Strategic Research Agenda

"Networked and Electronic Media"
European Technology Platform

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NETWORKED
& ELECTRONIC
MEDIA

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

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".

This document highlights 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 essential for creating new products, services and solutions that can be deployed worldwide in the future. This is the basis for the reflections that are being investigated by all NEM European Technology Platform stakeholders.

It is the convergence, currently happening between various industrial sectors such as telecommunications, broadcasting, information technologies, media and content providers, and consumer electronics, which will significantly reshape the environment and usage for media and communications. Borders 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 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.

The European Citizen is the centre

NEM is placing the consumer and European citizen in the centre of its perspective. It is the service which provides benefits to the consumer. Applications enable him to use content and services. Consequently, the NEM vision will eventually become reality in a large number of very different new types of services and applications. The citizen is connected to his current environment wherever he is, and this environment seamlessly offers services and applications to him matching his current needs and expectations. That such applications can intuitively be used without any barriers is self-evident.

Services drive the market development

This perspective is supported by today's understanding of the market environment. The importance of content and services is permanently growing as almost all stakeholders, in particular network operators, complement their business with services. ASPs like Google or Yahoo generate billions of Euro revenue with service provisioning (mainly searching) and advertising. In the light of the world soccer championship 2006 almost every media company bid for a transmission license.

Simplifying Content Creation and Management

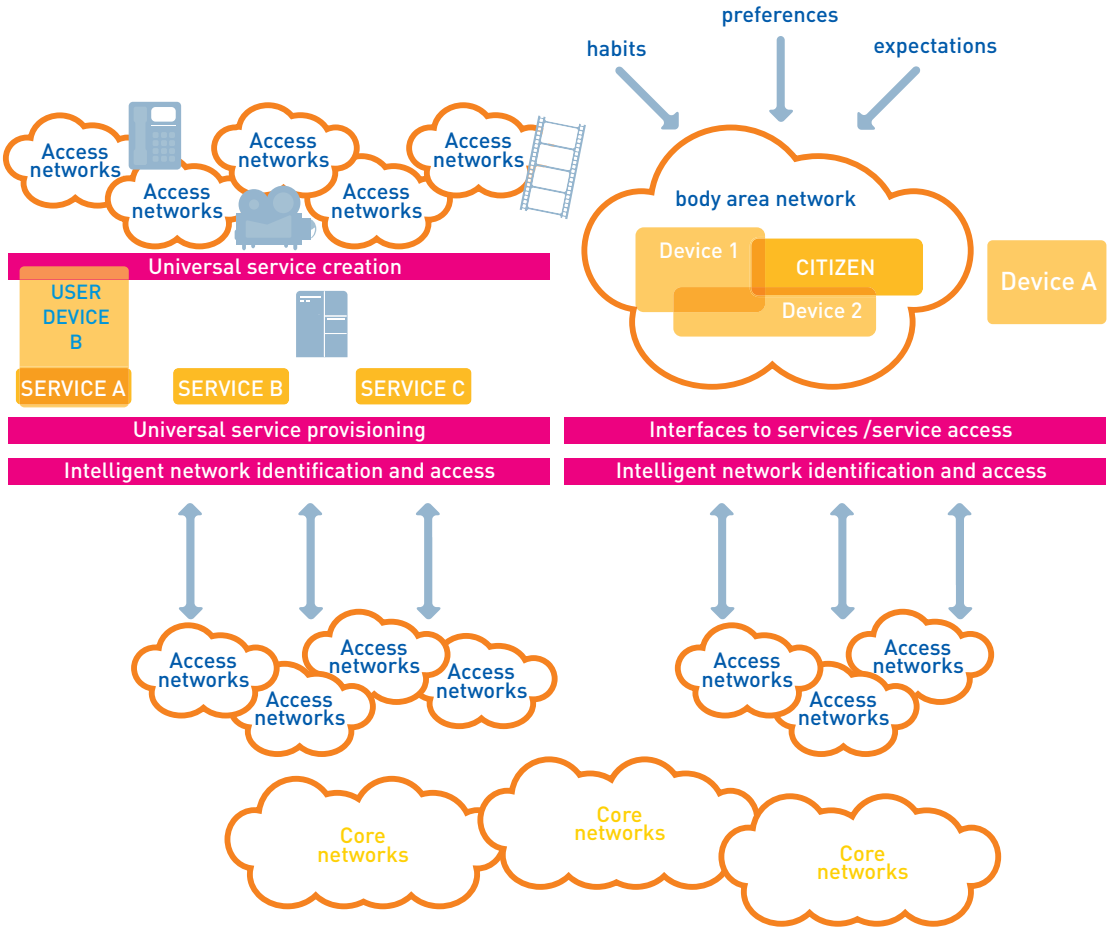
NEM identified the importance of content and services as one of its big challenges "to empower end-users by putting the user first". Services require content. For offering a broad set of services lots of content needs to be generated – and managed. This will imply not only a need for advanced content management technologies. Sophisticated tools for flexible, dynamic, and automated service creation are required as well. As the amount of content increases finding the relevant piece of content is getting more and more important. Already today consumer create content by themselves, e.g. in WEB-pages, blogs or podcasts. It is expected that the amount will significantly increase over the next decade.

Seamless Service Provisioning

The variety of services will call for techniques allowing to instantaneously creating new service by connecting service atoms, even over any kind of network. The consumer is pleased by services optimized to his needs. Important is also, that services are provided seamlessly. It is of no interest to the consumer which network has to be used. NEM identified this as another big challenge "To create interoperable network infrastructures that enable seamless multimedia networking". Today's infrastructure is inapplicable for the NEM vision as it is characterized by very heterogeneous, proprietary and thus not interoperable approaches, not to mention that not all technologies are available for the NEM vision.

Unified System Architecture as glue between heterogeneous network infrastructure

The technology platform NEM aims for developing an overall system concept and network architecture. This has been identified by NEM as an extremely important and challenging research topic. The current network infrastructure is characterized by an increasing number of access network types. 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. Broadband network access becomes a commodity. From April 2005 to March 2006 DSL connections grew by 39% to now 150 Million worldwide. Terminals implement more and more different access interfaces with the opportunity to use multiple interfaces simultaneously.



The challenge is that the amortization time in network infrastructure is rather long (10 years +) and NEM will have to develop technologies to glue existing infrastructure together. On the other side new network concepts are needed for seamless service provisioning. Not only planning of networks, but also optimizing network operation is critical in an environment, where networks are no longer designed for dedicated services. Seamless service handover between networks is a prerequisite for the envisioned services. Research has to include QoS issues, ease of configuration and service provisioning, and network and service management.

No Service Usage without Terminals

Consumers are already nowadays equipped with a broad range of electronic devices. It is expected that the already astonishing capabilities will even increase over time. Increased integration and reduced power consumption extend the applicability of devices. Besides integrated devices, device components can automatically connect to each other and instantaneously form new devices offering new features. The personal environment will be characterized with networking of various devices, which require intelligent gateway and networking capabilities. Nowadays, the development focuses on in-home networking. The seamless networking between home, portable and mobile use is about to come soon.

Technology development by components

To bring the whole ecosystem of user centric services to live many more components must be developed. For NEM the overall system concept serves as a "Map" to identify relevant or even missing technologies. Without claiming completeness, NEM has identified a couple of aspects. The localization of such aspects over the distribution chain is not trivial. 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. In the telecom environment such "enabling services" play a critical role.

From a commercial point of view the aspects of digital asset management, trust, and security as summarized in the big challenge "To promote "Electronic content from all to all" is important.

Consumers expect that services, in particular personalized service, are available regardless of devices and networks. One implication for service provisioning is the need to serve all kinds of devices and networks. With increasing variety and complexity of services an individual adaptation is not possible at all. Therefore, NEM seeks to develop a suitable middleware as stated in the big challenge "development of new middleware for media applications" The importance of such a technology is commonly understood as all market segments started now to develop something. However, the NEM vision requires a consolidation, which in fact would enable an even more attractive market for services and content.

SRA is a living document. The technologies mapped onto the system concept help to identify gaps and missing links for the overall vision of NEM. SRA reflects those technologies identified as missing or requiring development form today's perspective. 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. As the development moves on the SRA will need to reflect new insights. Solved issues will be removed as new ones will be taken in.

Business starts with implementations

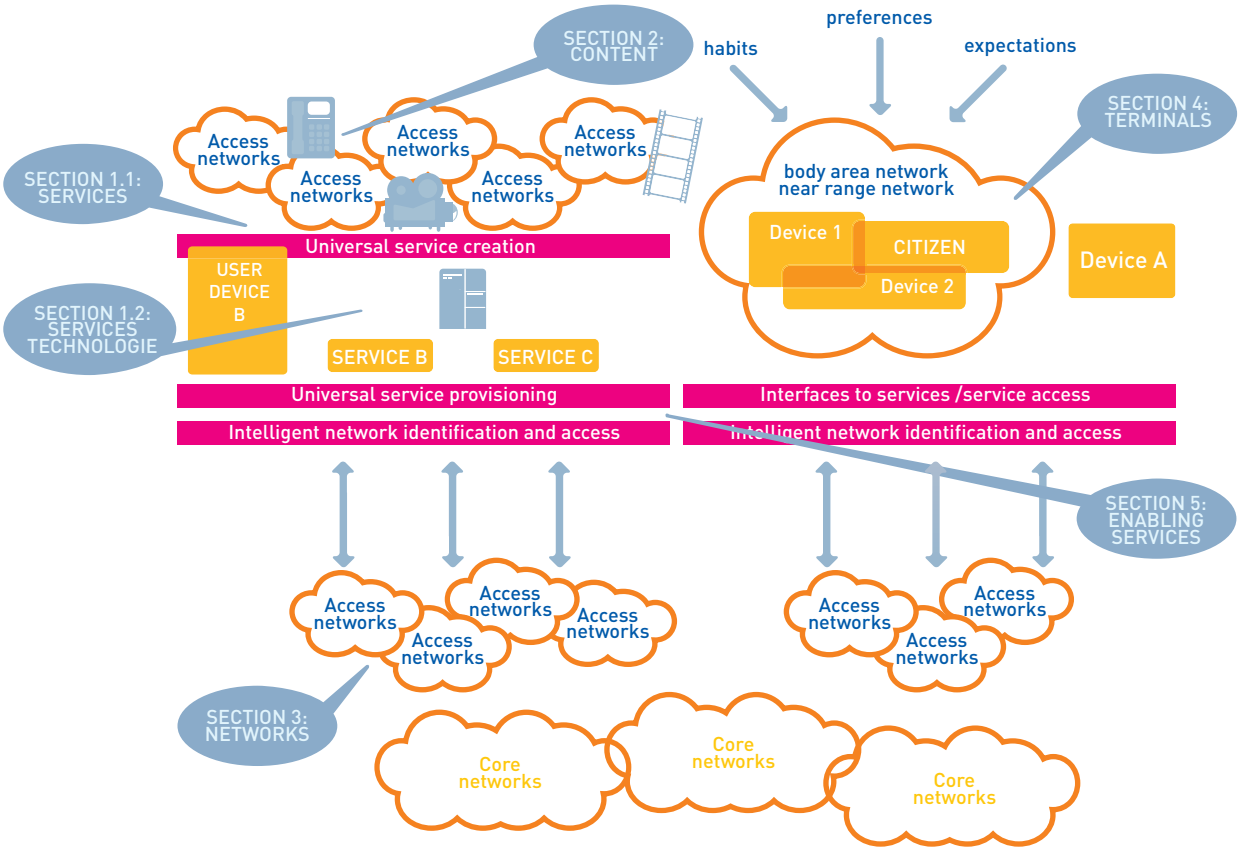
Besides technology it is important to establish and foster an environment for implementation of the envisioned scenarios and technologies. Seeking aligned approaches, or at best standardized solutions is only half the way. In fact, NEM has to influence the standardization bodies, both at a European and a worldwide level, with contributions to push for a homogeneous European technology platform. At the next step, the European regulatory landscape is required to stimulate the deployment of innovative (European) solutions throughout Europe. Besides putting national priorities on various regulations, some scenarios require a synchronization of regulations on a European level. 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 Therefore interoperability between all kinds of 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.

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.

2. NEM RESEARCH PRIORITIES

The structure of following sections follows a scientific approach as first the services and scenarios are described, including content related aspects. This is followed by the necessary network infrastructure, terminals and technological components. 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! In this future the consumer will pick his services from a plethora

of service offerings. Future service platforms will truly be convergent and deliver any application and content coordinated by a single customer profile.

With emerging "triple play" offerings the business model of broadcasters, telecom operators and service/content providers become coupled more and more. New business models will 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 thus pushes the development of sophisticated broadband network technologies and services.

The development of suitable, user-friendly, accessible schemes (economically affordable and operationally accessible for users including people with disabilities) of "non-linear" content is envisioned. This includes schemes to ensure regulatory rules and respecting applicable policy with regard to protection of minors and other policy rules (advertising, etc.). 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.

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 considered to be the most important ones from today's perspective. The structure of this section reflects the current understanding of suitable service categories.

2.1.1. Application scenarios

2.1.1.1. e-Applications

There will be a plethora of new eApplications deployed in the future. E-Government will rely on a large number of different eApplications, such as, eSocialSecurity, eTourism, eHealth, eTax, eVoting, and others. E-Inclusion is something that the whole European community needs to be part of.

2.1.1.1.1. e-Services

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.

E-learning focuses on enhancing the learning process using interactive multimedia content to provide more intuitive and immersive. The possibility to use remote access allows continuous learning independent of location and time. E-Learning allows also more efficient use of resources and distribution of the learning solutions to remote areas. This will have big impact especially in developing countries, where European learning solutions should be made available.

E-Health is big issue in coming years as the baby boomer generation ages. Also increasing standard of living is already creating numerous burdens to health care, for example the type two diabetes or hearth

diseases. The cost of health care services is growing steadily and it is estimated that without new health service structure industrial countries can not maintain the current level of quality. E-Health is major hope in reducing the additional costs.

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

The new solutions will be driven by the following scenarios:

- Personal environments will be populated by personal communication and computing devices, accessories, wearable's, implants. e-Services will be adapted to the user's individual situation, location and preferences.
- Business environments will benefit from e-Services 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.

One of the key aspects of e-Services is content creation and adaptation, management and distribution in multiple environments and also on fixed and mobile multimedia devices.

The way contents are created and accessed by users is continuously evolving. Contents are moving away from those based on collections of simple documents to those based on rich collections of interrelated complex multimedia documents. These contents must also be accessed by heterogeneous devices, some of them wireless connected, where quality contents and formats must be adapted properly to the device and channel.

Related technologies are also evolving to allow definition of more complex scenarios where mobility, personalization, adaptation, interaction between contents and user, user contribution and collaboration.

State of the Art

The evolution of digital contents is a reality in all environments, including contents for supporting e-learning. In the last years, technologies have been defined to support content compilation and distribution (like IMS Content Packaging), and environments to support "organization" and "execution" of these contents (like SCORM). More and more, definition of complex scenarios and interactivity with these contents is mandatory for new technologies and tools supporting e-Services.

Nowadays e-Learning standards are being developed by four main organizations: AICC, IEEE, IMS, and ADL (Advanced Distributed Learning Initiative of U.S. Department of Defence 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 e-Learning as the military is doing as well. One interesting initiative from MIT is $100 Laptop project that aims to offer children in third world an equal access to computer based education.

E-Health is currently divided into three major areas, well-being, home health monitoring and professional information exchange. Well-being is driven by industry and it is developing hand-in-hand with sport industry. The major promise of well-being is in preventive care, but the current challenge is in the medical reliability of available systems. Home health monitoring is mostly focused on post event monitoring, such as heart condition, diabetes, home nursing, etc. In professional systems the major work is focusing on interoperability and information exchange between large systems. In this area protocol development is important, for example the XML-based HL7 protocol.

Topics to be addressed

Although feature-rich e-Services demand high bandwidth broadband networks, such services must also be accessible through networks with limited capacity (mobile, wireless). They call for new high quality graphical environments for new and innovative services with digital content and software.

e-Services 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.

The main objective of this topic should be a solution which helps creation of contents (authoring tools) for e-Service applications which support advanced interaction models, personalization of the learning experience, distribution on heterogeneous environments and "play" through multiple devices, accessing content adapted to user preferences, context and terminal capabilities (typically wireless).

Another important focus is to evolve current learning environments to take advantage of new technologies and capacities, like broadband networks which allow a new generation of interactive and collaborative services like (mobile) TV, VoIP, video telephony, convergent services and so on.

In E-learning the possible new area is m-learning, i.e. use of smart phones to deliver e-learning solution to practically everywhere.

E-Health requires development for service structure that focuses more on prevention than acute treatments. The major challenge is to increase the public awareness to the benefits of long term well-being monitoring and develop easy tools to naturally combine the signal collection and user feedback to everyone's daily life.

Key issues to be solved

Creating e-Services must be very simple. Suitable tools and design guidelines must be developed. Related to e-Services, a key issue is the seamless interoperability and use of any kind of devices.

e-Services impose 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.

