologies.

The sensor and other external peripheral connectivity require dynamic communication architecture to enable game developers to use the external hardware resources. The game terminal must manage the external device connectivity in dynamic manner and inform the game application of the available external resources and what required services are currently not available. The game design should only need to address what possibilities are available for the game terminal and the device itself detects the real availability during the game play. This topic falls into the research areas of ambient intelligence.

2.4.2. Home Multimedia Devices

Definition

A multimedia device is capable of handling various media types at once. The device is capable running at least some combination of audio, graphics, video, animation and text as well as offer interactivity to select the content. The driving characteristic of a multimedia terminal is the power of managing multiple media formats at the same time. The terminal capabilities depend on what is the key purpose of the terminal and what supportive or additive purposes the terminal should serve. In addition there are several interfaces including those to networks, which allow the device to connect to the outside world.

“Home” devices aims for primary utilization in homes, namely stationary or portable ones. First generation stand-alone devices develop into hybrid systems, which rely in part on networks with considerable built-in capabilities. Convergence with navigation devices and other features, such as context-awareness, opens up a range of possibilities for innovative applications of considerable market potential.

In the future more e and more mobile devices will be used at home as well, substituting stationary “family” devices to some extend.

Objectives for medium term-2010-and longer term-2015+

Based on the previous sections a NEM compliant device must be able to support connectivity to heterogeneous networks and has the intelligence to support seamless service provisioning. For example it must be possible to transfer a service from a mobile device to the flat screen in the living room when getting home (and vice versa).

State of the Art

There exists a broad variety of “multimedia devices” stationary, portable, and mobile. Home devices coming from the traditional CE industry are more and more stuffed with features. On the other side PC based solution, including STBs are entering the market. These devices follow a different paradigm, but yet start to eat market share in the home. A third player in the market are gaming consoles, offering extremely high graphical power increasingly paired with connectivity to regular networks (WLAN, Internet, …) Stand-alone single player games have evolved into online multiplayer games and finally they are offering immersive entertainment experiences through cross-media and mixed reality gaming. This opens up opportunities on the world market for innovative application providers new to the market.

Topics to be addressed

It is expected that cellular network evolution from 2G to 3G networks solves some of the problems related to network performance by reducing the latency. At the same time the expected bandwidth is growing and enables content streaming and real-time voice and video connections.

Key issues to be solved

- It is necessary to develop low cost architectures for stand alone terminals to be accepted by the user or to merge services to reach reasonable cost structures for standalone TV/Radio terminals.
- New small special purpose software and hardware must be developed to replace the personal computer operating system architecture. The standalone terminal system cannot carry the over dimensional general purpose solutions.
- Devices need intelligence to adapt services and content to its specific capabilities.
- Devices must be able to seamlessly interoperate and inter-connect to other devices in the environment
- Devices must offer a easy and intuitive interface and navigation. The complexity of the underlying configuration and technology must completely be shielded from the user.

2.4.3. Residential gateways

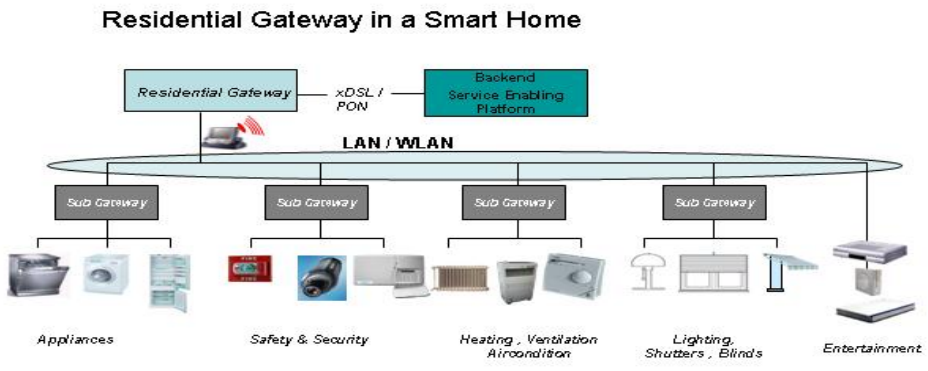
Definition

The residential gateway is defined as the module making the interface between the access network and the home networks. Most of the existing gateways offer xDSL technology for the access network and heterogeneous solution indoor (WiFi, Ethernet, Bluetooth, USB...).

It is a network component that enables the connection of a private network, either corporative or personal, to the WAN, under a typically local environment.

The residential gateway is one of the key devices in the connected home area. It allows convergence of applications, integration of appliances into systems, and in-home communication infrastructure and the possibility of providing news services based on this infrastructure.

That device is key equipment which will be able to support services thanks to the OSGi framework which offers an environment able to be shared by several service providers. Multiservice networks request multiservice CPE, and the residential gateway (RG) has of late received the majority of attention from service providers. A residential gateway (RG) is a network interface device that terminates a wide area network and connects to end-user devices directly or through a home network. In additional to features common to all gateways, an RG should include an embedded broadband modem, routing capacity and security features.



Objectives for medium term-2010-and longer term-2015+

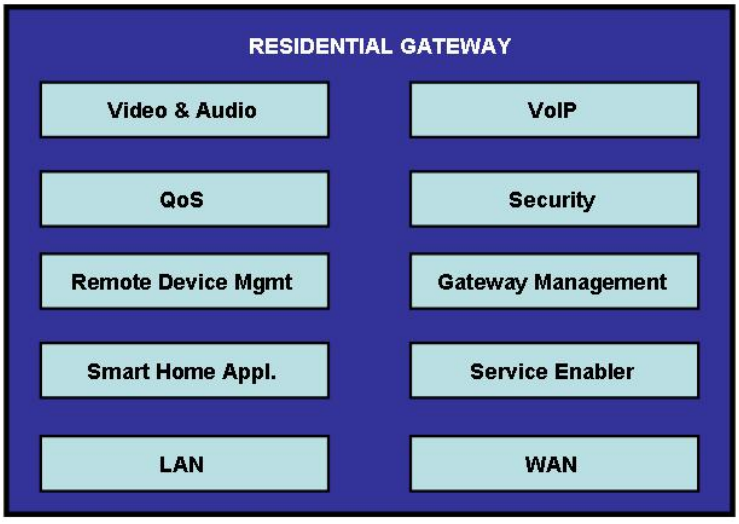
Several scenarios of residential gateway appear and there is a need to take that point into account in the European projects such as the NEM platform:

- Modem version = simple broadband modem
- Virtual RG = broadband modem + router + firewall
- Multiservices RG = broadband modem + router + firewall + service such as video, VoIP home automation, content delivery, ...
- MultiWAN RG = Multiservice gateway offering connection to all types of access network

The prerequisite of large deployment of new services is a common execution platform in the home and a common abstract layer for service and device access. Furthermore, a common management protocol for the gateway platform is necessary (update and control of components and applications).