Access control and privacy are important topics to all e-services. Some cases, e.g. eHealth and eGovernement, privacy is controlled partly by legislation, but in all cases there is need to monitor the access or control the process, e.g. in eLearning keeping individual grades require trust between student and teacher.

2.1.1.2. New Entertainment and Content Applications

Entertainment industry is facing number of new challenges to meet the new consumer needs which the new technologies will create. Typically the new service channels are born within subcultures that utilize the power of the Internet. In early stage the new entertainment services might have different incarnations and in the end the services will rapidly spread with one winning solution. Podcasting is a good example of an idea to use asynchronous media broadcasting that really hit the market after the success of Apple iPod.

The challenge is how to identify winning service ideas and predict the technology incarnation that wider audience would be willing to adopt. Pervasive gaming, digital cinema and advertising are elaborated as they are identified as highly promising topics by NEM participants.

2.1.1.2.1. 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 video gaming 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. Gaming application could also be enriched with some features provided by a telecommunication network, such as location, presence, voice / video calls / conferences, messaging, charging, in order to improve the interaction among the players.

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.

2.1.1.2.2. Digital Cinema

Definition

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.

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.
- The increasing availability of Television over IP enables new business models. The traditional order of sales channels over time is about to change putting cinema second after pay-TV. With the availability of high-quality equipment at reasonable prices independent cinemas get a new chance on the market and even cinema might become a "home experience".
- 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+

A commonly shared opinion is that electronics distribution of contents will be ubiquitous in the years 2010-2015. Digital cinemas will offer extremely high quality and resolution. It is not only the resolution but the viewing experience with sound and "feeling". Program offerings can be changed basically immediately depending on consumer demand. This will imply a radical change of the delivery paradigm, 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.

2.1.1.2.3. Advertising

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. Broadband media will transform the range and scale of available content, making it increasing difficult for advertisers to cover all bases. As such, advertising will become more personalised and will be targeted to individual interests and purchasing patterns. New forms of cross-media advertising (TV shows + SMS) are already emerging and campaigns can be more specifically targeted to on-demand consumers (individual and personalized marketing / marketing one-to-one). Advertising has already become ubiquitous and has enabled new major businesses, especially the Google case.

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.

Advertisements are also entering to new media channels. Microsoft recently announced acquisition of a game advertisement technology that enables management of dynamic marketing campaigns with on-line games based on geographical location or player community demography.

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. Moreover, user-friendly formalism can be used to allow end-users to describe the interest in receiving specific types of advertising. At last, it provides mechanisms which can be used to allow end-users to search for information of advertising benefit to them based on semantics and subscribe to ads by him.

Advertising can also be new content. In the Internet the best adverts are already circulating P2P manner. The potential of viral marketing is identified and utilized in various occasions. The major trends are forming and cultural differences how viral marketing works are not clear. Understanding the consumer views to innovative new adverts can lead to breakthrough business ideas.

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.

The impact of redistribution of the advertising revenue to media business models needs to be examined carefully. The new applications and services success will be defined by their business potential and the advertisements will be most likely a crucial part of any new service revenues.

2.1.1.3. Personal communication services

Personal communication has been clearly a killer application for many technology platforms including mobile communication (mobile phones, SMS) and early Internet (email, ICQ). More recent proof is for example the popularity of Blogs. As the interactivity increases in media networks, new personal communication applications will quickly emerge. For example, in Finland the recent unlikely hit is SMS TV chat shows, where people pay up to one Euro per message that appears briefly on the TV screen.

The following topics explore the possibilities and challenges of new media technologies in self expression and active sharing of content.

2.1.1.3.1. 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. Communication between individuals could also mean "feeling the presence" of a person in the background: rapid, informal communication (for example by a sort of Instant Messaging system, vocal or textual) with the inner aim to communicate the presence, the sense of vicinity of another person.

Enriched personal communication could be integrated in other services, such as gaming, access to contents, e-learning. Communication between individuals could also mean sharing an experience: while talking on the phone you can see what I'm seeing, during a chat session you can listen the music I'm listening to.

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). Advances in technology should overcome the first two barriers. In addition to that, new forms of video communication should be envisioned: a boy from his bedroom could virtually join his friend in a pub, two colleagues working in distant located offices could virtually drink a coffee together, and so on. In the future, the (tele)communication between individuals will be not only verbal or visual but it is likely that all five senses could be involved. We are assisting to the first implementations of "haptic" communication (i.e. communicate the sense of touch).

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 by involving also multi-media communications and multiple devices (also specialized on some of the media used in the discussion). 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.

2.1.1.3.2. Superdistribution and Content Sharing

Definition

Peer-to-peer has become a well-known term with the emerging of user-driven file sharing communities. Users allow access to their PC on which certain data is being stored. For finding the information the communities uses either centralized databases (type "Napster") or decentralized ones (type "Donley"). The basic principle, that the entire "network" is an almost infinite storage, and network load is balanced the provisioning of tools to find the nearest storage, has an incredible potential for the future. So far it was difficult to make a business out of it. In combination with "superdistribution", where a consumer is rewarded for forwarding content to other potential customers (without the rights object, which has to be bought desperately), P2P has also a commercial perspective. This explains why superdistribution and P2P content sharing are mega trends that have huge impact to the related copyrights. Services build on these technologies will emerge rapidly in mobile and iTV domains as the interactivity increases.

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

The concept of P2P has to be part of the development of services. The necessary technology has to be integrated in the service provisioning platforms and the networks. Viable business models must be developed in parallel for such services.

State of the Art

Nowadays P2P networks are greatly successful in the Internet: they are generating more than 50% of Internet traffic (over any other sources of traffic such as Web, e-mail, and so on). Content superdistribution in the mobile environment is also one of the most important aspects in content sharing. These scenarios can be interchangeable between these technological interfaces:

- P2P in mobile devices
- Super distribution in multimedia environments (IPTV)

Even though this practice is very widespread among mobile and multimedia (Internet) users it is also a complicated issue to guarantee the copyright management of these authors' contents. There are many risks to break the content protect law in this scope (for instance, MPAA managed to close one of eDonkey network main servers).

Topics to be addressed

The evolution in content sharing among ubiquitous users from fixed (Internet), mobile and multimedia (IPTV) channels is becoming more and more sensible, even more because peer-to-peer (P2P) sharing is available. Content sharing with P2P in multimedia (IPTV) or mobile environments is totally innovative. On the other hand, the super distribution concept in mobile system is very useful in content sharing between multimedia users. The success of P2P in Internet must be possible in other scenarios in order to obtain a network's convergence and make your content sharing between peers more interesting. If you have a legal framework with P2P you can choose the destination of your content purchase between Internet, multimedia or mobile network.

This topic defines an interoperability scenario that is based upon content sharing from any telecommunication network. This sharing will have to be managed according to the technical capacity of the devices where contents will be downloaded.

Content sources can be different:

- Phones, PDAs, smartphones, PMPs, ...
- PCs, laptops, tablets, ...
- IPTV, TDT, home HD, ...

Some possible use models to be posed in an interoperable P2P-DRM system are:

- Sharing by product (very useful in a convergent model).
- Crossed offers.
- Right purchase of product use and content downloading according to the user's device.

The general goal is to be able to provide citizens a legal environment of content sharing from multiple networks and devices, so that users will be able to get the required content or information in an anytime-anywhere model.

Key issues to be solved

The DRM topic is a big technical issue. From a service perspective the DRM and copyrights should be viewed from the consumer angle i.e. what copyright management provides convenience in use or other benefits. The current DRM models do not take the social dynamics in account and balance between user and copyright holder benefits needs to be explored.

The technical limitations of sharing content between different networks and terminals are dissolving. The new boundaries are coming from plethora of competing media formats and physical differences. The interoperability needs to be ensured at the same time as looking for new innovations for P2P applications in converged media world.

2.1.1.4. Online communities

Another part of personal expression is social bonding. The phenomena of network communities and smart mobs are well known parts of contemporary society. It is estimated that the biggest impact of Web 2.0 is the improved dynamics and management of service communities. This development will impact extremely likely also the NEM areas.

Below personal service creation promotes the consumer activity and social networks proposal provides innovations needed for community building. These are obviously only a scratch of what potential lies behind on-line communities for NEM.

2.1.1.4.1. 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).

By "personalized service creation" we mean, beyond the pure "personal content creation", the capability for individual users to organize, compose, manage basic media and communication functionalities in a way to better fit their own needs, the needs of a specific community where they act as service managers (family, association, etc...), or to become proper service providers to external customer communities.

Examples of "personal service creation" mixing personal media and communication could be:

- managing incoming audio/video calls, playing customized audio/video messages, routing calls to suitable terminations and recording them to be further reused as content etc.
- describe / confirm usage patterns (even when inferred by intelligent profiling systems), add/remove supporting devices
- establish access, visibility, distribution rules for personal content to other peers

In order to speed up service creation a service framework should be made available to the customer. It shall act as a toolbox where basic services can be selected and integrated in order to create a new personalized service.

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.

There are further topics to be addressed:

- "personal/home" service controllers able to execute flows of communication actions, media rendering and delivery.
- multimodal simple service definition interfaces through which users can describe the expected service behaviour
- user behaviour recorder and analyzer, able to automatically support the service definition

The tools should also consider the possibility to integrate the usage of telecommunication features (e.g., presence, location, voice calls charging) in the content-based applications.

One important support aspect to be addressed is the availability of an automated testing in order to extensively test a newly created service. This testing tool shall support the service creator to check all service features to avoid malfunctioning components and/or wrong data management.

The usage of distributed basic services in order to build a complex while personalized one shall address trust and privacy issues as well. The basic services shall be authenticated before being used, in order to be sure of both the service identity and to protect exchanged data.

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.

One key issue can be the revenue streaming from new deployed personalized services. They shall work properly (so they shall be carefully tested before deployed in the real world, if possible through the usage of an automated testing tool) and they shall be trusted (otherwise the user doesn't use them). Trusting a service means trusting all the basic service components as well.

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.

2.1.1.4.2. Communication in communities

Definition

Scenarios featuring the sharing (and the delivery) of media content and of individual's knowledge can grandly benefit from mechanisms providing a management support for communities and facilitating communications between the members. Then services are no longer bound to separately serve individuals but they can fulfil the needs and expectations of groups of individuals. Communities are a social phenomenon where people with common interests, experiences, and objectives are brought together. They provide a social place where individuals exchange and share information, knowledge, and emotions and jointly undertake activities without limitations (any place, any time). Virtually everybody is bound to interact and communicate within a multitude of different groups such as family, friends, colleagues and business partners.

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

A primary objective is to develop scenarios featuring communities using services in order to share content and knowledge. Then the major objective is to specify and develop an open-based architecture to support the management (creation, deletion) of flexible (and possibly ad-hoc) communities and provide communication means to their members that facilitate the decision making processes and the user experiences in communities (e.g. related to context-awareness).

State of the Art:

Existing Internet-based services have already emphasized the growing interest in communication supports for communities. MoSoSo (mobile social software) attempts to add additional dimensions to group communication by associating social networking and group services with contextual dimensions such as geographical location and time. Thus MoSoSo enables users to find people in their vicinity and at that time for social dating or business networking. For example users, might find friends of friends, on the basis that by having a common friend they are more likely to have additional characteristics in common. One example of a MoSoSo service is Dodgeball (Dodgeball.com) where text messages (SMS) are completed with location description, thus allowing friends to locate the initiating person. Another example is the Nokia Sensor application, a phone software application offering a way for people to create information and share it with other phone including text and graphics. Research on adaptive systems for groups has sought to preference and learning mechanisms to combine information about individuals (i.e. user models) to determine group models and therefore asset information about the whole group (e.g. preferences, expectations, interests). MusicFX is a group preference arbitration system that allows active members of a gym to influence the selection of the radio station played during workout. Group preferences are computed from members' specified favourite musical genres by using an arbitration algorithm. PolyLens is a collaborative filtering recommender system that recommends movies for small groups of users based on individual tastes. INTRIGUE is a tourist information server that tailors the recommendation of attractions for tourists groups. A group is modelled as a set of partitioned subgroups having similar characteristics and preferences. Attractions are evaluated for each subgroup with regard to their preferences and an average is computed for the group by combining the satisfaction scores of the subgroups in a weighted way.

Topics to be addressed

For facilitating communication in communities, topics to be addressed are:

Management of communities (social networks)

Innumerable types of communities exist such as, family, classmates, colleagues, or even chess fanatics. Each of these groups differs, this can be in terms of lifetime, creation mode (e.g. ad-hoc or scheduled), membership update, internal policies etc. Therefore group management mechanisms have to keep the knowledge of all group characteristics and to enable creation, disposal and update of simultaneous existing groups as well as their related group profiles.

Providing group awareness via group context

Context-awareness can facilitate the social interactions and the decision making processes in communities. Information about individuals and their situational context can be used by applications and services to make people aware of others' activities, other's availability in their social networks. For instance, users might find friends on the basis of having a similar location context (being in proximity). Also context information can be used to provide (recommend) services personalized to the group (social network) the user is currently interacting in/ with. For instance, when meeting up, a group can be advertised of activities, members can undertake together and that match the group situations and preferences.

Privacy of personal information in communities

The privacy of personal data is a fundamental user's requirement. People do not want anyone to freely access information about them (context or preference). Rather, they want to keep their information private from most people and only grant access at certain levels of detail to the people they interact with in communities. Mechanisms must be deployed that enable users to decide what private information is revealed.

2.1.1.4.3. Social Networks and Shared Knowledge

Definition

Social software is a concept at its very peak on the Internet. It includes several initiatives and new technologies. Social software can be defined as those applications that somehow imply knowledge collaboration and/or sharing among users; those applications encompass a set of tools and technologies that facilitate interaction and collaboration by means of social conventions.

Very related concepts are MoSoSo, Sharing Contents, Social Software, Mobile 2.0, LBS and Web 2.0.

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

The main objective of social networks is to use the Internet's scope and the means of these new technologies to expand contacts, in order to be able to share interests (of any nature) with a great number of people without any physical constraints. Social networks promote the possibility of strengthening unknown, scattered links, as well as creating a space to share knowledge, etc.

This new fact, which is causing a great impact in the Internet, has not yet a similar thrust in the mobile environment, where it represents a very innovative concept. A growing interest is been generating around it; from here on pioneer initiatives are coming up, such as MoSoSo (Mobile Social Software). This current proposal is focused on extrapolating these kinds of services to mobile users. If these services can take advantage of merging to other emerging technologies such as geo-localization, DRM, Mobile P2P, Wireless Village etc., they present a very interesting potential of research.

Mobile social software can become a powerful tool to boost the development of the information society, by means of bringing users nearer these new mobile multimedia possibilities, tools and services.

State of the Art

Within the Internet world there have been arisen the first initiatives about reference portals that try to set up social networks with several goals: finding old schoolmates, looking for new friends, making some business, looking for new jobs or picking up somebody. MySpace, Friendster, Orkut or LinkedIn are good examples about the stunning impact of social networks on the Internet.

Topics to be addressed

This topic tries to research the potential of an innovative concept such as the social software in the mobile environment. Hence we propose the creation of a "Mobile Social Network", where any kind of services and 'social' information can be stored and shared.

This concept of social network encompasses the integration of a wide range of new services and technologies whose identification and definition are included within the current proposal. As a reference, some features of the Mobile Social Network that can be considered are:

- Social repository of network contents separates the terminal from the contents acquired by the users, in order to facilitate the creation of new services of content and information sharing and exchange. Furthermore, this feature makes possible that users have contents at their disposal even though they lose or change their own devices. It also sets up an interesting solution for heavy-users that run out of storing space in their devices and do not want to lose their information and contents.
- Sharing of multimedia contents, hobbies, opinions about the last book that has been read or the last movie that has been watched, suggestions about restaurants or travels... among communities, contact lists etc.

- Calendar, network agenda in which events, meetings, can be synchronized, with contact lists and communities.

Another innovative scenario that is candidate to be tackled within the described scope is the convergence among social networks in the Internet and the mobile environment.

One of the main advantages of social networks in the mobile world is the possibility of achieving a real convergence upon many environments, from many devices. Moreover, users achieve access to all their favourite services in a quick, safe and centralized way.

Furthermore, this model provides a powerful tool for customer allegiance to the operators thanks to the lodging of this kind of services and 'social' information in the operator's systems. Thus, operators can get control of its churn. This fact becomes a value-added feature in front of terminal manufacturers and content providers.

Key issues to be solved

The networked communities and services have increased the need of how we present ourselves in the virtual dimension. The digital identity composes of identity, privacy, trust and reputation, just as our identity in the real world. The identity in virtual domain has one significant difference to the real world identity; our actions do not disappear but they are recorded and preserved in the network memory.

How to ensure unified information sharing of personal content and profiles (calendar information, playlists, etc.)? How to create and manage network identity and who should maintain the identity repositories? How to enable ubiquitous reputation system?

2.1.2. Service Technologies
2.1.2.1. Service Discovery and Information Filtering
2.1.2.1.1. Tools for content discovery

Definition

In a near future world where content is available everywhere from many providers on many client devices, 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

Some digital TV channels provide a service called Electronic Program Guides (EPGs) which may be compiled by the service provider or by a third party (who may, for instance, be a metadata aggregator using metadata from several sources, possibly including 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, and particularly from the community of active, relevant and collaborative viewers. Independent TV guides, like TV.com also offer information and user recommendations about TV shows.

Standards for metadata describing content have been developed by the TV-Anytime forum, based partly on the work done in MPEG7. These standards offer the possibility of linking with PVRs to provide services such as 'trailer selection' (the user can book a recording of a programme or series when a trailer is broadcast, without knowing the date and time of broadcast of the programme).

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 involved in discovery with different requirements characterizing two metaphors: library and bookshop. The difference between a library and a bookshop is that the former offer a wider stock and less commercially-oriented set of content. The offer in a bookshop will be smaller and is likely to be influenced by the popularity of the content and/or by someone's preferences. The library metaphor would have a large content base with little additional presentation surround, whereas the bookshop metaphor would have a small content base but with more surround (i.e. flashy formatting). There are implications on usage patterns: the library is search-intensive with huge amount of content to consider whilst the bookshop is likely to be more multimedia-based over a selected small portion of content base. Discovery service should be able to integrate and combine library and bookshop metaphor using natural and multimodal user interfaces providing also the way to promote some commercial-oriented or recommended content.

New ontologies for audiovisual content classification should be defined to be used by audiovisual search engines. It is imperative to use open standards, so that discovery services can be integrated with any PVR or other audiovisual equipment either at home or personal portable devices.

Semantic search algorithms should be integrated in audiovisual search applications involved in discovery.

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.

Defining a common query language for metadata (as addressed by the MPEG-7 "Query Format" Ad hoc Group) still needs attention in order to allow users or agents to interact with different metadata sources.

Discovery of right content for each viewer should be an effective and grateful experience, finding for example an effective way of visualization of content offer, in library or bookshop metaphor, using colours, shapes, and graphs to represent relationships, proximity and importance of content.

Automatic update of the pool of available content (premium, niche or personal) should be integrated and used in library and/or bookshop metaphor.

Key issues to be solved

In the ideal world it would be possible to formulate in an intuitive and non-technical language a search phrase. This would triggers and agent, which then searches the WEB and any reachable server for that information. Prerequisite is an appropriate description of what one is looking for. Audio-visual data, in particular in films is a great challenge. It is understood that the search semantic includes rights aspects and delivery aspects (availability, bandwidth, etc.)

New business models will emerge; the real value could be more in the service rather than in the content itself. However, proprietary metadata standards and EPGs - particularly in vertically integrated platforms, but also arising from bilateral agreements between equipment manufacturers, metadata providers or platform operators - may restrain consumer choice.

2.1.2.1.2. Context Awareness

Definition

Context is defined as "any information that can be used to characterize the situation of an entity, e.g. a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves". The Context Awareness is an enabling technology for creation and deployment of context aware services. Typically the context represents the user situation, but it could be extended to application or any other entity (see above definition). Context Awareness Middleware collects information (context data) from different context sources (networks, servers, devices, platforms, etc.) in order to have a better indication of the user needs and behaviours. Context Awareness must have well defined elements and related roles:

- Context Awareness must have well defined elements and related roles
- Context Provider: it is either a network element or an end user device which provides context data
- Context Broker: it is a server element which collects context data (acting as context consumer) and distributes them (as a context provider) on request; often the context broker adds value to the individual data which it collects.
- Context Consumer: it is the application or service layer (either server or client side) which uses or elaborates context information; this role can be played also by a reasoning engine, which is an intermediate element between the context provider and the application or service.
- Context awareness must be implemented in the middleware of terminals.

All context sources must technically share the same context ontology, which will be used by the context data consumer and by the context broker. Context Aware middleware will provide a reasoning engine that will understand (semantically), compose and will provide the application or service layer with a fully fledged context representation.

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

Definition and development of an open, modular and standards based architecture to support the easy creation and deployment of context aware services, i.e. personalized content distribution and proactive services that can adapt dynamically according to particular situations (context) that may occur to the user (e.g. location, availability, end user devices, access network, available bandwidth, mood, ...).

State of the Art

Three main areas are relevant to the scope of context awareness: context description and elaboration, user profiling and proactive service provisioning (content/ service push).

- Context representation and elaboration - Context awareness is being used by many applications to adapt service behaviour according to changing contextual information (e.g. the user's location). Recognizing and communicating context is a path to more efficient and effective use of technology. However capturing context digitally alters it fundamentally. Aggregation or interpretation that is done by software differs from aggregation and interpretation that is done by biological, psychological, and social processes. Finally, once digital information reaches a network it could appear anywhere on the planet at any future time. Context awareness is much broader domain than awareness of identity and location.

- User profiling - Existing techniques have been used for a long time by service providers (e.g. Amazon with click stream analysis) and telcos (categorization of subscribers). These techniques are very application-specific, and their results cannot be used easily by other services and applications.

Besides collaborative filtering (used by Amazon) there also exist other approaches like statistical based mechanisms as Bayesian networks. To overcome the shortcomings of current profiling techniques, they will be combined with additional approaches like rule-based reasoning and conflict resolution.

- Proactive service provisioning - Classically, intelligence in application is handled in a reactive way. Changes are tracked and notified to applications that behave accordingly. Examples are: simple context-aware reminder, Event-driven notifications services and Planning and personalisation based on learning mechanisms. Application should behave pro-actively. In other words the potential relevant changes foreseen to occur during a given activity should be anticipated on and the related solutions should be provided by the service or application before the problem has actually been raised to the user.

Topics to be addressed

Future research should take into account main aspects of the context reasoning process:

- Context Interpretation, i.e. deriving more abstract, higher-level conceptual context information from the low-level context information;
- Adaptation Inference, i.e. deducing potentially useful service adaptations from the higher-level context information obtained from the interpretation process.
- Semantic Web paradigms and methods (e.g., RDF, OWL, ...), enabling the representation and manipulation of context information through machine-interpretable ontologies;
- Context reasoning paradigms and methods, enabling the context interpretation and adaptation inference process. Candidate paradigms include:
  - Logic reasoning, e.g. ontology-based inference;
  - Rule-based reasoning, e.g. rule-based inference engines;
  - Probabilistic reasoning, e.g. statistical inference models;
  - Machine learning model based reasoning, e.g. models for the automatic classification and/or prediction of context patterns.
- Tagging of digital personal contents context based

Key issues to be solved

In addition to technical issues which are listed above, two key issues related to context awareness are:

- the business model perspective: it is relevant to clearly define the new roles and business relationships in context awareness scenario
- the privacy issue and the trust relationships

2.1.2.1.3. Service personalisation

Definition

People will have more and more services available and it will be more and more difficult for them to find them (on a VCR less than 30% of the functionalities are commonly used). The idea is to personalise the set of services available according to the context (when you leave your home, you just get the relevant set of services active)

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

The mid term objective should be the description of a standardised user profile that could be used to filter services in order to provide to the user the right set of services according to the context and to the

user rights. The long term objective should be the automatic learning of people behaviour in order to update automatically the user profile and to provide a corresponding service filtering.

State of the Art

Service personalization is not entirely new. In the communication world solutions for context-independent individual communications are offered by various companies. In the mobile world UAProf is one technology used. Missing is a platform independent approach encompassing all types of services

Several projects have already addressed that service personalisation concept such as IST ePerSpace and ETSI STF265 and some results and prototypes already exist. There is still a lot of work to do in order to define a standard and to study the automatic update of the user profile.

Topics to be addressed

- User profile description, which are the relevant data, what's about privacy and data storage
- Automatic user behaviour analysis and user profile update Service filtering according to user profile, context and rights.

Key issues to be solved

By living in a competitive and heterogeneous world consumers will not have a single repository. Thus, powerful mechanisms are needed to synchronize data and exchange information. In effect, a common repository description is needed. The seamless update of the repositories is key for seamless service provisioning for a consumer on the move. The real challenge comes in acquiring the user preferences automatically.

2.1.2.2. Service Platforms

2.1.2.2.1. Intelligent service creation and adaptation

Definition

Creating services for different terminals, networks and media formats is becoming more complex by the time. At the same time the amount of services and service providers is increasing. Intelligent service creation helps service creators in creating services for different platforms. Automating the service creation allows more people to create services - even without technical knowledge. The best case would be that the service provider only needs to create certain service for one terminal by using automated "bricks" and the service would be automatically adapted to suit different platforms. The same services and content has to be available for users regardless of time, location or equipment. Also the service creation should be able to automatically recognize the context where the service will be used.

The mobile software also need to be content aware, in the sense that when the mobile phone is being used for handling increased amount of media it's important to develop proper tools for content management in order to get acceptance from end users and keep competitive advantage against other phone manufacturers.

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

Main objective is to define and develop an open architecture to support easy service and application creation. The characteristics of different platforms have to be taken into account so that the services are easy to adapt for them. Tools for easy service adaptation will be made. The fast evolution in mobile equipment has to be taken into account.

State of the art

Current situation in mobile service creation is that the creator has to make dedicated applications or content for different terminals. If this is not done, the case may be that the service doesn't work as preferred or the service is available only by using certain terminals. In US CDMA networks Qualcomm BREW has been success as it removes these barriers with proprietary technology solution (BREW enabled terminals.

Current research topics try to at least solve transcoding (moving content from terminal to terminal with different decoding capabilities) and unified user interfaces with UML (User interface Mark-up Language) or similar framework.

Topics to be addressed

- Automating the process of service creation.
- Adapting same service to different platforms. Addressing QoS issues is also critical.
- Adapting user interfaces to different terminals.
- What do users think about services created by automated processes?

Key issues to be solved

- How to address the needs of different platforms in a tool that will automatically create services?
- How to make a useful tool, which is easy to keep updated?

2.1.2.2.2. Multimedia Middleware

Definition

Current embedded or multi-purpose platforms lack of common access paradigm to the Media subsystem, this results in;

- Increased costs for application provisioning, development and maintenance.
- Increased time-to-market for innovative service introduction.
- Huge efforts to ensure interoperability and portability.

The Multimedia Middleware is a software layer providing a stable architecture and API dedicated to multimedia and accessible by service developers and providers. The usage of a middleware layer aims at solving the aforementioned issues, addressing the following:

- To allow application software to execute multimedia functions with a minimum knowledge of the inner workings of the multimedia middleware;
- To allow the triggering of updates to the multimedia middleware to extend the API.

The first goal can be achieved by the usage of a common set of API provided by the middleware. The second goal is more challenging, as it requires mechanisms to manage the multimedia middleware components, and to ensure that these updates can be integrated in a controlled and dependable manner.

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

The key objective is to define an open standard Multimedia Middleware able to deal with distributed services and heterogeneous hardware/software platforms. A scalable solution across all platforms is desirable.

State of the Art

Several organizations are currently working on the definition of a Multimedia Middleware; examples are Universal Home API (UHAPI) and OpenMAX. MPEG has started a new initiative named MPEG Middleware (MPEG-E) with the objective of defining such Multimedia API but also a comprehensive model and architecture for Media Component life-cycle management including dynamic installing and resource monitoring.

Topics to be addressed

A work addressing the definition of a multimedia middleware should provide:

- Functional API allowing applications to execute multimedia functionalities;
- API providing the basic functions allowing each service application to adapt to the executing platform;
- API allowing the life-cycle management of the software components that provides the functionalities wrapped by the middleware layer (e.g. identification, download, etc...).

Key issues to be solved

Current convergence process between mobile and wired networks in act in the telecommunication market enlarges the set of hardware terminals and software platforms to deal with. A critical issue to be solved is the selection and definition of technologies to be embedded in middleware components in order to ensure their flexible and interoperable usage in multi-environment services. A Multimedia Middleware should also address the issues related to the integration in complex service contexts such as rich media personal communication. In this respect, specific extensions able to manage signalling protocol mechanisms (i.e. SIP) or QoS in a telecommunication network environment should be analysed and provided.

2.1.2.2.3. 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. One of the topic to be addressed is how to make the micropayments easy to use, secure and trusted by exploiting also the pervasive capabilities of wireless sensor networks (WSN), as for example biometric sensor for a secure authentication.

Key issues to be solved

There are legal issues and strong opposition by money management authorities (banks, etc,). Having a micropayments as a core part to the basic capabilities of the NEM infrastructure means that users can do micropayments everywhere in an easy and transparent way and means that it is secure and trusted by all parties, users but also content and service providers.

2.1.2.2.4. Mobile Payment Interface for Commercial Applications

Executive Summary

In the emerging Information Society many existing applications require modifications in order to make them available for broad spectrum of end users, i.e., to give them access to network-based resources. eCommerce is gaining more and more wide-spread acceptance and eGoverment and eHealth are good examples of such IST European initiatives. Access to many applications created within these initiatives is possible free of charge. However, a convenient payment scheme is required for some products or services. Remote payment solutions presently available on the market (i.e., systems with no physical contact between customer and merchant) are often inconvenient, expensive or perceived as unsafe. Good examples are Internet or Premium SMS based systems. In the first case micro-payment services using credit cards are not convenient and in the second one Premium SMS rates are often considered too expensive.

Recently developed mPay mobile payment system (patent pending) solves many of these problems.

We would like to propose to develop new versions of commercial applications that exist or are planned to be launched for public usage. These new versions would be integrated with the mPay mobile payment system.

Proposed scenario is quite universal and could be used in all countries (where mobile operators run GSM networks) that are interested in implementing the mPay system. Additionally, potential universal, wide-spread usability of mPay system synchronizes very well with the strategic agenda of the 7th Framework Programme for the years 2007-2013. It covers such research themes as Health, Information and Communication Technologies, Energy and Transport – in all these areas applications integrated with mobile payment system could be widely used.

Definition

In the emerging Information Society many applications and services are being developed for specific purposes. eCommerce is gaining more and more wide-spread acceptance and eGoverment and eHealth are good examples of such IST European initiatives. Access to many applications created within these initiatives is possible free of charge. However, some products or services need a convenient payment scheme in order to support their maintenance and content creation. Such products (applications) require some modification in order to make them available for broad spectrum of end users, i.e., to give them fee-based access to network resources.

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

We would like to propose to develop new versions of commercial applications that exist or are planned to be launched for public usage. Specifically, we propose to plan and implement a program consisting of many individual projects, where interested software houses and/or service providers would initiate co-operation with mPay S.A. to develop new versions of their applications, which would be integrated with the mPay mobile payment system.

State of the Art

Remote payment solutions presently available on the market (i.e., systems with no physical contact between customer and merchant) are often inconvenient, expensive or perceived as unsafe. Good examples are Internet or Premium SMS based systems. In the first case micro-payment services using credit cards are not convenient and in the second one Premium SMS rates are often considered too expensive.

An innovative mobile payment system – mPay (patent pending) – recently developed by mPay S.A., solves many of these problems. Low cost and straightforward authorization of remote payments of any amount (not only micro-payments) is linked to a list of pre-defined banking accounts. And most importantly – customers are using their existing mobile phones (any type/manufacturer and with no modification required to the phone and/or SIM card) to authorize transactions. Available interfaces include both voice and text. Payment scenario is always the same and it does not matter whether customer is shopping in his local store, paying for a taxi or just wants to buy a Coke in the slot-machine. mPay system also makes it possible to pay for services extended in time and gives rise to many additional functional options.

The proposed payment scenario is quite universal and could be used in all countries (where mobile operators run GSM networks) that are interested in implementing the mPay system. Additionally, potential wide-spread adoption of a mobile payment system synchronizes very well with the strategic agenda of the 7th Framework Programme for the years 2007-2013. It covers such research themes as Health, Information and Communication Technologies, Energy and Transport – in all these areas applications integrated with mobile payment system could be widely used.

Topics to be addressed

Adoption of mobile payments is growing, although many incompatible systems are appearing of various functionalities and territorial range. In order to promote wide usability of applications based on remote payment for content or services, some interfacing practices and standards have to be developed. A programme encouraging application developers to include mobile payments as an enabling option in their systems would give rise to a faster adoption of the most effective solution by this emerging market segment.

Key issues to be solved

Acceptance of a common standard for mobile payments is obviously the preferred situation in the long-term. Emerging local solutions of limited applicability inhibit adoption of other solutions by the same target groups of users. A forum of exchange of ideas and practical experience as well as creation of common initiatives would certainly promote convergence of the ongoing efforts towards one pan-European standard.

2.1.2.3. Service User Interfaces

2.1.2.3.1. Interactivity

Definition

Interactivity is the key property for NEM services. It consists of mechanisms that enable the user to send or receive information, participate, contribute or communicate with any kind of service or another users in some specific contexts (watching TV, listening to the radio, playing games, browsing the internet, etc...); everywhere (at home, at work, in the car ...) and with a variety of devices (TV, mobile phones, ubiquitous devices using radio technologies like Bluetooth, RFID/NFC, Zigbee, WiMAX etc.).