These new services have created a set of new requirements for the residential gateway:

- High Definition Video & Audio as well as IP-TV
- High Quality Voice conversation over IP
- Quality of Service (QoS) for all applications
- Security for Authentication, Authorization and Accounting
- Remote Device Management for a user friendly operation
- Complex Gateway Management Concept to schedule all operations
- Smart Home Applications for remote control of home and office appliances
- Software Service driving concept
- Future Local Area Network (LAN) connection
- Future Wide Area Network (WAN) connection



State of the Art

There is the Home Gateway Initiative in charge of the definition of the European gateway (`http://www.homegatewayinitiative.org/`) The Home Gateway Initiative is an open forum launched by Telcos in December 2004 with the aim to release specifications of the home gateway. In addition to Telcos several manufacturers have joined the alliance. HGI was formed to boost the market of home communication services to the millions of broadband customers served by its founding members. The initiative will drive the development of residential gateways supporting the delivery of services. The goals of the initiative are:

- To produce and downstream requirements for a residential gateway enabling end to end delivery of services.
- To work with manufacturers in order to leverage volumes, to validate with manufacturer against uses cases and requirements, to insure interoperability.
- The initiative will take as a basis the work undertaken within existing bodies such(as ITU H610, DSL forum, DLNA, OSGi Alliance..) and will analyse gaps with respects to its requirements.

Topics to be addressed

- The home networking via the residential gateway will enable a wide area of new remote applications in a smart home. All home appliances may get an IP access time after time.
- In the near future there might be devices, that, due to its complexity, versatility and price, could be shared on a community environment (building, neighborhood, industrial area, etc).
- At the time being, it is a relevant component to bring global connectivity to the residential and corporative environments.
- Integration of different types of access networks, including those of new generation.
- Incorporate wireless technologies in the user side.
- Self discovery of services, users and devices.
- Management of security within the communications.

Key issues to be solved

- Selection of the most appropriate network to access the service.
- Quality of Service evaluation.
- Billing model embracing the user, the access provider, as well as the content provider.
- Assure end to end security.
- Routing and addressing problems in mobile scenarios.

2.4.4. Virtual Distributed Devices

Definition

Virtual distributed devices are devices, which create themselves on the fly, They are based on essential components distributed in the near environment, which are connected virtually to one operational, customized device.

Objectives

As intelligence moves in our daily life infrastructure and even eye glasses may be equipped with some processing power, it is envisioned that there are devices which create themselves based on the components available in a certain range. In combination with intelligence and processing power

weaved into clothes and body area networks, a multimedia device could consist of the display integrated into glasses, earphones, wrist input device. As one gets close to a large screen that one is immediately integrated into the device and all content (provided the consumer had enabled it) is presented there. Once the consumer leaves the range of one component the device disassembles or creates itself new on the basis what is avaialbel. Services are automatically adapted to the current device capabilities.

State of the Art

Nothing comparable exist today. First experiments are made in labs, e.g. with intelligence waved into clothes.

Topics to be Addressed / Key Issues to be Solved

NEM researches platforms, architectures and interfaces for such types of devices. In particular the seamless composition and configuration is addressed, which requires extremely flexible networking interfaces. Obviously, such devices require suitable security mechanisms.

2.5. Enabling Technologies

Networked Electronic Media are the central element of the European Commission's i2010 agenda. An "integrated approach to information society and audio-visual media policies" has been communicated as the central element to reaching the target of a "Single European Information Space" as well as an "Inclusive European Information Society". Both, the social and the information technology related aspects are deeply related to audio-visual media. Communication will evolve to be a ubiquitously available part of out live, it will include as well speech and video communication as complementing audio-visual data (shared archives). Audio-visual information systems, predominantly television in its new, IP-based formats, will be available any place, any time and information will be internationally usable by clever conversions between different content formats, languages and content rights.

In addition to the above general aspects, the i2010 initiative calls for ambitious innovation and research programmes. In this way, NEM is paying significant attention to those enabling technologies which will make happen the NEM vision and ultimately have a positive contribution to the goals of i2010.

The following chapters address basic technologies that need to be in place to make this ambitious vision come true. Although the key technologies have been group around big general research areas, they should not be understood as close and shape limits, because the borders between these groups of research topics are not sharp. Major topics include:

- Even though there are a lot of business models for content without special Digital Rights Management (DRM) the lack of a global and interoperable standard for signaling and preserving content usage rights have been a bottleneck in the last years. NEM should keep research in the DRM technology maze as a highest priority.
- Media libraries must be searchable. Even in its most simple form (searching text-based metadata) this puts huge demands on RTD: Indexing digital content in an efficient and standardized manner manually (e.g. by speech communication), semi-automatically (e.g. by detecting scene cuts or highlights and then require manual input) or even automatically (by content analysis and synchronization with electronic content guides) is not solved today, thus, NEM should target solutions in these technological areas.
- Even today the semantic web is, at maximum, in its juvenile. Including semantics into audio-visual objects to enable sophisticated retrieval and searches will be an even more demanding RTD topic for at least the next two decades.
- Graphics representation is going to change dramatically. Autostereoscopic 3D on the one side, enabling a new form of telepresence, and an expected shift from pure z-Buffering to real three dimensional representation will deeply change the way visual media are perceived and consumed. Virtual or augmented reality will be represented by ray-tracing mechanisms rather than by polygon fills and will enable new dimensions in quality.
- Last but not least the electronic availability of media content will enable completely new content business models. Today's market place is based on suppression. What can't be found amongst the top sellers and within the major shops will hardly survive. Electronic media are available per definition. Search agents might be highly specialized on niche segments and therefore enable the critical mass of customers even for non-mainstream content. Overall this will increase the quality of the available information and therefore the educational level in the information society.

2.5.1. Interoperable Digital Rights management, content protection (watermarking)

The majority of content producing revenue today is protected by a contractual and infrastructural framework (DVD are explicitly produced for rental, film copies are treated in a very restrictive manner, broadcast is governed by levy systems or dedicated fees). It is therefore straight forward

that content owners seek for Digital Rights Management before transitioning to the digital domain. Digital Rights Management therefore is much broader than is normally implied. It comprises both, the contractual and the infrastructural framework by binding the content to a specific license and by securing it in a way that breaking this license cannot be done un-deliberately.

The most demanding aim is to break the individuality of current non-digital rights management systems. The necessity of establishing contract and infrastructure on case by case bases has lead to a myriad of different systems. Sometimes this even happens on purpose to bind a consumer (either an end-customer or a business-customer like a digital cinema) to a certain class of content. A "Single European Information Space", however, calls for interoperable solutions that enable free choice of content and content provider for any customer. Although a single technological solution might not satisfy a plurality of business and social goals and models, technologies to facilitate interoperability of solutions should be a major target.

The issue of DRM is attracting a great deal of interest worldwide. Building on work in FP6 and in collaboration with other international activities, FP7 R&D will put mechanisms in place to address the regulation, legal and implementation of a commercially viable rights management framework and associated technologies.

The main obstacle for digital media distribution is the possibility of making multiple copies of the same content without losses in quality: thus users may access copyrighted material without paying for that. Digital Rights Management (DRM) systems are designed to protect copyrighted material from being copied or accessed without permission. Simultaneously, technologies for DRM implementation should bear in mind the need of end users and satisfy their expectations regarding their good practices used in the hard world (personal copies, etc.). The FP6 DRM requirements would be a good starting point for further FP7 efforts in the DRM arena.

Internet experience tells us that users tend to distribute their value added contents between them. A clear example of this behavior is the distribution of contents by electronic mail (forward). The equivalent of e-mail in a mobile environment is the super-distribution of contents and future services P2P (Peer to Peer).

The phenomenon of massive distribution of multimedia contents will be a key tool for bringing into use and massive penetration of mobile technologies in Information Society.