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

Definition and development of an open, modular and standards based architecture to support the easy creation and deployment of innovative, user-centric, interactive services covering a wide range of scenarios (specially focused in mobile scenarios), contents and technologies.

The definition of these scenarios (TDT, IPTV, FM radio, digital radio, DVB-H, DVB-CBMS, video streaming over 3G, IMS etc.) and services is also a goal of this topic, just as the contribution to the main standards like 3GPP, DVB, OMA etc.

This architecture will allow operators, service providers and other actor's involucrate in this kind of services to design them totally independently of the channels and technologies used to interact with the users.

State of the Art

There is a lot of work to do about interactive services standardization, above all in mobile / broadcast scenarios. Nowadays most of work is focused to supplying the service (the TV service or the radio service etc.) not to add interactivity to it.

A pioneer project in this context is the INSTINCT European project. INSTINCT is committed to assist DVB in realising the commercial provision of convergent services in mobility with a special focus on the DVB-T, DVB-H and DVB-MHP standards in conjunction with the concept of wireless communications networks (notably GPRS and UMTS) combined with terrestrial DVB broadcast networks. INSTINCT aims to a carrier grade fully specified and open final platform for the delivery of convergent services in collaborating wireless communications and terrestrial broadcast.

Topics to be addressed

Researching activities will revolve around:

- Mechanisms to enrich multimedia content with interactive and/or complementary (for example more information) content.
- Rich Media and interactive content production and adaptation (standards, interfaces with content providers, development tools etc.).
- Establishing relations between interactive contents and multimedia contents (semantic relations, scheduling, personalization, synchronization, etc.).
- Distributing interactive content (synchronized with multimedia content, by broadcast or 3G networks and so on).
- Interactive content presentation on different devices (attending to usability criteria, content adaptation needs, user preferences and so on).
- Support for different types of services (voting, surveys, premium downloads, alerts etc.) and modalities of interaction and collaboration (messaging, browsing, chat, voice, user communities etc.).
- Interactive services in convergent fix-mobile networks.
- Interfaces for integration with other agents in the channel value (operators, multimedia content providers, interactive content providers, broadcasters etc.)
- Contribution to standards (3GPP, OMA, DVB etc.).
- Business and exploitation models

Key issues to be solved

The key issue is the development of authoring tools which allow not only an instantaneous creation of interactive services.

2.1.2.3.2. Multimodal interactivity with Media and Communication Services

Definition

Multimodal User interface aims at miming the human communication skills that make simultaneous use of communication "channels", or modes (voice, gesture, gaze etc.) in order to communicate and exchange information and control. By providing users with such a multimodal approach for interacting with media and for communicating, a natural and transparent way is offered for hiding and dealing with the complexities of the interaction. Multimodal communication may be simultaneous or not (i.e. use at the same time of the voice and of the gesture for pointing or expressing a command), and has to deal with multiple styles of interaction (mixing of the multiple modes) depending on the context (i.e. while driving a car, voice is the only mode used, whereas at home it is conceivable using also gestures for controlling device and communicate), on the type of application and on the user profile (i.e. different users may show different usage approaches, or preferences, with respect to the preferred communication mode).

Multimodal interactions make use of the user's senses: not only vision, but also sound, tactile feedback, taste/smell – and integrate their simultaneous use (audio and vision at the same time). Due to the increasing mobility of users, their surrounding environments (contexts) conversely change very frequently, posing the choice for making use of the most appropriate channel/mode (according to the moment situation) for communicating. Multimodal interfaces leverage on human capabilities from the perceptual point of view (users are able to perceive multiple things at once) as well as from the action point of view (user are able to perform multiple tasks simultaneously).

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

A multimodal interface platform (set of API) has to be developed which relies on commercial devices. The AOI integrates tactile / sensing devices (webcam, microphone, loudspeakers, display etc.) available in the ambient (e.g. home, car) or wearable by the users.

State of the Art

Multimodal interactions studies started in the late '80, but they have not yet reached mass market diffusion and availability. User-Service interaction is currently mono-modal: from the service user interface conception during the design phase, to the realization of the service functionalities and the use of the underlying hardware – the interactions do not envisage the integration of multiple modal channels in a seamless way. Voice recognition platforms are available on market, but their integration with generic applications is vertical and mainly realized ad-hoc. Hand gestures movement pointing systems are available on the market, but require dedicated hardware and proper installations: they do not fit a general domestic scenario.

Topics to be addressed

- Enhance voice recognition (e.g. increase reliability in noise environment)
- Enhance gesture/eye gazing recognition
- Hardware configuration: proper voice/gesture recognition requires proper set-up
- Development of a multi-device platform for integrating peripheral events coming from independent acquisition devices into a consistent semantic framework.
- Usability test definition

Key issues to be solved

Specification and realization of a general API have to be supported by distinct hardware configuration suites.

2.1.2.3.3. 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 (e.g. 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 within 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

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

2.1.2.3.4. 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.
- Enabling the creation and deployment of new services for controlling the access gateway and the devices
- 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 (e.g. 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 inter-working. 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.

2.2. 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. 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. This includes metadata creation and adaptation for the interactive content, by means of both automated and collaborative methods.

State of the Art

Collaborative tools already exist for text production (e.g. Wikipedia), and metadata production (e.g. del.icio.us), 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 home videos). 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.

In the future home / personal content production will play an important role on the market – and will be important to balance politically biased services. The focus will be on making the residential user a major player in content production, thus enabling a potential growth in content market together with European society cultural enrichment. Crucial topics to be covered are the following:

- Content manipulation tools running on domestic equipments which can easily support the capturing and assembling of "family and specific group/association (sports, cultural, entertainment, etc...) life";
- Publication and delivery systems with a suitable mix of centralized and de-centralized topologies, dynamically adapting according to the size of content audience.
- Above all, such tools must be intuitively usable - this will require trials with wide user groups in several stages to refine tool requirements and measure the benefits.
- Content production tools should include monetization solutions, that are simple and reliable means for content producers (including individuals) to sell their own content.

Content becomes useless as long as no additional information about the scene and the processing so far is available. Collaborative tools for metadata production, in particular for video (social segmentation and tagging of video material) is necessary.

Key issues to be solved

The main issues will be concerned with usability and rights management rather than with the technology itself. Personal content availability on TV requires a mediated infrastructure promoting and protecting private content.

2.2.2. Open content format supported by commonly available tools

Definition

An 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. 'Format' here is describing a file format for content including video, audio, data (such as subtitles), and metadata, and not the line/frame format of the video; metadata will describe whether the video is high definition, standard definition, a reduced-definition standard for small screens, or a special-purpose format such as the DCI format used for digital cinema.

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

Within the NEM context a content 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 a 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. The aim is that manipulating multimedia content should be as simple – or if possible, simpler – as editing text with a word processor.

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 and the emerging SVG (the formats 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. New standardization initiatives as MPEG-4 Scalable Video Coding (SVC) address the issues related to the transmission of multimedia contents through heterogeneous networks and support of editing by means of devices with different capabilities.

The Synchronised Media Integration Language (SMIL) is an open playlist format which is supported by a number of popular media player applications. However, its potential as an enabler for interactive personalised media has yet to be fully recognised.

The MPEG community has invested important resources both in the development of standards. The MPEG-21 standard aims to ensure the interoperability of contents, and the MPEG-A initiative (Multimedia Application Format) includes a clear business orientation in order to define specifications adapted to the functionalities required by the industry. With the MPEG-E initiative (MPEG Middleware), MPEG aims to provide a middleware specification, including a well-defined Media API and a common component model, in order to facilitate the access and management of media formats through different platforms.

SMEs currently dominate the field of content creation, and tend to be moving towards open-source software standards. In future, domestic users may dominate, and will require reliability and simplicity above all.

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, and able to manage synchronised contents such as audio/video streams, whether the publication chain is based on a rich client or on 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.

An important effort should be devoted to creating an open infrastructure or middleware dealing with the content format and concerning development and maintenance of first class media services through heterogeneous platforms

Work will be needed on standards conversion for video, including frame-rate conversion for the emerging digital cinema standards based on motion JPEG2000.

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. In particular the above mentioned standardization process should be able to provide a detailed set of profiles, listing the technologies required for a specific application format in order to ensure interoperability and flexibility, with simplicity for inexperienced users.

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 etc.) 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.

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.

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

Users perceive 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. Personalization is not just limited to on-demand TV, video or music, but equally relevant for life experiences like 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. Such a middleware infrastructure must be capable of integrating data and resources from delivery networks, sensor networks and content metadata.

State of the Art

There are a number of personalization software products available. Recommender systems 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, either based on collaborative or on content-based prediction techniques.
- 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. The Open Mobile Alliance (OMA) adopts a CC/PP-based profile, i.e., User Agent Profile (UAProf), to describe mobile terminal capabilities . 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 (DCMI), content description of complex audiovisual data, e.g., MPEG7 by the Multimedia Picture Experts Group (MPEG), and content delivery and protection, e.g., MPEG21 also by MPEG. Some IST projects started to conduct research in that area, e.g. the ePerSpace Project, whose objective is to provide an open platform able to give access to any content provider using a common user profile 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'.

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).

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). The ubiquitous and nomadic inter-PAN networks allow collecting a vast amount of data, so one of the topics to be addressed here is how to organize and integrate all this data into context-related information.

It is possible to identify three 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 automatically collects, integrates and aggregates all relevant context information coming from various networks (delivery, sensors, mobile etc.)
- 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 enjoy a common experience 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 the opportunity 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.

The increasing ability to produce digital content offered to the end user by consumer electronics makes personal content more and more a primary ingredient of person-to-person communication ("Let me show you on my phone/camera the pictures/movies of the baby, the wedding, our college dinner, etc…").

Also, "communication" about TV/media contents is becoming more and more frequent both in traditional contexts (office/school chat on the last reality show/sport event, etc…), and in IT/TLC supported contexts (Internet chats, SMS's).

"We talk about 3rd party content, we use our content to talk".

NEM is willing to propose solutions which could significantly improve the mix of live/recorded content and (tele)-communication for all situations where the interacting people are not co-located, aiming to get close to normal-life co-located situations such as "we are here together for a birthday, for watching a live music concert, for exchanging our holiday experiences".

Moreover, a new content paradigm should be addressed, where "private" non co-located communication, like the examples above, can become part of "public" (multi/broadcasted) content (distributed reality shows).

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

A first objective would be to study and propose solutions able to create a rich "living room" experience where several remote users have the possibility to watch a TV programme (for instance a football match) while able to communicate with each other in the most natural way. Such a service needs integration of two streams, one coming from the content provider, one coming from a telecommunications provider, and the solution has to be standardised in order to ensure interoperability.

Users can be grouped according to their interest or mood, mechanisms for personalized content, community support and rich media communications are needed. Study of such 'first generation' solutions would also stimulate ideas for new forms of content exploiting this convergence.

As a longer term objective, NEM should study and provide solutions for interactive communities of users to produce and share any content (movies, music, photo, games …) and react on them with the other people as they could do in a physical meeting.

Those solutions have to manage synchronous and asynchronous communication, broadcasting and on-demand distribution, fixed and nomadic situations (home, car, on the move, at the hospital, in the plane …). The service has to be able to run on any types of device whatever is the situation of each participant.

State of the Art

There are some projects and prototypes such as AmigoTV offering proprietary parts of the solution (for example, only voice communication supported).

From the technical point of view there are already some possibilities to offer services which allow various forms of user communication to share live or recorded content. Prototypes, trial services of interactive chat-on-video, instant messaging with audio/video communication, content sharing have been already developed / deployed. All of them rely on the availability of an interactive (broadband) data/communication access coupled (in the best case, in the same device, like a STB / mediacenter / mobile) with broadcast access.

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

- Content personalisation according to the user's interest and mood
- 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
- Interpersonal communication platforms that include the possibility to share a piece of content while in a communication
- Tighter integration of communication support and presence capabilities into home and mobile devices (STB, Media Players), at several levels:
    - Audio/Video Rendering/Capturing: management and merging of different output streams on video, bundled with audio/video capturing (screens/STB with built-in camera & microphone, etc.)
    - Network Access Capabilities (adding connectivity to media players, etc...)
- Integration and coordination of media management and communication in Home Broadband Access Gateways
- Innovative user interface and device coordination 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. Moreover it is important to consider the interaction between human and machines in order to ensure correct perception of the summarized content. 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 mosaicing. 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. 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 ...).

The DVD format has been exploited to create interactive applications, often as spin-offs to major broadcast formats, although Internet-connected DVD applications have been largely unsuccessful.

Mobile phones are a common mode of interaction with broadcast media, usually for voting or text chat

contributions. Some broadcasters have begun to integrate live video feeds from amateur contributors (usually via web-cam) in cult programme formats.

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.

Specifically, the launch of TV-based services delivered over broadband will provide a great opportunity to develop new forms of screen-based storytelling in which narratives can be shaped to suit the preferences of the viewer. Over and above the technical benefits which NEM bring to existing production workflows, new paradigms must be developed for content production. These must include new tools which help both professionals and amateurs to easily author and test personalised interactive experiences which the viewer can enjoy in a potentially huge variety of combinations.

They must also make it easy for traditionally separate technology elements from the telecommunications and media industries to be dynamically assembled in intuitive ways - thus removing the barriers of cost and complexity from experiences which blend content and communications and allow editing, remixing and sharing as part of the format.

Overall, a significant challenge lies in hiding the technical complexity of integrating personalised content and communications technologies and making the proposition of converged applications and formats attractive to the creative industries. Cross-disciplinary, practice-based research involving real production teams and real audiences is essential.

Finally, with a potentially significant increase in new formats, more clarity will be needed around the protection of intellectual property relating to these formats, and how (and if) copyright rules can be applied.

2.2.8. Content in the mobile world

Definition

The mobile terminal is very personal; it is always available and has high local and global connectivity capabilities. Mobile devices have a strong potential for being one of the most important media equipment in the near future. On the other hand, mobile devices have certain inherent limitations that need to be taken into account when next generation content distribution technology is being developed. While the mobile terminal is always at hand, it also has to remain handy; although it is personal, it also has to be communal; these ambiguities are what makes mobile content production, consumption and processing a special case among the media industry, requiring many techniques and approaches

presented in previous sections to achieve the objective of effortless interaction with media services using mobile devices.

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

The usability and collaborative aspects of the mobile content applications will be enhanced by extensive utilisation of mobile context information, profiles and metadata. Mobile terminal can be used as a user interface to control or utilize other media devices at home and work. For instance, the user is able to display high definition video stored on mobile device on a larger display at home. Mobile terminals can also act as a cache for personal content mainly stored in the network. Mobile terminals will include new content aware media applications that provide content creation with metadata support, aggregation and management of personal content and controlling external media devices. Content augmenting with context and personal communication related information will be possible. New mobile platforms for open content formats will be established to enable efficient development of advanced mobile content applications.

State of the art

Currently advanced mobile devices can be used to browse the Web, play games, listen to music, watch TV, record and view videos, etc. Mobile terminals have become media capture and storage devices that users can utilize to produce and distribute content. Nevertheless, most of the mobile devices cannot efficiently use content that has been designed for a PC because of the limited display size and processing power. Usually content has to be tailored to the characteristic of the mobile device.

Current trends indicate that storage, content processing and data communication possibilities of the mobile terminals are progressing rapidly. At the same time, at least for mass produced low- and mid-end mobile terminals, the user interface technology is not evolving as fast. For example no low-cost breakthrough is expected to emerge in the near future that would solve the limitations of the relatively small display in mobile terminals.

Topics to be addressed

One of the main challenges in mobile content industry is to increase the usability of the mobile terminal for producing, managing and consuming different kind of content from various sources and applications in a unified way so that end users are given a familiar look and feel across different use scenarios. This involves aspects from software development processes and middleware design up to definition of the commercially viable value networks to bring together terminal and networks manufacturers, operators, service providers and content creators and owners.

Technical research topics include

- Tools for managing and aggregating personal content by taking into account mobile phone possibilities and limitations in techniques for summarizing content, search content, push services for specific user preferred content depending on mobile context and allow users to produce different compilations of the content for different mobile contexts.
- Connecting the mobile terminal seamlessly with any other media devices in the surrounding environment. The familiar look-and-feel of media applications in mobile terminals can be extended to offer same interface for consuming content using external A/V equipments. Mobile terminal may act e.g. as an UI, storage and communication device and key for protected content for home A/V devices.
- Content production and augmentation tools that allow combining content with personal and social network communication, content in surrounding devices, artificial objects and interactive content.
- Middleware and mobile platforms development for embedding content aware media handling functionality and interactivity tools into mobile operating systems in order to provide required unified look and feel already at the system level.

Key issues to be solved

Context awareness in the case of the nomadic mobile user implies providing interactive content –applications depending on the user's current location and social situation. The techniques to achieve this, while practically available, have to be carefully considered as to how to present the possibilities of including context information with the applications. Matters of privacy and easy configurability for levels of participation are of premium concern.