Nevertheless, this will only be possible if there are effective digital rights management (DRM) solutions on the distributed multimedia contents. DRM will guarantee that all participants in the value chain (end users, suppliers of contents, authors, operators, etc) are benefited.

Similarly, new business models nearer to the user will be necessary. Models which allow the user, for example, trying a game during a limited period before buying it, seeing a trailer of a film before acquiring it, etc. but controlling the use that the user does of these contents while simultaneously preserving their individual and social rights.

We are attending the launching of different technological DRM initiatives, these initiatives are still emerging, like the one leaded by Open Mobile Alliance, as well as proprietary technologies that have had a wide acceptance in Internet (ej. Windows Average or Real Player) and initiatives in the scope of free software like DreaM by Sun Microsystems.

There is a long way to walk in this area at technological plane, for example the evolution of OMA standard version 2, questions like the digital company/signature to guarantee a trusted environment between the terminal and DRM platform; technologies and standards for protection of continuous contents (streamings of audio, video) still in a very immature state; innovating in concepts like portable license or licenses for communities of users; interoperability between different DRM technologies(OMA, Average Windows, Sun DreaM...), univocal identification of contents and products, etc.

DRM systems today are far from perfect. No one knows if DRM systems completely satisfy the users and content owner's desires. Some problems of current DRMs can be mentioned:

- No single DRM system is suitable for all the possible content delivery environments : (at least mobile, internet, IPTV: -DSL or DTT-, satellite)
- There are no fully interoperable DRM systems at the moment: content services providers that implement different platforms will have problems to trade content to reuse content. To

implement this content market among providers usually out-of-DRM systems must be used and extensive re-encoding and reprocessing of rights is needed.

- Current DRM systems do not have some good properties that may be interesting for Telcos: standards based, reusable for different platforms and environments, highly secure, etc.

Despite the existence of alternatives DRM is a practical approach to put all the pieces together in the online content market and one that has the potential to make happy almost everyone in the content chain. Alternatives to managing rights through technical means (that's DRM) are difficult to implement and usually involve global actions that will have to be imposed to the marked by the regulators: levies, taxes, fees. In a global market this is by far more difficult to implement than DRM. Technology research should point towards solutions to facilitate wide acceptable implementation of DRM techniques.

Amongst others, such interoperable DRM systems/platforms should enable:

- Interoperation of content services throughout different vendors and systems.
- Commerce of audio-visual material over heterogeneous networks.
- Exchange among broadcasters and content owners of audio-visual material with associated documentation.
- Exchange (whether for financial reward or not) of owned and produced audio-visual material.
- Use of further business channels, as electronic commerce.
- Further services associated to the multimedia world, in a fully convergence environment of mobile, interactive, and fixed networked services and applications.
- Trust of all participants in the value chain, from content originators to consumers, by addressing, in a way that is fair to all, the DRM issues involved when handling audio-visual material in networked and electronic media.
- Stimulate the manufacturers to put on the market modules to evolve the archive system with new and powerful facilities.
- Achieve the trust of the content providers by means of addressing in a suitable way the DRM issues involved when handling audiovisual material in networked and electronic media.
- Assist, identify, develop solutions to be adopted as new regulatory framework in case so required.

While there are a number of ongoing activities in specifying DRM frameworks for audio-visual content (MPEG-21, OMA BCAST DRM 2.0, DVB-CPCM, DMP etc.) and there also are activities in specifying content licenses (TVAF, DVB), there is only very few activities on interoperability (e.g. CORAL) and those are limited in their scope. There are other standards related to some aspects of content trading: User authentication and identity representation (Liberty Alliance), Content Identity (DOI, ISBN, ...), Metadata (Dublin Core, SCORM, ...) and there are functional but non-interoperable end-to-end solutions (Windows Media DRM, OMA DRM V1.0, RealNetworks Helix, Apple Fairplay,...).

The demanding task of the NEM/TP is to educate industry and content owners to benefit from the potential of the Single European Information Space instead of using digital technology for obfuscation and isolation of content. Besides the required set of tools for setting up an interoperable DRM framework this is also an educational task. i2010, however, requires this task to be solved.

Watermarking is a key technology for DRM systems and is used to add extra information to multimedia data. This extra information is used for copy control, data identification and tracing. Nowadays we can say that this technology has reached a good level of maturity.

Other key challenges are:

- PKI, digital signature and certificate management in mobile environment ´
- Mobile Antivirus

2.5.2. Metadata

Metadata (data about data) can both describe the structure/meaning of the resources composing a system and specify the management operations to perform, at a high level of abstraction, depending on system conditions. In particular, semantic metadata provides resource descriptions understandable and processable not only by human users, but also by machines.

Among the different possible types of metadata, **profiles** and **policies** are considered of increasing interest and start to be widely exploited in open and dynamic distributed systems. Profiles represent characteristics, capabilities, and requirements of users, devices, and service components. Policies express the choices ruling system behavior, in terms of the actions that subjects can/have to operate upon resources. Policies are maintained completely separated from system implementation details and are expressed at a high level of abstraction to simplify specification by system administrators, service managers, and even final users.

General metadata will be extracted from different metadata source. This will be able to continue using different and advanced standards for specific areas of interest (domains). Results of searches and the interoperability will be better, because different kind of metadata could be processed as one.

Semantic metadata can be usefully adopted in several application scenarios. Web metadata allow automated browsing, retrieval, and processing of Web documents, thus facilitating the demanding task of managing the huge amount of knowledge available on the Web. Metadata can also be adopted to describe the behavior and the properties of service components, e.g., Web Services, to allow their automated selection and invocation by software agents. In addition, policy metadata enable the flexible management of complex systems: policies can dynamically regulate the behavior of system components without changing application/system code and without requiring the explicit cooperation of the components being governed. By changing policies, a system can be continuously adjusted to accommodate variations in externally imposed constraints and environmental conditions.

There are a huge number of metadata standards like Dublin Core, MPEG-7, LOM, OWL, etc. These standards are specialized in different knowledge areas, but it is difficult to match contents characterized by different metadata in a general search process. Within the research community the importance of metadata has been constantly grown in the last years together with the emergence of Semantic Web technologies. Therefore, the main standards for metadata specification are actually represented by semantic languages, primarily the Resource Description Framework (RDF) and its various applications, like the Composite Capability/Preference Profile (CC/PP) and the UAProf profile specification. All these semantic technologies provide XML-compliant specifications to ensure maximum metadata portability. More recent efforts propose the adoption of the Ontology Web Language (OWL) to specify semantic metadata such as service profiles.

Tasks to solve are:

- analyze composition and translation possibilities between different metadata standards,
- define general requirements in order to characterize different kind of contents (learning object, multimedia content, bibliography content, etc.) on a common knowledge area (interoperabilty),
- propose common lines to the different standardization organizations,
- provide tools to generate metadata information from other metadata sources. For example, extract relevant information from MPEG-7 multimedia content and integrate it in OWL definition (semantic web).

An emergent research topic is the exploitation of metadata in *context-aware applications*, i.e., applications that are able to adapt their behavior to changing situational conditions. Metadata seem

to represent a key building block to achieve context awareness by enabling high-level context modeling/reasoning and context-dependent behavior specification. Another emerging research direction relates to the possibility of integrating also metadata (rules) that dynamically limit the behavior of system components and guide their mutual interactions. In addition, various efforts are directed towards the definition of proper metadata to enable automatic service composition. The usage of metadata is also rapidly spreading among life-science research communities, such as biologists, where the possibility to seamless share and exchange knowledge, e.g., experimental results, represents a very promising perspective.

The provisioning of context-aware services, as previously described, requires adequate metadata modeling techniques and the definition of common metadata patterns, especially by means of ontologies. Several proposals and techniques for context representation have emerged, but they typically tend to be developed independently. The challenge is to harmonize and integrate different metadata models. In addition, because the semantics of metadata need to be handled by automated reasoners, a trade-off should be reached between automated semantic handling and the actual portability of applications. Another significant problem with semantic metadata lies on the potential inconsistencies stemming from the logic approach of ontology languages: there is the need of further investigation to guarantee that data consistency is preserved whenever metadata-based reasoning over those data is performed.

2.5.3. Media formats

Media formats include source and coded representation of audio, video and 2D&3D graphics and transport streams or file formats that multiplex the media tracks with potentially metadata tracks in a single logical or physical container. Persistently, multiple media formats continue to proliferate, creating problems and high costs for the content value chain companies and confusion for the end customer. In some circumstances this situation is inevitable given the various physical and capacity constraints of the available delivery chains.

The consecutive advent of musical CD, DVD, Home cinema and Digital TV (including high definition profiles) has entailed an ever growing consumer's expectation for better and better media quality. Meanwhile, the content value chain has been progressively migrating towards full digitization, from capture to delivery and presentation. Pursuing the transformation by fostering wide adoption of digital high definition formats, technologies and equipments in a consistent manner throughout the value chain is indispensable for market development and cost efficiency. In particular, it will be necessary to handle, store, exchange and distribute 1080p and above HD content.

Long movie production is still mainly in 35 mm film, although progressive use of HDTV cameras can be observed. TV movies and programs production in HDTV is now a reality in other regions in the world, but has to generally take off in Europe. However, the used formats are still limited: 720p does not use all the available screen definition while 1080i entails blurring effect owing to inconsistency with the progressive scan of flat displays. However, progressive scan cameras in 1080p begin to appear. Advanced coding formats are MPEG-4 AVC High profile for TV distribution and motion JPEG2000 for digital cinema.

The spreading of HD image formats both enables and requires improved coded representation of content suited to the different tasks and levels of the production (distribution chain, including better compression efficiency for both perceptually lossless or lossy coding and easily editable format). However, research on the minimal set of usage states for audio/visual content should be pursued while conforming to European copyright law and standardizing its recommended implementation and signaling. In parallel, a flexible media format framework built on baseline and optional formats to enable efficient use of distribution resources while maintaining service provision should be developed alongside technologies that enable economic cross-format conversion.

2.5.4. Multimedia search engines

Multimedia search engines ideally allow finding pieces of multimedia content corresponding to a user query in a fast and pertinent way. With the massive amount of ever increasing multimedia

data spread over the world, there is a pressing need of search engines able to efficiently locate them. Multimedia search engines aim to locate valuable multimedia data, regardless of their specific media type and supporting any media type as a query input.

In a near future the need of quickly finding multimedia information needed to help with the task at hand will become a more common and important activity. NEM envisions a scenario where this can be done without caring about media formats and where what is looked for can be specified using any piece of multimedia data as search clue.

Current search engines have taken a major step in improving their precision by resorting to techniques based on link analysis, which cleverly exploit the structure of the Web. However, they are still stuck with text-encoded information and retrieval of other kind of media is still done using associated keywords.

Tasks to be addressed are:

- (Semi-)automatic assignment of semantics to multimedia data
- Contextualization of multimedia search and retrieval
- Personalization of multimedia search engines
- Searching for interesting information without knowledge about the format and/or representation of such information
- Development and exploitation of semantic relationships among heterogeneous multimedia sources to discover relevant information offered by specific sources
- Study and development of semantic-based techniques for efficient and effective search over multimedia data sources

A major issue to be solved is that of semantic heterogeneity, since the syntactical heterogeneity of multimedia data can in principle be solved by adopting a common description and interchange format. Another major obstacle is represented by the very specific nature of multimedia information, which is hardly capture-able by any known data model. Models able to provide the “right meaning in the right context” need to be developed. Further, new query paradigms able to support users in the task of specifying both what they are looking for and how approximate results should be ranked are to be investigated. The main issues for media data search are efficient automatic semantic indexing and search architecture. The amount of data to deal with, as well as their temporality, also makes it very different from text search.

2.5.5. Transition from analogue to digital TV, radio

Europe is going through a transition from analogue broadcasting standards to new all-digital standards. Digital broadcasting offers better spectral efficiency, enabling broadcasters to offer a much wider choice in the same bandwidth, and a wider range of interactive services. Digital Switchover includes the change of several paradigms, since TV reception potentially is mobile, can be adapted to various transport formats (like IPTV or IPDC) and Single Frequency Networks (SFNs) can be implemented. Therefore a portion of the spectrum traditionally used by analogue TV can be reused (this is true for terrestrial, cable and satellite broadcasting) by, for example, introducing new media formats expanding the range of services.

Broadcast services will continue to be available, but using all-digital standards, with additional data services and interactivity offering the possibility of much wider innovation in content formats. Increasingly, broadcast content will also be available on demand, both through storage in the home and on request over many different networks from broadcasters and other content aggregators. There will be a seamless integration of broadcast and on-demand content chosen by the user with the help of intelligent agents using descriptive metadata distributed as part of broadcast content and via metadata aggregators.

Standards are available from DVB for digital television broadcasting by satellite, on cable networks, community buildings and terrestrially. Migration from analogue to digital TV is taking place at different speeds in different countries, depending on their different media landscapes.

Although several different standards are used for interactive services with digital TV, an interchange standard (portable content format - PCF) has been also defined.

Standards for digital radio are available for Band III and L-band (DAB) and for the bands below 30 MHz (Digital Radio Mondiale). However, after ten years, DAB has found success in only a few countries and Digital Radio Mondiale has only recently been launched. There is no clear digital migration strategy for Band II (currently the FM band). The new DVB-H standard brings new opportunities for multimedia service implementation.

Innovation in programme formats, combining audio, video, and data services in new ways to create attractive content, will be an important driver for complete switchover. Carriage of HDTV on DVB networks, particularly DVB-T or ADSL, would require some work in the short term, applying the technological advances of the last ten years to ensure HD carriage with reasonable spectrum efficiency.

Digital switchover for radio services needs to be planned and facilitated, ensuring that digital services offer sufficient advantages to consumers to warrant quick adoption. In particular, a strategy for switchover of Band II (FM band) is needed.

For complete digital switchover, usability of digital services will be important, since the elderly and the disabled will often be among the last to take up digital services.

New concepts of multicast distribution are necessary to realize a mass market for IP oriented TV and Radio. For the voice and video streams it is not acceptable to need a personal computer as a receiver. Therefore the internet radio architectures have to improve further and merge with other services to get terminals with reasonable cost structures.

2.5.6. Natural and multimodal user interfaces

Natural interfaces mimic typical human-to-human patterns of interaction such as speech, gestures, facial expressions and body motion. Integration of several modes of interaction is the base for design and implementation of natural interaction paradigms. Multimodality is a large research theme dealing with the study of man-machine interaction in the context of the combination of several input/output modalities. Modalities can be sensory (eg: vision, hearing/speaking, touch) or not (eg: physical information on the environment such as noise level, temperature or car speed), active (consciously used by the user such as a voice command) or passive (unconsciously used, such as the tilt of a mobile terminal).