Personal content and metadata generation and sharing is challenging from the viewpoint of utilizing context information efficiently and in a user-friendly manner. Especially in the case of personal mobile content, the level of noise and other inherent quality characteristics (non-professional production) in the original content presents a challenge for content analysis algorithms.

Content adaptation is a major issue in mobile content presentation. Both multimodality and intelligent scalable presentation techniques have to be combined with context information in order to present the user with the most relevant content presentation for each situation. Also the capabilities of terminals and networks are an issue here.

The mobile market will always be abundant with legacy terminals not utilizing the most up-to-date techniques; the industry has to maintain services also for these devices, which again is an issue of content adaptation and multimodality.

2.2.9. Entertainment in the Zipf Tail

Definition

The internet offers an almost unlimited choice of content. Currently this is true for text, and in the future it will be true for audiovisual content. When such choice is offered, a large proportion of selections are of a small number of very popular items. However, there will still be a very large amount of traffic generated by the occasional selections of the huge choice of other items; this is the long tail' of the Zipf curve.

The Internet will change the TV entertainment industry beyond recognition. The Internet can provide (at least one) potentially unique channel per customer. This is currently being exploited in the first IPTV/VoD systems being deployed by major telcos. However, if we take this to the limit then it is technically feasible to make content available which has audiences very much smaller than the current broadcast TV audiences. What will TV entertainment look like in the tail of the Zipf curve?

State of the art

The Internet currently provides a wide range of entertainment content, but, in spite of the rise in popularity of downloaded music, entertainment delivery over networks has not penetrated mainstream TV-based entertainment. We effectively have two very different entertainment industries at each end of the Zipf curve; over-air broadcast at the fat end, Internet downloading at the thinner end. There is clearly a large, empty space, for a new, Internet, entertainment industry to develop. Indeed, with the right business models and technology, we can fatten this tail considerably.

Topics to be addressed

There are many challenges to developing this new industry. The business models will be quite different. The traditional role of a broadcaster is likely to disappear, with a more direct connection between content producers or aggregators and viewers. One can imagine the traditional broadcaster being displaced content aggregation, hosting and discovery service providers (on an international scale), such as Google or Yahoo. There be even more reliance on advertising, but this advertising will be highly targeted (and so might be useful rather than irritating). This will place more value on accurate

consumer modelling. Efficient content delivery itself will also depend on user modelling, with pre-loading HDDs on PVRs or portable viewers for consumption on demand. Content discovery will need to be linked with user models, and with delivery optimisation.

Key issues to be solved

Content production must change. It must be possible to produce high quality content (designed for various viewing devices) much more easily and cheaply that is currently possible. This content must be ingested and hosted at very low cost and without (too much) specialist knowledge from the content producer. The issue of viewing content on TV's in living rooms, rather than on PCs, requires significant progress in a number of areas. The home environment has not been sorted out properly. We have had attempts at dual personality PCs which are trying to be halfway between traditional PCs and set top boxes, and various attempts to create a remote control-driven interface. Windows Media Center is one such attempt, but is a long way from what is needed for mass adoption. The PC is uncomfortable in the living room, yet the Set Top Box doesn't have all the functionality needed.

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.

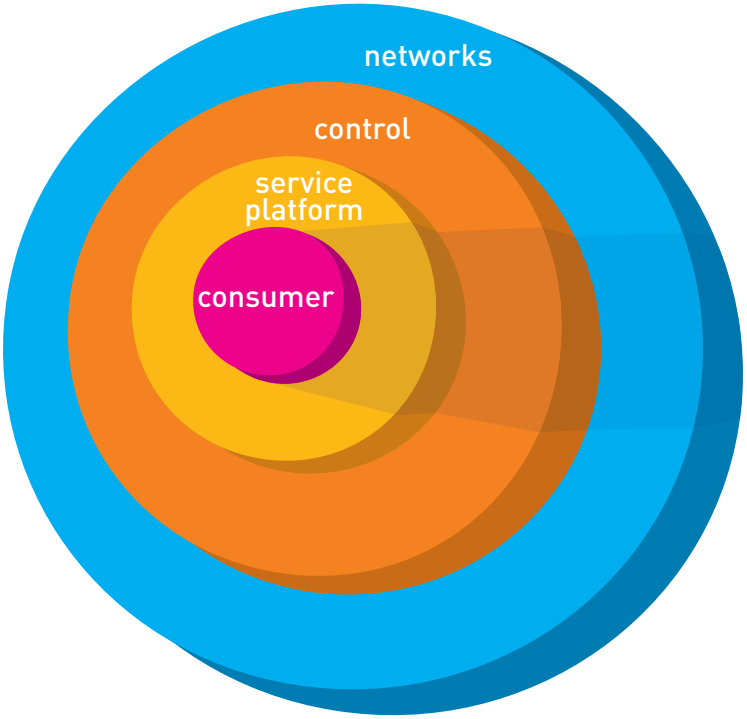
The future network will accommodate seamless end-to-end multi-media communications across a complex combination of network constituents such as personal area networks, body area networks, home networks, fixed access networks, mobile access networks, metro networks and core networks. This will involve 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.

The user becomes the center of gravity in the Telecommunications world. As such, future networks need to reach them anytime, anyplace what implies that extended connectivity to suburban and rural areas have to be taken into account in network designs. New access networks will need to be developed to cover the last meters in geographically disperse areas in a way that Telecom operators could consider it as a business case.



2.3.1. Network Architecture

Definition:

Network architecture is about the organisation and structure of networks and its connections. 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 Ethernet and IP-based 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 and IP-based networks are 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.

Network architectures need to evolve from the concept of isolated infrastructures of a service provider to a multi-provisioning of services based on wired and wireless hybrid heterogeneous networks for broadband, broadcast and mobile, where the requirements of the users have to been covered without making them to take care of the networks where the content is conveyed. This will make network providers to advance in the seamlessly capacities and convergence of networks, not only based on management protocols or gateways but also in a real advance in the network convergence.

Topics to be addressed

Main challenge for the upcoming multi-media ready broadband 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.

Topic 1: What comes after the Internet ?

Networked MM World Whilst the majority of networking research in the next few years will continue to integrate and build upon the Internet and its technologies and principles as conceived 30 years ago, present exploratory research into a new Networked Multimedia World will gradually takeover, and by 2010-2015, this new paradigm will become the centrepiece of networking research. The original features of the Internet have evolved, and are still are extended. Some examples are hierarchy for scaling, multi-casting, congestion control, QoS and security. Despite these evolutions and extensions, it has become clear that the (old) Internet is fundamentally challenged – and even violated - by new trends

and requirements such as, for instance, new (commercial and governmental) stakeholders, growing non-technical user bases, erosion of trust, need for security, intrinsic mobility and diversified application requirements. During 2007-2010, the architectural foundations of the new Networked Multimedia World must be designed starting from currently known and that meets these known requirements and other still visionary requirements. From this fundamental architectural research, applied research will spin-off during 2010-2015 to design novel, and integrate existing, technologies and functions that make up the Networked Multimedia World. Key capabilities such as security, robustness and economic viability, and an integrated approach of mobile, wired, wireless and sensor technologies will drive this research. It goes without saying that this Network Multimedia World should support any form of communication (human-to-human, human-to-machine and machine-to-machine), and thus per definition spans, and thus revisits, all present domains of networking as there are personal area networks, body area networks, access networks, aggregation networks, core networks, etc.

Topic 2: A new paradigm for networks: 'Network Directory Service'

Networks are still being viewed as connectivity pipes independent of what flows through it. Such a view was sufficient when the traffic flowing through it were not diverse. But with new & upcoming diversity in network traffic and the explosion in the location & number of end-points for these pipes, the traditional view does not meet the needs of the new-networked multi-media. If an end-user wants to interact with a particular multi-media content, it should not be necessary for the end-user to have previously separate business relations with the first/last mile provider, internet access provider or broadcast TV provider, etc. The ideal network is the network that is invisible to the end-user and that regulates itself on the fly to meet the needs of the end-user of course within the cost constraints chosen by the end-user. The activation of an action on the multimedia content should trigger off a set of reactions in the network so that the correct connectivity service is provisioned on the fly for that action on the multimedia content. For this to happen, there should be a framework in place, for the network domain and the multimedia content domain, to mutually advertises themselves and their capabilities; and provide a single package to the end user. The main features of the new network are:

- They have the capability to organize themselves dynamically to suit the needs of the multi-media content that needs to be transported between any 2 end-points continuously.
- They have the capability to advertise what it can do, when it can do, cost of doing it and how to activate it and pay for it.
- They have the capability to prove that it is offering what was requested (using monitoring techniques)
- A 'Network Directory Service' could be a standardized method to advertise the capabilities of the network, which can be used by the multimedia content provider to conveniently choose the best network for transporting the multimedia content.

Topic 2: Knowledge plane

An evolutionary change of the Internet will be the introduction of a functional plane, denoted "knowledge plane", enabling per-application control without the need to build per-application network infrastructure. This functional plane can be thought of as a loosely coupled distributed system with global scope, made up of components running on hosts and within the network. It augments network "control & management" paradigm of low-level data collection and decision making with higher-level processes and expert systems to learn about its own behaviour over time, making it better able to analyze problems, tune its operation, and generally increase its security, reliability and robustness. It collects and filters network conditions while reducing, and routing this information from different parts of the network to locations where they are useful (feedback loop), and operates successfully in presence of limited and even imperfect information. The result will be a network capable of driving its own

deployment and configuration, diagnosing its own problem, and making decisions about how to resolve them. Given the different types of networks involved, the amount of persons, machines and sensors that will be connected, and the amount of data that they will be generated, a knowledge plane with intelligence to provide aggregation and autonomous control will be required to keep the Networked MM World manageable.

Topic 3: Ubiquitous Gigabit Access

The vision of the physical access infrastructure for 2010-2015 is that there will be ubiquitous wireless broadband availability at gigabit rates. This requires a wireline access network to feed pico-cell antennas that are at a few tens of meters from the end devices. The wireline access feeders will be realised by gradually installing more fibre in the first mile. It is however expected that also hybrid fibre copper solutions using legacy wireline infrastructure (twisted pair, Cat5, coax) will be still required to overcome the installation cost and which can deliver gigabit rates over a hundred meter.

Topic 4: Convergence of Broadcast, broadband and mobile for networked MM world

Networks need to achieve a convergent technical approach in 2015 to provide users services not depending on the capacities of the network, only depending on the needs of the services, making irrespective the service of the underlying network and allowing the content and service reach the user by the convergent network, not the isolated each of them. This will mean that networks have to be aware of each others, its state, its capacities, its data protection mechanism and DRMs, its availability, etc. using the compatible management and operational protocols.

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 of →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:

- 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.
- Layer-spanning network planning and optimization for more modular and flexible optical networks including a largely automated network 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.
- Methods for supporting multimedia delivery in future simplified mobile network architecture. In the future, the mobile networks will share the same infrastructure with fixed networks. This reduces drastically the costs of building mobile networks and, at the same time, raises up new QoS related concerns that should be addressed.
- 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)
- End-to-end QoS provisioning with technology-independent solutions introducing intelligent network control at IP layer (convergence layer).
- Intelligent, possibly remote and multi-provider manageable home network access gateway and home network solutions supporting ubiquitous access for a user to multimedia services, either in his home location or from a remote location, via wired or wireless/mobile technology, and providing a seamless QoS supported operation between home communication services and network-delivered services.
- Common or interoperable operational and management network protocols to allow the convergence of networks.

2.3.2. Home networking

Definition

Digital home experience is every day more and more facilitated by the growing speed of access links to the internet. New high data rate services such as TV programs or Video on demand over ADSL are already a commercial success. New mass storage devices are already in the market: media renderers, servers ... and promise to make the digital experience even more exciting with e.g. upcoming HDTV. Moreover, end user devices are fitted with high speed interfaces to easily transfer all types of multimedia supports. These trends will certainly in the coming future make the VHDR-HAN a convergence arena where these devices and services will have to interwork at home and in continuity to the operator's network.

The home network is used to connect multimedia terminals and appliances as well as "internet things" within and around the home. The main goal is to offer new user experiences in the daily life, thanks to Machine2Machine and Ambient Intelligence which free time and attention by delegating capture and information processing to machines, sensors or things. Users will expect that portable terminals and appliances will work equally in other environments away from home, such as cars, caravans, hotels, and cafés. Home networks will be used, for instance, to view a TV programme recorded on a PVR in one room of the house on a screen in another room, to share the same music in different rooms, to transfer video from a camera in the garden to an editing station in the house. It could also be used for home automation, for white goods / equipment connectivity as well as for voice and video calls.

It must be possible to install a home network with minimal alteration to existing homes. This requirement, along with the need to work outside the house, practically requires the use of wireless or powerline networks (no new wire concept including low data rate and broadband technologies). It is obvious that each home will have its own network topology according to its architecture and it is obvious that heterogeneous network configuration will be the most common situation.

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

Digital Mass storage devices gain more success to the home every day. These devices, whose standardization is ongoing by e.g. within DLNA fora, offer not only demodulation of digital broadcast programs, access to remote services by operator's networks but also high connectivity to end devices such as TVs, home cinema or PCs. To enable the use of these devices, the trend is to use them everywhere at home with high data rate connectivity to transfer content either from remote servers or between devices sparsely distributed everywhere at home. On top of that, end users are not always geek people and expect most of the time highly simplified use, installation and maintenance of these devices by means of user friendly interface, and autonomic mechanisms. This shows that HAN is definitively a locus where services and connectivity have to converge.

Another factor to be taken into account is the enabling technologies to access to the network. Beyond ADSL technology, which already offers several tens of Mbps, LTE Radio Local Loop, and FFTH is seen as an enabler of very high speed demand.

Several hundreds of Mbps are reasonably reachable in the coming future, backed up by emerging standards such as GPON 2.4 G. An important parameter to take into account is the very low latency provided by these systems. Not only sustained transfer services which demand bandwidth for a while are possible but also highly interactive services (online gaming, telepresence...) may benefit from ultra short latency times.

For sure, these high bit rates and low latency time cannot be available at home without considering how they can be transparently accessible to end devices.

	vDSL	FTTH GPON 2,4Gb
DL Average	55 Mbps	48 Mbps (50 users)
Max	55 Mbps	› 400 Mbps
UL Average	20 Mbps	24 Mbps (50 users)
Max	20 Mbps	› 400 Mbps
Latency	› 16 ms	200 µs

Figure 1 : FTTH Access

Several networks types will cohabitate in the home and will interoperate through the residential Home gateway. Wireless and powerline networks need still improvement in order to reach very high data rate service and application requirements.

The main objectives are:

To develop requirements and technologies that allow communal (wire and wireless) home networks (e.g. 802.11n, UWB or HomePlug and next very high data rate generation) to meet the requirements for carrying audiovisual and any types of multimedia signals:

- High capacity [several HD signals – 10s of Mbit/s]
- High reliability [99.99% availability]
- Low latency [←100 ms]
- High density [3 streams per household]
- Minimum spectral usage [←80 MHz total worldwide, not necessarily in one contiguous band]
- High utilisation [→80%]
- Capable of continuous use with steady-state traffic

To develop technologies fulfilling the home automation and Machine2Machine requirements at attractive price:

- Low bandwidth (i.e. les than 100 kbit/s)
- High reliability [99.99% availability] specifically for security applications
- Low size (thanks to miniaturisation)
- Low energy (and indeed large autonomy)
- Able to address any kinds of "internet things" from RFID to lamp bulbs

State of the Art

Several standards are working on to provide solutions able to fulfil the services and application requirements:

IEEE 802.11n is about to be standardized in 2007:

- Improvement of coverage
- Very high data rate are announced,
- Introduction of MIMO technique (up to 400 Mbps)

It can bring a short-term solution but will not resolve the spectrum issue. Interference with other access points is one of the bottlenecks of these technologies as it is therefore difficult to control the quality of services à TV stream. Pico-cell systems with a better frequency reuse could bring higher spectrum efficiency and safer radiated power levels

Wireless networks using 802.11 standards are widely used to connect computers and other IT equipment. However, the 802.11 standards have been optimised for transfer of data files, an application that requires perfect accuracy but imposes no particular constraints on transfer time. They use repeat

transmission of data that are not received correctly. Streaming audiovisual signals have quite different characteristics from file transfer: forward error correction can make them reasonably tolerant of transmission errors, but they must be transferred in real time. Tests have shown that transfer of audiovisual signals over existing wireless networks is extremely unreliable and inefficient.

UWB:

- 3,1 to 10,6 GHz, possible at 60 GHz
- Power densities allowed in Europe not yet settled
- Coverage will be limited to 1 to 4 meters at 480 Mbit/s

A single AP located at the GW will no more be enough to have a global coverage at home. But UWB is, a good opportunity need to overcome the problem of spectrum efficiency and interference. UWB could be utilized in a explore mesh network topology, or in conjunction with a VHDR wire network (as Power line n copper of optical fibre). UWB access point could be implemented only where wireless is needed. Therefore, hybrid solutions combining wire and wireless technology is a good way to global coverage of the home.

FSO (Free Space Optics):

IR technology

- Can reach 1Gbps
- Coverage limited to a single room
- Feeding beacons with fibre optics

VLC technology

- Reuses the lighting infrastructure (LEDs)
- Countermeasures are necessary to cope with the ambient noise

Free space optics offers a good way to solve the problem of spectrum, interference. It is now under study in Japan.

Powerline communications technology already exists using many standards. HomePlug A/V seems to be the most suitable solution at the time being. It will support at the same time all types of multimedia streams (TV, file downloads, VOD, VoIP, music transfer, etc.) with an acceptable quality of service for the user point of view. But the physical layer can be improved in order to reach even higher data rates. So the study of next generation after Homeplug A/V is a topic for the next generation of home network.

HomePlugAV:

- OFDM Modulation
- 200 Mbps PHY
- Turbo-codes
- TDMA and CSMA

After HomePlugAV:

- Using CDMA together with OFDM can increase BR by 25%
- MIMO techniques possible offer a better robustness

Optical fibre is a very good candidate for next generation of cabling. Technology has improved a lot, and one can see now very small diameter fibre with very small curvature. As optical fibre is now reaching houses with FTTH with a very high data rate capacity, optical fibre cabling seems to be a good solution to provide the house with very high data rate capacity. One can find different type of fibres.

Plastic Fibres

CYTOP Multimode Fibres

- ←25dB/km loss (850 to 1300 nm)
- 1.2 Gbps/km
- Core Diameter 120 um
- Easy to connect

Micro structured Fibres

Hole assisted Monomode Fibres

- No loss even with 5mm bending radius
- Preconnected curl cord

RoF (Radio On Fibre) has been already studied a couple of years ago, but components and applications were not yet ready for massive deployment. Now with very high access network capacity, and VHDR HAN, ROF is a very promising solution. The concept is distributed radio signal on the optical signal directly to simplified access points.

Home automation solutions already exist but no standard takes the leadership and people are faced to a number of solutions which do not interoperate together (Konnex, X.10, ECHONET, Lonworks, Zigbee, Zwave and several proprietary solutions). This situation implies costly devices which avoid mass market development.

Topics to be addressed

A number of issues need further consideration in the context of VHDR-HAN:

- When moving from one room to the other, an end-device can be seen as either nomadic or mobile, transposing set of issues of cellular networks coverage everywhere at home.
- Intrusive access or eavesdropping is therefore also to be considered,
- As stated before, end devices such as HDTV, even hung at walls, shall be connected by some means, raising up the question of "VHDR static coverage" as well,
- End devices from different manufacturers have also to interwork either directly or via the HAN.
- When several services run simultaneously, some of them may tolerate transfer disruption or delay whereas others cannot. Quality of Service (QoS) is another dimension for consideration to guarantee quality of simultaneous plays.

The home gateway gives already some answers to these topics as a convergent box for access to the network and connectivity to end devices. It is now faced to the increase of data rates as well as home coverage expectations.

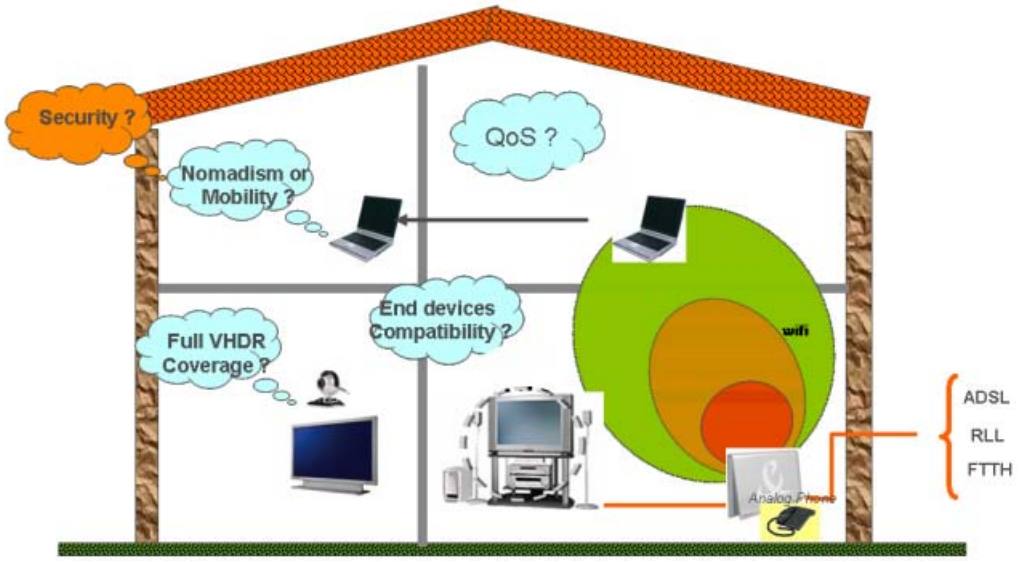


Figure 2 : HAN as a convergence platform

Reliable transfer of audiovisual and multimedia signals over home networks requires transmission protocols that can guarantee an appropriate quality of service, in conformity with the requirements outlined above. The need to transmit several HDTV signals requires wide bandwidth and high spectrum efficiency. Many such networks will have to operate in close proximity, for instance in blocks of flats and in suburban developments of closely-spaced small houses, so spectral occupancy and interference will be important.

Home automation networks should converge in a standard solution shared by all vendors in order to provide a reliable and cost effective solution covered all the service and application requirements such as device control, security management, authentication, location and device maintenance.

Key issues to be solved

Facing the above challenges, there is a need to define top level requirements to make this convergence a success.

First of all, high data rate needs definition. Thanks to a Dynamic Bandwidth Assignment function, about 400 Mbps access speed to the telecom network can be envisaged, relayed by more than 1 Gbps at home. Ultra small latency time, less than 1 ms round trip time can be offered thanks to simple framing and coding of short packets. These new parameters will allow new generation of services and new network architecture: P2P, Thin client terminal, very high quality real time videoconferencing.

QoS has to be implemented. It is one of the main challenges considering the heterogeneity of technologies of class of services, the heterogeneity of connectivity technologies, and of equipment.

Major connectivity standards are not yet ready to offer such high data-rate, some technologies are still under specifications in the standardization bodies. These standards should natively provide "beyond Gbps" connectivity and worldwide accepted by harmonized regulation.

As the HAN complexity increases in terms of combined technologies, classes of services, and heterogeneity of equipment such as CE devices, telecom devices, mobiles, PC devices, it becomes a necessity to provide the customer with autonomic HAN self configurable.

The above non exhaustive list of requirements has a considerable impact onto the design of the VHDR-HAN: number of access points and (distributed?) gateway architecture. This complexity has carefully to be balanced in terms of constraints onto an embedded system and low cost requirements.

An appealing subject of further consideration is the candidate list of connectivity technologies. As most of our home environment is already built, connectivity without new cables has top priority: radio WLAN/WPAN/WBAN systems, POWER LINE communications, FREE SPACE optics ... Keeping in mind that existing products cannot perfectly address HAN requirements, these solutions need certainly some further research.

However, considering no new cables would be too much restrictive. DIY (Do It Yourself) fibre or copper cabling should reduce not only installation and maintenance costs but also somewhat reluctance from the end user to introduce new technologies at home.

Among the other several detailed requirements, some attention has also to be paid to express coverage issues, not only in terms of "geographic" terms but also in terms of (semi-) static or dynamic scenarios.

Another topic is the possible combination of the core connectivity technologies (wire and no wire technologies) to enable best global coverage. Mixture or combination of technologies could be compensated for complementary weaknesses and strengths of respective core connectivity technologies. For example the small cell radius WPAN connected to a wire backbone in the home could provide a best coverage, allowing wireless access hen needed at high data rate, it would be a good way to solve the problem of frequency management.

Current powerline systems, both in the access network and for in-home networks, cause serious interference to wireless services in the MF and HF bands, (radio broadcasts, air and maritime navigation services, RFID, ...) which are guaranteed protection by the ITU Radio Regulations and by the EU's EMC Directive. Further research is needed to ensure the coexistence of powerline systems and licensed uses of the radio spectrum.

Finally, studies of wired and wireless media propagation channels are a research topic also to try and assess QoS at home. For example, further experiments have to be carried out to characterize the specific scenarios that may be encountered in the home daily life.

Current wireless networks work in the licence-free bands, which are now becoming very crowded. Issues of reliable transmission and interference could be mitigated by allocating a small amount of spectrum for home networks. This would require study of the absorption properties of building materials used in different countries.

Current home automation networks are mostly proprietary solution and each type of application uses a specific solution. Keeping the concept no new wire, wireless and powerline solutions seems to be the most suitable candidates for home automation networks. However, there are still a number of candidates which actually do not interoperate together. The challenge for home automation network will be the design or the selection of the few best standard solutions (no only one: home automation networking will be heterogeneous) able to fulfil all the application requirements. In consequence to the highly distributed and heterogeneous solutions for home automation applications, the main challenge will be the architecture design and middleware development for all these devices (things, sensors ...) to ensure seamless interoperability, ease of installation, configuration and use.

All these technologies should have to interoperate together at the application layer in order to offer seamless services and easy to install solutions. From that point of view, one of the main challenges will be the interoperability between the low bandwidth solutions (home automation, voice, etc.) and the high bandwidth home network. That topic has to be addressed seriously at the standardisation level because at the time being these two "worlds" do not have this common objective.

2.3.3. 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 entire network or across hybrid networks.

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 broadening 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 auto-mated 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 ranging from improving the security and robustness of its core packet delivery service over accommodating an explosion of access modalities to enabling networks for 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 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), which combines functions in the various layers to optimise performance and QoS.
- To research advanced end-to-end QoS provisioning systems, for multi-domain and multi-services heterogeneous networks tacking into account also mobility and security aspects. Connection Admission Control, QoS routing, Scheduling and Congestion Control functionalities, for instance, shall be provided by this control architecture (Convergence Layer) operating entirely with IP protocol layer, at a Network Technology Independent (NTI) level. This can guarantee a transparent control of any Underlying Network, without affecting IP or specific Underlying Networks protocols. Each domain (or autonomous system) will be controlled by a Resource Manager which will handle sessions and connections providing QoS (admission control, traffic engineering, and security).
- 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.
- To research on network monitoring tools to determine the characteristics of the Subscriber's access lines in order to know if the services are being provisioning according to the agreed SLA and, if there were room enough to provide a new service (i.e. for a visiting subscriber) without impacting the other services. Those monitoring tools should be connected to the Network Management system.

- To research on increasing the bandwidth of the networks without looses of quality for the user, with guarantee of service and capacity to the user and service provider to cope with high-bandwidth consuming services and ease DRM network based architectures.

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 etc.)
- 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)
- Network management independent from specific underlying technology (convergence layer)
- 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
- Lightweight mechanisms for balancing competition between different flows when the network resources are scarce. The priorisation should be performed taken into account the requirements of different applications, the user preferences, and the operator policies.
- Techniques for managing and configuring user devices remotely. As majority of users do not have technical skills to configure future networks devices, the devices have to configure themselves or they have to be configurable remotely by a service provider.
- 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.
- Developing tools for monitoring QoS of networks and services. The information from these tools can be used in network administration or service adaptation.

While all the aforementioned research topics should be focused on the currently deployed network infrastructures and provide smooth evolutional paths, research on disruptive solutions should also be fostered. Tackling old problems from an unexpected point of view has always produced the most innovative solutions which have really advanced the technology. The main topic of research in this area is the architecture of the Internet and the basic underlying protocols:

- Is the physical layer evolving towards uniformity and can this monoculture be harmful in the future?
- Is TCP the most efficient protocol to carry the traffic of tomorrow's Internet?
- Does the SPF (Shortest Path First) paradigm of today's Internet fit the needs of tomorrow's Internet or are there new and better paradigms which can result and simpler and more robust routing protocols?

2.3.4. 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 are provided seamlessly. 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 and architecture for service delivery. Today, the network environment is featured by a fast migration to IP / (Gigabit) Ethernet based networks, the 3GPP IMS domain being one example. With Voice over IP and video applications over telecommunication networks, this technological trend is complemented in the fixed network as well.

In essence, IMS technology provides a SIP-based control layer with open interfaces to the transport layer and the services layer above. However, due to the backgrounds of Fixed Mobile Convergence (FMC), it seems to result in a quite heavyweight and inflexible call control layer infrastructure.

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 plethora 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.

In order to operate in heterogeneous networks where the underlying network connection may be transferred from access technology to another (e.g. from WLAN to 3G), applications need to include mechanisms to adapt their operation to tracking and changing network QoS. This will require mechanisms for collecting network status information from the transport stream and in the case of wireless networks also from the radio interface to make fast adaptation decisions. Also applications themselves could benefit from the ability of influencing handover decisions in a heterogeneous network environment. That is, by telling the applications' QoS requirements to a mobility management application, handovers could be triggered optimally by guaranteeing that the used access network is capable of supporting the QoS level an application needs.

Today, various service architectures stemming from the telecom and IT worlds exist in parallel (e.g. CORBA, Web Services, Parlay, J2EE, and 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 not useable across networks, and cannot adapt according to dynamic user context, and i.e. do not meet the requirements of telecommunication services concerning real-time capabilities.

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.

Also, in current networks, the service provider is pretty much dependent on the network services of the dominant Telco. For the framework of 2010-2015 it is envisioned that, at least access networks, should be multi-provider and multi-service. In this scenario the Network Service Provider will sell connectivity to the Service Providers in a fair competition with other NSPs. With this model the user will not longer buy connectivity but services, and new business roles like "Service Brokers" will appear in the market.

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
- A centralized mechanism for collecting and processing cross-layer and cross-domain information from heterogeneous networks and terminals
- Obtaining a handover triggering solution capable of selecting access networks optimally by taking into account the application QoS requirements
- 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 services 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 neighbouring 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.

- Extensive multi-access test network. The number of different network technologies and applications is all the time increasing. To make them all work well together, preparatory work in test networks is needed. The multi-technology test platform can be used for performance measurements and testing e.g. handovers between different networks, adaptive applications, or interoperability of different devices.

- To design future-proof network infrastructures sharing rationalised architecture models and integrating complementing components, while leveraging IMS-like concepts and standard open network interfaces, to keep offers open to partners and competitors when and where technically possible.

- To build novel management applications or protocols with new concepts of inter or intra control-tracking of different parameters of the network to avoid QoS break and to provide seamless operation of heterogeneous networks to the service provider.

- 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 and has raised legal issues (e.g. content piracy) for

the users. Some of the research issues for integration of 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.

• New methods for more economic/more efficient service provisioning:

- To enable dynamic self-organisation, e.g. in order to map service requirements on available network resources to enable more cost-effective service provisioning.
- To synthesize new services through re-use of distributed basic components, and re-use of existing/available services in a standardised way.
- Evolved IMS nodes offering functionality above the IP layer, including local application logic, protocol handling and media processing capabilities.
- Bridging of GRID and IMS architectures, middleware for dynamic inclusion of GRID resources into the IMS network and vice versa, GRID multimedia subsystem
- Enable usage of resources provided by Intelligent Clients serving as Grid resources/"service clients" to perform network functions.

• 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).

2.3.5. 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, gaming, etc.) the complexity of network optimization has dramatically increased making 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 routing 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

2.3.6. 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.
- Ubiquitous common access to pervasive service platform thought different MM gateways with common features for the different environments allowing automated updating of ubiquitous network information with special care to personal environment related information.
- 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 adapting 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.

Broadcasting networks integrating terrestrial, satellite, and mobile transmission for providing 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 canters, 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 complex device management. They will also have to absorb HD capabilities for large displays. The second one is the rapidly raising demand on small mobile and portable terminals. These will have to combine some capabilities listed above with issues such as low power consumption, small form factor 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, media renderer, media centre etc., 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.

There will be a multiplicity of devices: iPod, 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 technology, 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 Centre PCs.

The technology integration plays a significant role in both device areas – fixed media centres 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. However, the aspect of fashion and "must have" gadgets must not be underestimated. This very much drives the device multitude in the CE business, like mobile phones.

But there is another potential development. 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.

Terminals are increasingly sold and bought based on services which they are bound to; criteria like price, performance tend to become less important instead. Media consumption, personal communications and interactive data access are the reference service categories for present devices and this is not likely to change in the foreseeable future. However, end-users expectations go in the direction of being able to run all such service types on all the terminals they own in a seamless and coordinated fashion, getting top media quality on fixed devices and scalable performances on mobile devices, moving all sort of content and information items across devices. Therefore, general-purpose, multi-function devices are requested, although each of them may be optimized for supporting specific applications.

A goal of many businesses worldwide is to deploy an integrated "ecosystem" of services and terminals in the user's environment (home and mobile alike) in order to be able to make such a complete offering to the end-user. An ideal objective is to make one's "ecosystem" to become "the" gateway of choice towards all communications, media and information services by gradually driving users to get accustomed to a new way of accessing applications. At stake is, among other things, the management of customer's personal data. The "ecosystem" owner clearly is a candidate for acting as the "home environment" operator to which an increasing demand for simple and homogeneous ways of accessing information can be addressed by customers. Such an entity would be in a position to satisfy all primary information-related needs of the average end-user while at the same time guaranteeing an adequate service level by means of remote management/provisioning mechanisms as well as direct consulting for the user's environment designing, certification and maintenance.