Research questions focus on two main fields. The first one deals with fusion/fission of information at signal, semiotic or semantic levels in order to understand and interpret multimodal inputs from users and furnish the required information with the optimal modalities, taking into account the context of usage. The second one deals with ergonomic and usage studies on how users appropriate themselves multimodal systems, what is the learning curve, how they tend to specialize themselves with time.

Natural and multimodal interfaces are one of the enabling technology of *Ambient Intelligence vision*, where devices are pervasively embedded in the surrounding, interacting transparently and in a context-aware manner with the user. In this vision the gap between user intention and its expression in a way that is “understandable” by computers is greatly reduced. To reduce this gap, communication skills readily available to humans (e.g. direct manipulation, gestures, speech) for interaction with physical environment should be exploited. Input is from context (not from explicit request) through behavioral and physiological measures implemented through multimodal and multi-sensory unobtrusive devices. We foresee a multimodal future, in the sense that several technologies such as speech recognition, handwriting recognition, gesture recognition, speech synthesis, haptic feedback and so on become mature. According to the different usages, these technologies will be integrated in order to offer to users more efficient interactions, allowing a better adaptation to individual differences (modality preferences, degree of expertise, handicaps...) and to the context (reduction of global error rates at the input thanks to the possibility of switching from one modality to the other, or by combining information from several modalities). Multimodal services will be more efficient and will give a more powerful experience to users.

Commercial systems are available for natural interaction through speech, gestures or facial expression. The variety in this field is wide. High-end technology are usually more accurate and in

many cases do not need the user to wear devices. This is the case of many vision systems for motion and face recognition. Highly accurate system needs high-power processing capabilities and/or large storage. Examples are libraries and dictionaries for speech recognition systems. Thus, a constraint to mobility is the need for fixed high-end processors and data-storage. In the case of vision system, the user is limited in her/his mobility to the area detected by cameras. Moreover complex calibration phases and maintenance are often required. Low-end devices are less accurate, but often do not need complex calibration process, are less expensive and mobile. Two challenges for this kind of solution are: battery lifetime and unobtrusiveness (i.e. reduced size and weight).

Usage of Body Area Networks (BANs) of smart sensors for implementation of natural interaction interfaces. This can be achieved in three stages:

1. Deployment of BANs based on inertial sensors, which enable the capture of movements and gestures for user interaction with the environment (e.g. pointing, object manipulation), behavior understanding (e.g. what user wants to do, what user wants to interact with) for context-aware service provisioning, authentication (e.g. gait recognition) for enabling\authorizing access to rooms, appliances, devices or services.
2. A second stage is targets the understanding of the emotional state of the user through activity recognition and biological and physiological parameters measurement such as blood pressure, perspiration, breathing, heartbeat, captured through a multi-sensors body area network.
3. A third stage integrates actuators for providing haptic feedback for different purposes, such as prosthetic aids in healthcare applications or augmenting immersive virtual reality experiences.

Challenges to be faced are:

1. Power consumption (better energy efficiency): increasing lifetime of mobile devices and sensor networks is crucial to support mobility but also usability and reliability. Energy scavenging techniques for alternative power supply must be explored and research effort done for managing unreliable\discontinuous energy sources.
2. Reliability: wireless sensor networks and mobile devices are often resource-constrained systems. Wireless communication is subject to noise, interferences and delivery of messages among parts of a distributed system is subject to loss and errors. A major challenge is optimization of hardware-software resources, communication protocols and network topology for reliability.
3. Size: Transparency and feel of naturalness is achieved through unobtrusiveness and wear-ability of devices. System on chip solution, extreme miniaturization and MEMS technology can be the basis for developing a new generation of smart sensors of the size of dust.
4. Costs of technology and user interaction devices must be targeted for commercial market for a widespread diffusion and access. Ubiquitous computing and pervasiveness of embedded system can be achieved if affordable.
5. Intelligence. Existing hardware and software is not flexible enough to adapt to changing environments, resource availability (e.g. energy) and integration of heterogeneous sources. Very ad-hoc solutions are used especially in WSNs. It would be preferable to use the same devices for many purposes and contexts. Design for flexibility is required (modular hardware-software, easy component interchange for maintenance, upgrade and capabilities integration, middleware abstraction layers, dynamic re-programming, learning capabilities)
6. Create a standard (W3C/MMI group) in order to promote multimodal solutions at large scale, across different networks and terminals.
7. Obtain substantial feedback from users by longitudinal field studies in order to better understand what multimodal applications bring to users in the long-time experience, so that multimodal solutions will be design and marketed efficiently.

2.5.7. Privacy, trust

Today's internet world relies on a contractual binding between the business partners. This is normally done on a service per service basis (e.g. by trusted exchange of credit card data). Systems like *Liberty* try to assimilate user data and authentication for a variety of services, trust models like CMLA do the same for a dedicated security system (in that case OMA DRM v2.0). In the era of NEM, premium content will play an important role and the establishment of a trusted channel on a case by case basis would undermine the advantages of networked media. Therefore trustworthy platforms have to be established that enable the secure but nevertheless seamless authentication of users while fully maintaining his anonymity outside the actual transaction.

Networked electronic media have to be based on integrated trust models that enable business partners (as well in B2C as in B2B) to mutually authenticate while maintaining their privacy. Today, trust models for certain service classes and general authentication services are totally separate. IT will be important to integrate them in a way as to enable the user to seamlessly authenticate to the system independent of the service she/he wants to access.

Today the only open standards based initiative for seamless authentication is the Liberty Alliance. But service class specific trust models like the CMLA, which can deal with any OMA DRM v2.0 content, can complement those general services and lead to an integrated trust platform.

It should be also considered the development of powerful agents to facilitate the compliance of rules governing the protection of minors, and the implementation of regulatory and policy rules addressing publicity and content categorization.

The step from service based authentication towards integrated authentication puts several highly demanding tasks onto the NEM goals:

- Transparency: The user must be aware of who has access to which part of his authentication profile.
- Revocability: For all parties, the business partners (on either side) and the trust platform, there must be a clear set of rules how and when to revocate all or parts of a user's authentication profile.
- Privacy: There should be no leaking of privacy information other than required by law.
- Security: While the technical systems can be made as secure as processing power allows, the seamless authentication by the user is a bottle neck. Innovative concepts as well as education of users and plausibility checks have to be integrated into the system.

2.5.8. Flexible compression

Networked electronic media have been enabled by data compression. For example, MP3, providing a data rate for high quality audio that has been near to the data rate telephone modems could provide, has boosted the electronic distribution of media. This early phase, however, used a reliable transmission channel (the phone line is orders of magnitude more stable than a wireless channel) and didn't provide for streaming. Both streaming and time varying channels require a very flexible network architecture incl. the audio-visual compression technology.

Today still most of the audio-visual channels are relatively deterministic. NEM, however, has to be built on quickly and deeply varying channels due to mobility and fading in the wireless and heterogeneity in the wired domain.