In fact, key elements of any "ecosystem" are hardware and software platforms that are interoperable across fixed and mobile applications and a consistent customer experience provided by a well-identifiable "access metaphor". In particular, essential technologies for controlling content distribution and positioning in the value chain are represented by digital rights management technologies for media protection.

Typically, numerous European companies have potential "ecosystem cores" already in place, being represented by "vertical", single-service devices like residential gateways, fixed and mobile phones, set-top boxes, smart-cards, etc. A strategic goal of the European industry now becomes to evolve towards an integrated "NEM ecosystem" built around a new generation of devices complementing each other. The service centric approach of NEM requires that services can be accessed by all kinds of devices regardless of the provider, in fact pushing for a horizontal market. NEM is about the support an overall service logic in order to provide a personal environment (at home or on the move) as complete, versatile and usable as those that are being set up by competition worldwide. This would include at least the following device classes:

- Advanced Home Gateway: a control centre for home network management and home profiling
- Media Home Terminal: a fixed, family-shared terminal for content consumption, conversational services and data browsing at the highest possible media quality.
- Broadband Portable Terminal: a portable, family-shared terminal for content consumption, conversational services and data browsing in limited mobility.
- Personal Mobile Terminal: a portable, personal terminal for content consumption, conversational services and data browsing in extended mobility.

On board of all such devices uniform DRM and media technologies as well as a coherent access metaphor are required.

Naturally, the chances for an "NEM ecosystem" to succeed strongly depend on its potential customer base: it is hence of paramount importance to put together a critical mass of promoters of a European home and mobile environment, leveraging on convergent interests of different actors in the European landscape, without forgetting, where applicable, to allow for a certain degree of interoperability with third-party ecosystems. An example picture of such home environment is provided in the following figure:

In particular in the figure:

- "Broadband Home Network" is meant to represent a backbone communications infrastructure for optimal distribution of broadband services and content within the home, with suitable QoS, bandwidth and coverage;
- "Personal & Supplementary Networks" extend service support by providing local connectivity isles for cable replacement and low-throughput sub-networks for control/configuration purposes;
- "Remote Device Management" indicates a platform for the provisioning and assurance of all home network nodes, including the Home Gateway and fixed/mobile terminals;

Uniform Media/DRM Middleware points at technologies acting as a sort of "ecosystem glue", which ensure that uniform formats and protocols are used whenever content is exchanged among the various home environment components

2.4.1. Terminals and Devices

2.4.1.1. Residential Gateway - Architecture

Definition

The residential gateway is defined as the module building 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 etc.).

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, in-home communication infrastructure, and the possibility of providing news services based on this infrastructure.

That device will be able to support services thanks e.g. the OSGi framework which offers an environment able to be shared by several service providers. Multi-service networks request multi-service CPE, and the residential gateway (RG) has received major attention especially 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 addition to features common to all gateways, a RG should include an embedded broadband modem, routing capacity and security features.

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

Several incarnations of residential gateways 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
- Multi-service RG = broadband modem + router + firewall + service such as video, VoIP home automation, content delivery etc.
- MultiWAN RG = Multi-service gateway offering connection to all types of access network

The prerequisite for a large deployment of new services is a common execution platform in the home and a common abstraction 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 H.610, DSLforum, DLNA, OSGi Alliance) and will analyze gaps with respect 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, which, due to their complexity, versatility and price, could be shared on a community environment (building, neighbourhood, industrial area etc).
- At the time being, the RG 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 on 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.

2.4.1.2. Residential Gateway -- HAN / WAN interaction

Definition

The in-home network is based upon wired and/or wireless technologies. At issue is security of the connection of the home network, management of applications on the in-home network (bandwidth, resources), and managing end-2-end QoS. The Residential Gateway (RG) acts as an intelligent bridge between access network and in-home network to safeguard security of the home network and manage the in-home network and its applications.

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

It is expected that over the coming years most communication (including voice, video-call, TV broadcast, content & activity sharing) will take place over broadband IP networks. The network (HAN as well as WAN) will become more intelligent and will enable the allocation and execution of specific tasks on the device or devices best fit for that task. It is anticipated that a shift from 'connected devices' to a 'distributed system' will occur, in which devices evolve from stand-alone boxes with a network connection, to network aware devices that show collaborative behaviour. Seamless access at the best possible guaranteed QoS to any content/service anytime and anywhere independent of the location and/or of the device is key. On top of that, especially in the consumer area ease-of-use (EoU) is an important topic. Registration of terminals and services should be as intuitive as possible while a guaranteed level of security must be maintained.

The increasing complexity of the overall network infrastructure, devices and services will require advanced, consumer-friendly system interaction. A Residential Gateway could be the enabler of this seamless interoperability. However, business models for the RG (who owns/pays platform) and service deployment (will there be regulation to un-bundle network services and application services) might be an obstacle for enabling this seamless interoperability.

Technologies/features that need to be addressed in this context are:

- QoS (currently only priority setting) to offer Voice and Video over IP with the same perceived quality as the legacy services POTS and analog/digital broadcast over CATV.
- Device/Resource management, including network management
- Services management
- Security will be an increasingly important topic, as networked devices are more vulnerable to attacks both from outside the home and inside the home.

State of the Art

The convergence of PC domain, A/V domain and communication domain using PC/IT technology for processing, storage and broadband wired/wireless networking is taking off. Until recently it was only the home-PC that was connected via cable modem or ADSL modem to the Internet. Nowadays people start to build there own in-home IP network by connecting a broadband router to the broadband modem and connect multiple PCs and/or IP-enabled media rendering devices to this network that share the same Internet connection. It is expected that over the coming years most communication (including voice, video-call, content & activity sharing) will take place over broadband IP networks. Advanced A/V codecs in combination with high bandwidth access technologies will enable services like HDTV-over-IP. This trend of connecting more and more networked devices in the over wired and wireless technologies, is asking for better Quality-of-Service and security measures.

Topics to be addressed

- **Quality-of-Service**

Current QoS as in UPnP-QoS primarily focuses on assigning priorities to single streams, which allows

for a primitive form of bandwidth allocation. More sophisticated ways to manage bandwidth and adapt the streams to bandwidth available will be required in order to enable prioritization at the application level by the end-user (rather than at the stream-level based on the content type). Topics that need to be addressed:

Enable prioritized multiple stream services (like videophone);

Adaptive A/V codecs to adapt streams to the available and dynamically changing bandwidth;

Advanced A/V codecs to handle streams between terminals with different capabilities; in case of a videophone call between a TV-monitor and a portable phone, the portable phone needs to perform better than the TV to encode the signals.

• Resource Management

Resource management is a generalization of bandwidth management (covered in QoS topic) as bandwidth is only one of the resources available in the network and the devices connected in that network that can be managed. For a service for which more than one resource is needed to render it, issues will pop up that are very similar to those found in Operating Systems, like the famous 'dining philosophers', a well-known problem in concurrent programming. Research will be needed to investigate the problem area. This topic will have to address the consequences of moving from the current concept of connecting devices that we are familiar with today in a network to devices that have been designed to cooperate in a distributed environment (the HAN is the system).

• Context Awareness

In order to support the Resource Management topic it will be required to equip devices with means to identify themselves and acquire some notion of the environment they're in. For example absolute and relative location, date & time and presence of other objects and perhaps even people.

• Security

A system of interconnected (wired and wireless), cooperative and sometimes invisible devices needs to be protected against malicious attacks. Although the average end-user may have some notion of the vulnerability of the PC, he/she is probably not prepared for the threats in a connected environment. 'Big Brother' may become a reality in his / her own trusted home environment without knowing it.

The system needs to be able to detect (new) devices and services and warn the end-user if necessary. It will be required to come up with new measures to ensure a safe and secure environment while taking into account that real people have to deal with these measures. Enforcement must be simple and straightforward and definitely not become a barrier to the users.

Related topics to be addressed are: identification, authentication, authorization, secure payments, content encryption, secure communication channels in the home and between home and WAN, secure installation/removal of devices and services, intruder detection and alert.

• Ease-of-Use

Serious attention will need to be given to more natural ways of interacting with the future home environment. Key will be the level of support that can be provided to the user. This includes multi-modal user interfaces (like speech and gesture recognition) and context-awareness (mood recognition while installing a new device).

Key issues to be solved

The NEM home environment is essentially defined by software (with hardware support), in the sense that its boundaries are not going to be of a physical nature for they tend to coincide with the "NEM ecosystem" boundaries in the user domain, which will be primarily set by DRM and media formats. Hence, besides self-configuration to optimize internal resource usage, key aspects of an One of the challenges along the road from the current situation towards a fully converged situation is to provide an evolution scenario from the current situation (mixed analog & digital, different network technologies etc.) towards 'all IP situation'. There are many options for network technology available that do not seamlessly cooperate. Products designed for the home should be easy to install, provide obvious user value and be affordable. Digital home products must interoperate with each other and with existing consumer electronic devices such as TVs and stereos.

Currently, open industry standards are often too flexible – products built by different vendors all too often fail to interoperate well. Design choices should be narrowed through industry consensus to better achieve interoperability. Current end-to-end solutions based on proprietary vertical implementations bring products to market early but have little impact on rapidly establishing a new category of products

2.4.1.3. Advanced Home Gateway

Definition

Control centre for the NEM home environment, provides interconnection among terminals, remote device management, automatic device configuration, resource allocation (especially by assigning media stream priorities) as well as home network security. It can also be used to track and statistically analyze resource consumption patterns within a household, as well as to build and maintain a sort of "household profile" that can be exploited for customization of the home environment performances in order to better fit customer expectations and simplify service usage.

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

The home gateway is an important piece of hardware sitting in all digital homes equipped with a broadband connection: it should evolve in the medium term to become a device fully aware of service semantics, able to administer all home resources to maximize application efficiency as well as to trace media consumption, i.e. by providing centralized management of home terminals and collecting information on content usage at the family level. This is only possible if the home gateway is integrated with the rest of the NEM home network infrastructure, including fixed and mobile devices, sensors, smart-cards, etc.

In the long term the whole NEM home environment, of which an advanced home gateway is going to be the core, needs to evolve from a multi-terminal home network with duplicated "intelligence" on several self-contained systems, dedicated peripherals for each device and duplicated DRM and media processing power to a single distributed hub with partitioned "intelligence" among several specialized modules, shared peripherals with common interfaces and concentrated DRM and media processing power; all in the perspective of a shift from coordinative to cooperative inter-working among the bits and pieces of the "NEM ecosystem".

State of the Art

Current residential gateways tend to be much optimized towards the specific needs of each service provider, leading to a remarkable varied set of interfaces and features that appear on the different models, spanning from several WiFi flavours to traditional Ethernet, power line and phone line technologies on the LAN side, as well as from FTTH to xDSL on the WAN side. In perspective, trends can be identified (for instance in such international consortia as DSL Forum, DLNA and HGI) towards standardization of architectures and functions aiming at economy of scale, as well as towards modularity and on-field upgradeability for increasing flexibility and reducing operational costs.

Topics to be addressed

Basic home gateway functionalities have to make the NEM home network work as a relatively independent facility with respect to the service provider's overall geographical infrastructure, thus distributing and balancing processing and communications loads between the remote and the local parts of the NEM assets, as well as covering a number of scenarios where outbound connectivity is not available or essential (but NEM services must still be provided to the customer). These include for instance device registration and discovery, device management and maintenance, resource shaping and optimization, media routing and adaptation.

Advanced functionalities, like for instance home/individual intermediation and home/service provider intermediation, build on the concept of a NEM home network being regarded as an autonomous entity with typical behavioural patterns and a "personality" of its own, sitting at an intermediate stage between the remote service provider infrastructure and the individual users, and acting as a representative of the whole family/household for everything that is related to profiling and the gathering of sensitive data.

Key issues to be solved

The NEM home environment is essentially defined by software (with hardware support), in the sense that its boundaries are not going to be of a physical nature for they tend to coincide with the "NEM ecosystem" boundaries in the user domain, which will be primarily set by DRM and media formats. Hence, besides self-configuration to optimize internal resource usage, key aspects of a home gateway centred household to be investigated concern interaction with other networks/home environments and in particular content trans-coding from the "NEM ecosystem" language to other possible standards.

2.4.1.4. 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 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 solutions, 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 an easy and intuitive interface and navigation. The complexity of the underlying configuration and technology must completely be shielded from the user.

2.4.1.5. Media Home Terminal

Definition

Shared fixed terminal providing access to content, communications and data browsing applications, it allows for media consumption at the highest possible quality within the home, optimized user experience and easy customer interaction. Furthermore, it is a preferred device for storing / managing a household digital media library as well as accessing digital broadcast and broadband channels.

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

Currently available devices must be expanded to incorporate more functionalities and provide higher performances in terms of processing power, storage capacity and content managing / redistribution, in such a way that applications now spread over many different pieces of equipment can be run on a single platform, including for instance entertainment, personal media, gaming, communications and messaging, information search & retrieval and data browsing. A key feature in the medium term is a new paradigm for interacting with all such services directly from the TV set, in a simple and intuitive way not implying knowledge of or acquaintance with tools and procedures that are typical of the IT world.

In the long term, a certain degree of modularity should be devised for a NEM media home terminal, like for all terminals within the NEM home environment, so that the specific hardware provided to a customer matches her service profile at no additional costs, while at same time being upgradeable as the service profile and requirements thereof change over time.

State of the Art

Set-top boxes and digital media centres are the closest approximation currently available to the target device. Set-top boxes are pieces of equipment that get connected to a TV set, providing essentially entertainment services like broadcast TV or on-demand media and allow for user interaction through a remote appliance. Examples are digital terrestrial television, satellite pay-TV, or IPTV (TV over broadband fixed connections). Media centres are PC-based devices acting as central media hubs for the home, from which digital content can be distributed to all other terminals. TV-centred video-communications, data browsing and messaging are other significant applications for all such devices, as well as digital video recording.

Topics to be addressed

It is fundamental to adopt a uniform technology for NEM media management and content protection, allowing for seamless interoperability and integration of different services (e.g. video on demand, pay-TV and mobile messaging) provided by diverse operators and running on the same NEM media home terminal.

A common software execution environment has also to be selected for media processing devices within the NEM home environment, possibly promoting the development and consolidation of existing open initiatives (like for instance the DVB MHP standard) as an alternative to proprietary operating systems causing lock-ins to a company solution.

Furthermore, an adequate level of hardware and firmware support must be obtained from chipset makers for the selected NEM media and DRM technology and suitable interfaces must be agreed between NEM media devices and third-party consumer electronics appliances like for instance audio/video peripherals or sensors/actuators.

Key issues to be solved

An obvious criticality of a competitive nature for a NEM media home terminal is represented by the possibility that proprietary solutions developed for the mass-market and optimized for very specific applications (e.g. gaming consoles, home theatre systems, etc.) establish themselves in the average

household leading to a fragmented technological landscape in the home. A possible way of counteracting this trend is to quickly develop and launch multi-functional media products that, although less specialized, offer the benefit of multiple service integration in the same box as well as straightforward navigation and interaction with all of them.

2.4.1.6. 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 most likely happen 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 favour 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, keypad 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) the keypad is currently 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 semi-public 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 1990s was approximately size of an 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.

2.4.1.7. Broadband Portable Terminal

Definition

Shared portable terminal providing access to content, communications and data browsing applications anywhere inside the home (but not necessarily outside), with greater media quality and interaction ease with respect to personal mobile devices.

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

In the medium term such always-on, easy-to-use device could be conceived as an operational hub for typical home-automation applications such as home appliances programming, remote health care and surveillance.

Multiple service support (with a special eye to entertainment and browsing services) and device portability are instead two goals to be achieved in the long term in order to correctly position the new NEM broadband terminal as an intermediate piece of equipment between a full-fledged media device for the living room and a pocket mobile phone, without isolating it in the home environment but rather raising it to the same level of completeness and cross-application functionalities yielded by other apparatuses.

State of the Art

Examples of such terminals are the currently deployed videophones, mainly devoted to video-communications often complemented by messaging as well as "push" and interactive data services, either across dial-up or broadband connections. Key technologies are signalling protocols (e.g. the SIP standard protocol) and codecs for efficient audio/video compression.

Topics to be addressed

A key feature is an adequate degree of integration between such devices and other terminal in the "NEM ecosystem", providing for instance the ability to seamlessly exchange content and data as well as to route media streams among all of them: for instance, it should be possible to listen to music stored on the NEM media home terminal on such device or to send the video streams of a videoconferencing session to a NEM personal mobile terminal.

Device customization based on individual profiles (e.g. automatic activation of a personal address-book

or a specific background look & feel) is also a must for a piece of equipment that is conceived to be used in turn by different customers at different times.