In the context of MPEG-2, hierarchical coding was shown to be less efficient than simulcasting for distributing content in different resolutions. However, this conclusion might not apply to other compression algorithms. In addition, the variety of end devices and their coding/decoding capabilities have been growing enormously over the past years. This becomes obvious when noticing that one of the most important coding standards suites (MPEG-4) includes two completely independent and incompatible video codecs. Together with DRM interoperability, the ability to flexibly compress and code audio-visual content is a key enabler for ubiquitous audio-visual information.

Since the area of transcoding has only been touched under the viewpoint of quality of service (QoS) up to now, there are a lot of important issues to deal with under NEM:

- Efficient trans-rating (rate adaptation) and trans-coding (to keep server side processing power requirements acceptable).
- Automatic image and sound quality measurement (to ensure remaining quality is high enough and prevent cascading losses).
- Editorial issues (pan & scan, color reduction, adaptation of number of audio channels, 2D/3D conversion etc.).
- Buffer models for realtime trans-coding (data rate must be changed seamlessly).

Content licensing issues are very complex to handle in an environment that enables flexible compression. There needs to be education of and agreement with the content industry to allow service providers to make content available under various business models acceptable to consumers and on a variety of end devices without implying renewed licensing negotiations (which would put the servicing threshold too high).

2.5.9. Human language technologies (translation tools, speech recognition)

With the rapid advances in the information society, language transparency is becoming vital. HLT (Human Language Technology) provides the most elegant way to seamlessly overcome language barriers.

For all citizens to become e-included in the information society, the products and services of that society must be accessible in their languages. Language transparency, in which products and services are offered cross-lingually and in a localized manner, is one of the major prerequisites for the successful establishment of a common European NEM market; the final goal is to smooth communication across languages, just as we can freely move across borders within the EU.

Research and development in HLT is nowadays rapidly transferred into commercial systems, and it is becoming increasingly pervasive in everyday life. Apart from the well-known areas of machine translation (MT), automatic speech recognition (ASR), and text-to-speech synthesis (TTS), all of which are now packaged into inexpensive applications of varying quality for the commercial and home markets, at least for languages with a broad speaker base. However, the extent to which the languages spoken in Europe have been researched systematically varies widely from language to language, with a minority being well investigated within dedicated EU and national programmes (such as English, French and German) and some of them hardly being addressed at all.

If we want the contents and products to reach a broad variety of potential users, high-quality HLT resources and HLT products need to be developed for the less researched language groups:

- Affective or 'emotion-oriented user interfaces'.
- Continued effort on standardization of HLT human-machine interfaces.
- Work towards user- and application- and environment- independence of HLT technologies.
- Develop missing language resources for less investigated EU languages.
- improve machine translation techniques for rapid content localisation.
- The systems and applications should be should have natural and easy-to-use man-machine interfaces, able to register, model and/or influence human emotional and emotion-related states and processes - 'emotion-oriented systems'.
- Develop machine translation techniques for a large number of EU language pairs.
- To search for alternatives to current data-driven speech technology approaches in order to improve speech recognition performance.

2.5.10. Multimedia analysis and computer vision (object recognition and tracking, data fusion)

Object recognition in multimedia sequences opens the field for a variety of new applications and improvements of current systems. Within Object recognition there are two basic levels: The physical recognition that separates objects for the sake of object based coding, improvement of coding efficiency (by applying parameter models to the moving objects) and for adapting the quality focal point (e.g. in foreground/background separation). The even more demanding level is the semantic object recognition that not only extracts an object but also deduces its meaning (e.g. the "Renault of Fernando Alonso" or "the British Prime Minister"). Object recognition can be supported by fusion of data from several sources (video, audio, pre-existing metadata).

Object recognition can revolutionize video coding. Several publications have proven that in certain application scenarios object based coding can improve the efficiency of H.264 by a magnitude, while being robust enough to not decrease efficiency for general TV material. Once objects are extracted, coding can be adapted and semantic information can be generated. Automated indexing, multimodal fusion (e.g. overlaying a politician's speech with its original manuscript) and object based data retrieval/search engines are typical examples.

For restricted application scenarios (monitoring, political talks/Parliament debates) demonstrators have been build that prove that viability of object recognition and data fusion. The integration into an overall framework for automated parameter and metadata extraction, however, is missing.

The RTD topics most promising under the scope of NEM are

- 3D-object recognition on a physical level (extracting the object itself and applying a complex motion parameter model).
- 3D-object recognition on a semantic level (identifying the object).
- Definition of ontologies for restricted application scenarios.
- Automated indexing.
- Data fusion (video, audio, metadata). Early, late and recursive fusion must be elaborated.

The semantic level of object recognition is a field that needs a variety of technologies that are only implementable in collaborative RTD efforts. Ontologies that bring together the physical parameters of objects with potential semantics (at least in restricted application scenarios) form the baseline. Object databases (e.g. all national politicians in a database supporting indexing and fusion for senate debates) have to be generated and standardized query and modeling languages have to be developed.

2.5.11. Content indexing (audio, video)

Indexing or Indexation means generating search keys enabling efficient retrieval of content in both relevance and speed respects. Some keys simply consist of textual metadata handled by classical database management systems. Some others need specific handling.

The main aim is to develop advanced automatic analysis and recognition tools and systems for audio visual (photo, videos, music) content capable of generating highly semantic metadata in a very fast and reliable way. Target services include audiovisual delivery over fixed and mobile networks (TV, VoD) and all associated functionalities (intelligent PVR, summarizing or content adaptation), personal content management, professional content management including video surveillance and video conferencing application.

Only a few techniques can be considered as mature and effectively deployed: audio and video segmentation, image and music identification, recurrent shots detection (eg: news anchor) and speech-to-text transcription in very favorable conditions.

For almost all recognition techniques (vocal, person, object, event), stress must be put on relative independence to content type and recording/capturing conditions, essential for reliable and effective use. Knowledge-assisted complex scene understanding is an ambitious but natural goal

for more advanced functionalities. One-pass multiple entities recognition is also a fundamental topic to address to maintain acceptable processing complexity.

All other recognition techniques must progress a lot in order to achieve the minimal level allowing using them in operational services.

2.5.12. Mixed reality; Animated computer graphics (2D, 3D)

More and more, as well in gaming as in production, reality will be augmented, refined or even substituted by synthetically models. MPEG-4 Part 2 (DivX) has been the first video coding standard incorporating elements from real and virtual worlds. VRML elements or animated human characters are examples.

Some interactive Avatars as ECAs or representations of humans in collaborative applications exist but lack of realism in co-articulation rendering, gesture rendering, credibility when real time constraints, are necessary for interaction.

It has been recognized that multi-view video is a key technology that serves a wide variety of applications, including free-viewpoint and 3D video applications for the home entertainment and surveillance business fields. Multi-view video coding and transmission systems are most likely forming the basis for next generation TV broadcasting applications and facilities. Multi-view video will greatly improve the efficiency of current video coding solutions performing simulcast of independent views. Succeeding HDTV multi-view video will probably reshape consumer behavior significantly. We need to go further in believable, expressive rendering, better co-articulation rendering and synchronization of audio and Non Verbal Behavior (NVB) in context of multilingual/multicultural use. "Intelligent", context aware and semantic based control of avatars must be more investigated. Scalable rendering depending of the context (human interaction, network, display), including mobile and Immersive display (holographic display) should be addressed too. The control language of the Character for networked applications should be normalized.

Real time rendering for interactive applications, multimodal interaction with "intelligent" virtual characters taking into account moods, expressions and emotions, contributions to standardization of command language must be researched.

Believable virtual characters are key elements of future Virtual Reality, Telepresence, Interpersonal and Collaborative applications. Realistic animation and rendering is a major factor of believability and credibility of virtual characters. Virtual characters can be used as assistant which can be Embodied Conversational Agents (ECA) with dialogue and non verbal behaviors capabilities. They can also be used to represent human for inter-personal, collaborative applications (from professional applications to games). In any case they must convey information and be believable in the man machine multimodal interaction or in their relation with other virtual characters. Their use in interactive, networked environments will increase and a trade off must be found between quality of animation and real time interaction.

In addition to new and mighty models for representing human characters and 3D objects their rendering by means of ray tracing is a highly promising way forward. Ongoing research on multi core platforms shows that real time rendering of dynamic scenes with ray tracing might be possible in the timeframe of the NEM.

Mobile augmented reality is a promising interaction technology. As an example, it allows viewing route indications (arrows, virtual guide, etc.) directly in the user field of view by means of a hand-held camera or see-through glasses. Spatially distributed hypermedia is also an interesting concept to explore. Multimedia documents can be geo-localized and are viewed as the user navigates in a city or a building. The user may be allowed to modify the documents or add new ones allowing a sort of spatially distributed web-logging.

2.5.13. Personalization

Personalization is a function able to adapt the content or the service to the user profile. For instance, when one wakes up he/she would like to have specific information (weather, news, traffic,

etc.); when one comes back home, he/she would prefer to have other information (messages, who called me, who visited me, the evening TV program, etc.).

That personalization could be done according to several criteria such as the time but also the location or a specific situation, as well as many other preferences and priorities set by the user.

People are more and more overloaded with information due to the high bandwidth connectivity and have more and more difficulties to find the right information. Content and Service Personalization could help them into finding the good information according to the user profile. That user profile could be filled manually or could be managed automatically. For the automatic management of the user profile, it is possible to log the usage of the user and to update the user profile accordingly.

Examples of study of these concepts are currently being conducted in the FP6, targeting the prototypes in order to test the usability in front of real customer. Other activities also cover research into personalization of services for users and also privacy concerns for users using Virtual ID concepts

For making personalization an essential part of a variety of applications, a common solution for every type of services and that pays respect to the user control and his privacy must be developed. First approaches have been made with UserML and the GUMO (General User Model Ontology).

Main problem areas are the required transparency of the system behavior for the user and the overcoming of privacy concerns.

Another topic that is interesting for personalization is the elucidation of user preferences (i.e. allowing the system to determine what the user is likely to want to see on their mobile device and to determine the types of services and media that a user may want to have available to them). This must be combined with the user's context (time, location, temperature, etc.) and must be taken into account in any research activity in this area.

Furthermore, future research should take into account how to make a user's context and personalization preference as a tradable commodity between stakeholders in the provision of a service.

2.5.14. Intelligent agents and semantic technologies. Ontologies

Semantic techniques have recently started to be applied within multi-agent systems to provide software agents with reasoning capabilities that allow them to exhibit intelligent behaviors, especially when involved in mutual interactions. In fact, semantic languages permit to assign to a generic resource a well-defined meaning, expressible in a format that can be acquired and subsequently processed by a machine, possibly to draw new conclusions from the existing facts. To support such machine-understandable modeling of semantics, ontologies, i.e., explicit conceptualizations of a knowledge domain, and automated reasoning tools are used.

All contents will have homogenous metadata, allowing cross information in advanced searching process. Intelligent agent will recover the optimal data for any request, managing personal profile, content metadata, context information, etc. Semantic Web technologies should provide intelligent access to heterogeneous and distributed information, by enabling software agents to mediate between user needs and available information sources. Ontologies may also allow knowledge sharing between independently developed agent systems, thus achieving dynamic interoperability even in absence of a-priori common information.

- Internet stores and manages terabytes of data focused to presentation (HTML, wml...) without any kind of metadata characterization.
- Search engines recover information with little precision and require human filter tasks. Matching by literal word, not by concept (product for any company could be the same as item to other one).
- There are conflicts with translations, because one word has different meanings.
- There are little precise terms for matching issues (For example, one can find sites with prices in $ and other ones in €).

This situation creates complex B2B models (companies must discuss meaning of each interoperable item) and simple B2C models, because it is very complex to filter contents and to make comparative searches.

As far as ontology languages are concerned, a large consensus has been achieved within the academic community about the adoption of the Ontology Web Language (OWL) as the leading ontology language, recently standardized by W3C. Various OWL ontologies, with little standardization yet, have been adopted to define metadata about agents, e.g., profiles and policies, and they are used in conjunction with various reasoning engines, such as Pellet, Racer, or Jess. Semantic techniques have been proposed to achieve intelligent discovery and selection of services by software agents, by means of dedicated languages. Currently different research efforts co-exist, e.g., the Web Service Modeling Ontology (WSMO) and the Semantic Web Service Initiative (SWSI), which aim at overcoming some of the expressive limitations of previous modeling solutions such as OWL-S.

- Manage homogeneous taxonomies that allow unified content categorization from different domains (matching domain specific concepts with general concept).
- Easy creation of intelligent agents (evolution of ontology languages like owl and create easy tools for manage them).
- Create intelligent agents composed by existent ones (composition).
- Work with literal in several languages within intelligent semantic environment.
- Combining and crossing information from different metadata standard.

A research topic recently emerged within the semantic community is the need to integrate ontologies with rules to achieve a flexible control of agent behavior. This would require establishing syntactical and logical relations between the different types of logic that are used to encode ontologies and rules, e.g., description logic and programming logic. Rules might also be exploited to dynamically adjust the boundaries within which a software agent is allowed to autonomously act. To this regard, a crucial issue is the definition of semantic models of security, privacy, and trust that intelligent agents can reason about to take decisions on their dynamic behavior. Finally, semantic technologies seem to naturally address the need for pervasive applications to be context-aware, i.e., to be able to sense and reason about their situational context. Therefore, further research is needed to explore the possible implications that the adoption of semantic techniques may bring in context-aware deployment scenarios, such as the ones for advanced multimedia streaming, from both a conceptual and a deign point of view.

In order to achieve automated and dynamic composition of multimedia service components associated with semantic metadata, it will be crucial to define an adequate representation of services. This would require comparing, harmonizing, and integrating the various approaches to service descriptions that are currently emerging. Another challenging issue is concerned with the adoption of semantic techniques within pervasive environments, where resource-constrained devices might not be able to sustain the overhead caused by the adoption of semantic-enhanced middleware solutions.

2.5.15. Display technologies

Display technologies always played a vital role as key enabler for technology. Display technology in the scope of NEM is any technology enabling new usage models for audio-visual content. This might refer to spatial resolution, to integration of 3D or to wear-ability that enables mobile consumption capabilities.

Mobile TV reception and ubiquitous audio-visual media have to be accompanied by innovative display concepts like holographic eye glasses, wearable OLEDs or similar. Even textual search has been strongly limited by displays (i.e.failure of WAP), so that there is a high demand for better displays in the audio-visual era.

The HDready logo recently agreed by industry paves the way into higher resolution. Even though this sounds straight forward it is the verge from analog displays interfaces to digital ones, from integrated TV's to the desktop computer paradigm.

The trend of moving towards the desktop computer paradigm involves the ability to view multiple media sources at the same time, replacing many existing forms of communication and media, such as telephoning, radio & television, e-mail, reading & sending letters, etc. The result is that there will be growing need to have ubiquitous high resolution, large displays with common interfacing capabilities to allow multiple media sources to be handled at the same time.

Display technologies have to evolve up to a level where displays can replace paper in terms of visual quality. This will trigger the wide adaptation of even higher resolution content (2-4 times HDTV resolution and up) to visualize maps, radar, high resolution pictures and applications which will be used for sharing and collaboration. These displays will grow from standard 19" to wall size, depending on the number of users. These displays have not only to support multi modal interfaces but also multi (concurrent) user interfaces.

Arising from this simple transition is a lot of issues to solve:

- Wireless high bandwidth interfaces to enable the separation from image generation and image reproduction.
- Secured digital interfaces for the interoperable connection of displays to any rendering device (UDI and its successors).
- Innovative displays in very high resolution stationary (autostereoscopic 3D displays, living room caves) and mobile form (OLED or holographic displays integrated in eye glasses).
- High density (>100 dpi) large area displays (>1 sq.m.) for paper replacement.

Besides basic technologies (innovative display concepts), there's a lot of regulatory questions (UWB spectrum management) to answer and cross industry education (traditionally computer interfaces like VGA and CE interfaces like SCART have been different, HDMI being the first but not yet sufficient step towards interoperability) to pursue.

2.5.16. Platform-independent porting tools. Adapters

Adapter systems can facilitate the establishment of interoperability of different (open software) European standard tools and interfaces for the development of games and content in general. They have to be placed, developed and maintained. It is also important, that these adapters do not contribute considerably to losses of performance, so they have continuously to be improved. These adapters are so important, as they multiply network effects for (publicly funded) open software. They are also necessary to port proprietary standards (e.g. 3D graphic software) or hardware (e.g. consoles) to open source middleware and software.

2.5.17. Acoustics and sound generation (Auralisation)

Auralisation is a plausible (realistic) creation and rendering of 3D sound scene: sound source position, orientation and size, reverberation, occlusion, obstruction over different displays such as stereo headphones, loudspeaker setup (stereo or 5.1 configuration).

Auralisation technologies will be more and more used in Games. The game market will help auralisation to enter the multimedia content market (music, video, TV and rich media contents). Specific authoring tools and players will be developed for the multimedia content market. The aim of auralisation is to create "artificial" sounds for a listener thanks to electronic and electro-acoustic devices as if they were real sounds coming from real objects from a precise position in space.

Auralisation rendering technologies are now available on all PCs and new game consoles. In a soon future they will be available on mobile terminals. They are mainly used in games. Auralisation authoring tools already exist for game developers (ISACT, XNA) but they are still far from having the maturity of graphic authoring tools. For music, video, TV or rich media content almost no authoring tools using auralisation features exists.

We need authoring tools adapted to the type of content to be created (game, music, video, TV, rich media, etc.) and that allows content creators to produce content that takes into account the

features provided by auralisation technologies (interactivity, realism, immersion, customization, adaptation to the terminal). We also need individualization of auralisation over headphones.

Auralisation over headphones suffers from the lack of individualisation. When using non-individualized rendering techniques over headphones, the frontal sound sources are perceived by the user over the head or behind. This causes many consumers rejecting this technology. Convenient authoring tools allowing the creation of content using auralisation features are mandatory. Such authoring tools, that content creators are willing to use, are necessary to ensure the availability of content created by using auralisation features, thus allowing auralisation technologies to reach the consumer market.

2.5.18. Interactivity and Mobile Digital TV

Digital TV will pave the way for two features not common in analog TV systems:

- The digital data format enables a more sophisticated accompanying data. Even though the World Teletext standard defined a format for digital data sent in addition to the classical TV signal, the architecture of end devices did not allow for embedded applications. Today's Settop-Boxes incorporate a microcontroller and an operating system that is capable of running applications in case they are sent in a commonly understandable format (PCF, MHP).
- Mobile reception. As well for DVB-T, which is receivable up to ~170 km/h dependent on the actual RF frequency, as for the upcoming DVB-H, that is receivable at much higher speeds, mobile reception is one of the most visible features.

In addition to those system inherent features, digital TV transmission opens the way to separate content from its delivery. There is a clear trend towards IP-packaging of DTV content for broadcasting (IPDC, IPTV) and for local distribution (DLNA).

The business model of a broadcaster and a mobile telecom operator becomes convergent regarding on-demand audiovisual contents. Hence, convergence between DVB-H and 3G/4G technologies must be addressed, everything integrated in a fully convergent scenario involving fixed networks. Models must be built on the basis of open service interoperability, seamless end to end services architecture, in such a way that Digital Television and Interactive Digital Television services can be accessed in a transparent way by means of mobile handheld terminals.

Special attention must be paid to MHP mobile applications, on the basis of DVB-H or even extended DVB-T functionalities. Digital Video Broadcasting (DVB) is a set of standards that define digital broadcasting using existing satellite, cable, and terrestrial infrastructures. Numerous DVB broadcast services are available in Europe, North and South America, Africa, Asia, and Australia. The Advanced Television Systems Committee (ATSC) standard is the digital broadcasting standard used in the U.S.

Related to mobile TV, there are three primary open standards developed by industry associations with contributions from multiple players in the mobile DTV marketplace:

- DMB (digital media broadcast) has deployed today in Korea with several handsets already in-market to support the standard and is expanding to Europe and other parts of Asia.
- DVB-H (digital video broadcast-handheld), an optimization of the terrestrial DVB-T standard to allow broadcasting to handheld devices, is quickly gaining ground with trials in Europe, the U.S. and parts of Asia.
- ISDB-T (Integrated Services Digital Broadcasting-Terrestrial) is the standard in Japan.

There are other technologies that have been developed for mobile DTV that do not fall within the open standards category, for example MediaFLO in the U.S. market.

Most discussion of mobile broadcasting technology revolves around dedicated networks, such as DVB-H, DMB and so on. In the short term, 3G itself could provide an attractive broadcasting solution for mobile operators, using 3G MBMS standard, which could be available from 2007. MBMS, which requires relatively small changes to the underlying 3G standard, enables broadcasting to any number of MBMS-capable handsets within a 3G network.

Standard designed by the DVB project for enabling interactive services is called Multimedia Home Platform (MHP) and is now widely adopted among European countries. In addition to MHP, there are also, other proprietary systems such as MediaHighway or OpenTV. In the United Kingdom, the MHEG standard is widely used on the terrestrial platform. As a result of the various products and services in the market, the DVB Project has been working on the development of the Portable Content Format (PCF) to deliver a wide range of interactive television services to multiple platforms with a minimum of re-authoring. It has significant interest for operators who wish to migrate towards MHP by allowing them to manage simultaneously a mixed population of devices.

In a way analogous to what the DLNA (Digital Living Network Alliance) defined for local content distribution, there is a need for media format guidelines in the IPTV/IPDC era. Even though all receivers will be able to receive the IP-packaged media data, there's no guarantee for interoperability, since the upper layer protocol suite might be very heterogeneous (e.g.TCP/HTTP vs. UDP/RTP) or codec implicit signalling (DivX, WM9…). Moreover, decoders will have to deal with a broad palette of codecs, like H.264, MPEG-4, VC-1 and others, which calls for some operation guidelines.