Key issues to be solved

A number of issues regarding such device are going to be those affecting also mobile phones, namely the need to identify a suitable trade off between performances and cost/power consumption. The possibility to exploit techniques and components that are typical of the mobile world (like cheap application processors optimized for mobility) must be assessed, in order to try to keep the terminal price in the range of typical consumer electronics appliances in spite of the fact that it is going to share many features of laptops and tablet PC.

Another potentially hot topic regards privacy of personal data and media exchanged through communications applications, which may soon raise concerns similar to those that have led to extensive usage of digital rights management techniques in the content-to-person market segment.

2.4.1.8. Personal Mobile Terminal

Definition

Personal mobile terminals provide access to content, communications and data browsing applications on the move, both inside and outside the home, with media quality and interaction features optimized for mobility. It is a preferred device for hosting a customer's personal identification module allowing for centralized assembly and management of an individual profile (identity, settings, preferences, etc.) as well as for customized access to the NEM home environment services and terminals including rights management and transaction clearing. It is also a preferred device for accessing mobile channels within the NEM home environment.

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

Current mobile phones must be enriched with additional enabling components (e.g. advanced browsing, localization), bridging also the consumer and enterprise needs. In the medium term, it is also essential to enhance the overall security of the mobile terminal, for example by integrating on board biometric authentication techniques, as well as to increase the device interactivity and usability introducing deeper customization features.

In the long term, besides becoming an essential node in future "peer-to-peer" networks, the NEM personal mobile terminal shall is bound to evolve and increase its performances in order to support all sort of "quadruple play" services (media, data and voice in broadband mobility).

State of the Art

Current mobile phone applications range from mobile browsing and combinational services (like "push-to-view") to mobile messaging and media delivery. Key technologies among others include mobile broadcasting, digital rights and media management, operating systems and application frameworks, terminal security and device management platforms. Available products range from embedded connected devices and low-cost phones to smart phones and convergent (3G/WiFi) phones.

Topics to be addressed

An essential goal is the introduction on NEM personal mobile devices of open hardware and software architectures enabling a multi-party cooperative approach to the development of services and applications. Relevant standard defining organizations should be addressed by a joint effort in such a direction, in particular 3GPP and OMA, in order to prevent technological fragmentation of the market and to guarantee that proper attention is devoted from manufacturers to the migration from "vertical", self-sufficient apparatuses to "horizontal" devices fully integrated within the NEM home environment. In particular, an ideal evolutionary path would include at least the adoption of open operating systems

and middleware layers as well as the inclusion within the mobile chipsets of features to accelerate and optimize essential functions like multimedia codecs, localization tools, speech recognition tools, RFID components, etc.), facilitating also the development of solutions that are convergent and interoperable with the TV and fixed broadband worlds.

Key issues to be solved

A technological criticality may be related to the need for a uniform approach to fixed-mobile convergence, especially as regards tools and techniques for conveying mobile traffic over fixed networks when mobile terminals featuring both 3G and WLAN access capability become widespread in the marketplace: here, also, competing solutions (e.g. UMA and IMS-based) should be evaluated and a consistent NEM policy agreed in order to avoid severe interoperability issues.

2.4.1.9. 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 for medium term – 2010 and longer term – 2015+

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 etc. As one gets close to a large screen that screen 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 of what is available. Services are automatically adapted to the current device capabilities.

State of the Art

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

Topics to be addressed

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.

Key issues to be solved

- Representation of devices by functional entities
- Specification of interfaces between functional entities, preferably in a dynamic manner, so that new functionalities can be learned and automatically be integrated in future applications.
- Global context awareness of functional entities.

2.4.2. Core Building Blocks for Terminals

2.4.2.1. Subjective Assessment of Media Quality

Definition

Subjective media quality is the quality of a multimedia service as perceived by the user. Subjective media quality goes beyond the scope of technical parameters like resolution and signal to noise ratios.

It includes application specific issues like channel switching time for TV applications, audio delay for communication applications, loading time for software applications and the like.

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

In NEM the overall service quality is the decisive criterion. Midterm quality of service definitions have to be implemented and standardized (e.g. by ISO) that broaden the technological viewpoint and include the application environment.

Long term those definitions have to be included into Quality of Service frameworks and standards (UPnP QoS, network management frameworks as published by the DSL Forum and HGI etc.).

State of the Art

Although objective measures exist to calculate the objective quality degradation of the audio and the video per picture, it is proven time and time again that the objective measures do not always correspond with the perceived quality measurement results. This is due to the dynamic nature of the quality changes, which confronts the viewer with blind spots after scene changes, and causes uncomfortable viewing during rapid quality changes, gradual perception of quality degradation, etc. At this moment there is no clear indication which factors are the dominant ones and how they need to be measured. Furthermore, the properties of the content itself, i.e., type of film, level of interest and importance for the user affect the perception.

Topics to be addressed

With the onset of new services (mobile and wireless) new guidelines and standards are required with regards to the perceived quality of the media experience. This is a new research field for which we need to techniques and methodologies for subjective assessment to address and support crucial design and engineering problems, such as bit rate reduction, scalability, skipping frames. This is of crucial importance for the development of new services for mobile and wireless environments.

Key issues to be solved

The generation, transport and rendering of audio and video content need extensive software systems to optimize the total processing chain and provide the highest possible user satisfaction. The setting of the parameters of the system depends on the perception of the results by the end-user. Although objective measures exist to judge the quality of an audio video signal by comparing the original signal to the rendered signal, it proves that this measure is not sufficient. The context of the rendering and the dynamic nature of the signal make that an end-user perceives the quality differently than an objective static measurement indicates. This discrepancy makes it nearly impossible to judge the best settings without a better insight in user perceived quality.

2.4.2.2 Open Middleware Framework

Definition

Consumer electronic devices are complex software systems that may range from PC-like architectures to custom hardware like mobiles or portable A/V players. The relevance of software in those devices is now largely greater in terms of complexity and effort with respect to the hardware parts. This happens

in all consumer electronic devices such as set top boxes for media applications, mobile and smart phones, in leisure and tourism, navigation and media controls in automotive, decentralized controllers in domotic applications, etc. As the software content of consumer electronic devices rapidly grows, separate 'middleware' threatens to stem the progress of free innovation. Currently no adequate solution exists to support multiple application domains and component lifecycle management. An open middleware framework is a component-based software engineering solution that addresses these problems by allowing to dynamically compose applications. The focus is interoperability.

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

Today's consumer electronic devices are complex software systems ranging from PC-based architectures to mobiles, whose software is enormously complex and laborious to produce, compared to the hardware. Moreover, there is an increasing requirement to provide the consumer with new features or solve any occurring problems, hence, the need to frequently receive updates in a cost-effective way. This calls for dynamically upgradeable component-based middleware. To enable such a novel component-based framework, effective and rigorous development of components and complete component-based solutions and applications should be facilitated to reduce software development costs and to form a basis for the dynamic management of applications and services. For example, in the EU, automotive software is rapidly developing in quantity, complexity and capability, but it has limited commonality with other household devices. Effectively utilizing all of the software that is available to an individual is an almost impossible task because of the lack of commonality. As an example, consider the task of using the same piece of music as the ring-tone on a mobile phone, as the 'error' bleep on a home computer, as the 'headlights-left-on' reminder in a car, and as the 'door-left-open' alarm on a fridge. What might be seen (naively), as a rather trivial task is actually a major technological challenge.

State of the Art

Currently, there are two types of software solutions for complex consumer devices: (1) - a completely proprietary, closed-source solution, and (2) - an open-source solution. Past efforts to combine these two types in one solution have been successful and were supported by many industries in the professional domain, thus proving the feasibility of the concept. However, the professional (business-to-business) domain contrasts greatly with the converging NEM domains as represented in, e.g., consumer electronics devices, which have quite different requirements. A comparison of the four component-based development methods in existing state-of-the-art solutions shows that most have problems coping with verification and validation methods, reuse capabilities and support based on formal behaviour description, and managing and supporting design patters at structural and behavioural levels. Most of the proposed component-based models have a run-time engine that enables management of the dynamic capabilities. However, in the case of component-based middleware for consumer electronics applications in all possible devices (from set-top boxes to PC architectures and mobiles), needs are much more complex because of additional requirements that are not commonly covered by classical component-based middleware and models. A large part of the run-time engines/middleware are not capable of taking advantage of a formal model of component behaviour during the addition, replacement or the adaptation of new components, which are quite frequent in consumer electronics devices in which multi-media content is processed, decoded, decrypted, filtered, annotated, adapted, decompressed, during a run time.

Topics to be addressed

Development of an open middleware framework solution for the modelling, production, verification and validation, and dynamic deployment of software components of middleware for consumer electronic devices in a realm of domains, endowed with intelligent inference mechanisms for dynamic composition, negotiation, adaptation, replacement, and recovering of components, and supported by suitable tools for the effective and smart deployment of components according to the device status, final user needs, and component profiles.

2.4.2.3. Personal Identification Module

Definition

A customer's token for gaining access to all of the NEM home environment services and terminals, a portable piece of equipment controlled by the "ecosystem" provider and used for individual authentication and storage of a personal profile (preferences, settings, rights, etc.) exploited to customize service consumption and applications.

The incarnation of the Personal Identification Module can be manifold. It can be pure hardware (e.g. smart card with memory), it can be pure software (e.g. secured storage on one or on distributed servers) and it can be used in combination with personal knowledge (e.g. pin-codes) or biometrics.

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

In the medium term, all other components of the "NEM ecosystem" have to be designed in order to be able to interact with a customer's personal module, thus making it possible for an end-user to authorize / enable any operation that requires acquisition, usage or releasing of individual data (e.g. for service personalization, payment, digital rights consumption, authentication, etc.).

It is also essential to ensure in the long term that an appropriate level of support be provided by hosting devices to modules whose requirements concerning communications speed and flexibility of interaction tend to increase constantly.

State of the Art

Currently available tokens are essentially smart-cards, i.e. cards featuring a microprocessor, internal storage and wired / wireless connectivity with the external world. Smart-cards have been in use for a long time and are widespread on the market especially as mobile phone SIM / USIM; a steady increase in memory and processing power facilitates usage if smart-cards as repositories for ever larger quantities of data, as well as for performing highly sensitive security functions due to their inherent tamper resistance.

Topics to be addressed

Interoperability among modules and devices must be achieved by defining common communications procedures. Interaction with a module can be achieved for instance by physically inserting / transferring it into the various terminals or having it hosted all the time by the same "proxy" device. The latter approach can rely on well established wireless communications standards (e.g. ZigBee) by means of which the module can even be made relatively independent of the hosting device as regards the ability to contact other pieces of equipment.

A common module software platform must also be identified following up closely to the evolution of open environments (e.g. the JavaCard environment in the Smart-Card scenario).

Key issues to be solved

A convergent approach of European service providers and manufacturers in the international standard bodies is required to ensure that a consistent set of proper features enabling practical usage of personal modules in an extended way is going to be available in the right timeframe, avoiding market fragmentation and proliferation of incompatible solutions.

Relationships and possible synergy – in case of a hardware incarnation of the module – among the various card types (e.g. SIM and memory cards) should be explored in order to devise an optimum way of exploiting available technologies as well as to drive their evolution in accordance to the needs of the NEM environment.

2.4.2.4. Distributed User Interfaces

Definition

Distributed user interfaces are user interfaces for which not only the content presentation, but also the user input and control are distributed over the networked environment. Different sets of input and output devices can constitute an environment.

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

By using physical interface devices, a more natural environment in which real-life stimuli for all the human senses are used, will give people more feeling of engagement. Multimedia content can be distributed to several interface devices. For example, screens show the major part of the audio-visual content, surround audio equipments present the background music, ambient lights create harmonious atmosphere, and robotic toys render the expressions and actions of a character to react on the multimedia applications.

State of the Art

For many years, the research and development of timed media technologies have increasingly focused on models for distributed multimedia applications, i.e., distributing content sources of a timed media presentation to the final user over a network. Distributed presentation interfaces in the user's home is another issue and the question of how to structure the system and content to support distributed interfaces for timed media applications is barely emerging.

Topics to be addressed

• **Context Dependent Interaction.**

For distributed user interfaces, the context encompasses the environment configuration, the application context, and the user preferences. Since the system platform can vary from, for example, a simple TV set with a set-top box, to a complicated home network environment, the configuration of such an environment is dynamic in both space and time dimensions. Furthermore, the user may activate or introduce new interface devices during a media show, the application has to "know" what kind of environment it is running on at every moment and has to adjust itself to fit the current environment, and the way of interaction may also depend on the application context.

• **Synchronized Media and Interaction.**

In an interactive media application not only the media, but also the interactions are timed and should be synchronized with each other. Furthermore, this has to be done in an environment, which consists of many interface devices. Multiple representations of the content or its parts should be distributed and synchronized on these devices according to their nature and the application semantics.

Key issues to be solved

Typical user interface structures for digital TV applications separate the graphical user interface (GUI) and the media content. Similar structures can be found in immersive broadcasting, for example, consumers can compose their own personal show from a variety of streams of audiovisual and graphics data. Conceptually, video clips, text and graphics are overlaid on top of the TV program to provide a richer and more compelling experience for the viewer. However these structures have no possibilities whatsoever for content presentation on multiple networked devices and distributed interfaces.

2.4.2.5. 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 spectacles, 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 analogue 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 are many 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 are many 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.

2.4.2.6. Transducers (Sensors & Actuators)

Definition

Very broadly, transducers are meant as all kind of artificial devices able to capture and reproduce human perceptible status. They include sensors and actuators for human senses: audio, video, taste, smell, tact, and for other parameters (position, motion, force, etc...).

In a "connected" and "digital" world such transducers well coupled with networks and content repositories, help more and more to approximate the "real" interactive experience in situations where the user is not co-located with the real environment (people and real world).

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

The main objectives are:

- significantly enlarge the set of human parameters and "senses" that can be detected, digitally manipulated and rendered by consumer transducers
- Evolve transducers and device/resource management architectures to support the evolution from mono-device (few senses) service experience to a rich multimedia experience achieved by coordination of multiple transducers.

State of the Art

Today the only class of transducers that can be considered relatively mature and massively deployed (even in very specific shapes) are the Audio/Video ones together with very specific haptic (input) ones (IR remote controls, keyboards, mouse/joystick).

They commercially appear in different packages, ranging from almost bare transducer (a video PC monitor) to complete devices (cell phones).

No significant commercial presence is recognizable yet of other transducers for taste, smell, tact.

2.5. ENABLING TECHNOLOGIES

When building an end-to-end solution for seamless service provisioning, certain functionality needed can be located in different instances. As they may be located in the service provisioning, the network itself or within the terminal, it is not straightforward to assign them to one of the proceeding section. The actual implementation depends on business models, existing infrastructure, partnerships etc. Also, there are technologies which require several components across the delivery chain. Therefore, such technologies are collected in this section with references to the previous ones.

2.5.1. Privacy and Trust

Definition

Services and its content must be provided securely to the consumer, potentially even between businesses 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 consumer (in particular the business customer) trusts his business partner for maintaining his privacy and for correctly handling the business issues – in particular payments. Without trust, no viable business is possible.

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 is typically realized 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.

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.

Broad-band, WiFi + UMTS and high computation power make nomadic terminal exposed to the same security threats as and more than PC. Virus, spamming, phishing, DoS are the most common techniques in use. Currently the approach of established PC security industry players is to port PC security measures to nomadic terminals.

There exist commercial solutions to help to identify and deploy security policies to be applied on network and security devices in order to comply with service and security requirements. COPS is a standard (RFC 4261) protocol designed to distribute clear-text policy information from a centralized Policy Decision Point (PDP) to a set of Policy Enforcement Points (PEP) in the Internet. There are solutions aimed to make easy for a user to set the security setting of the nomadic terminals according to a context (nomadic terminal features and user location) where the application for nomadic terminal is executed.

SIP (Session Initiation Protocol) is a standard communication protocol to support signalling over IP. SIP can be used for many services. The most popular and promising service supported by SIP is VoIP. A number of SIP vulnerabilities are known and the current approach to prevent SIP attacks is based on devices capable of recognizing and blocking a number of data patterns that characterizes some attacks. Privacy of communication is currently entrusted to some entities which are expected to reveal the association of communication data and content with the authors just when there are strong suspects of offence.

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.
- Early discovery" of new types and occurrences of attacks to nomadic terminal (nt) users. Some new specific terminal security threats are expected to affect nomadic terminals as credit and privacy are easier and much attractive target according to the increase in number and complexity of application software running on it. "Early discovery" of new types and instances of attacks must take place earlier than now because of the immediate and readily perceived bad effects on customers.
- Making the network resilient to exceptional peak of network traffic caused by a malicious behaviour of some users or by a bad configuration or undersizing of some network devices.
- Preventing some attacks to nomadic terminals taking into account the threats caused by any hostile device attached to the terminal or by a misuse of access level granted to the user who holds the terminal.
- Preventing VoIP user and proxy impersonation, message tampering, session tear down and denial of Service. Finding a trade-off between privacy, security and non-repudiation.
- 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.
- 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.

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.

An important aspect to be considered as well is 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.

Anomaly detection techniques must be developed and tailored on the kind of services and communication infrastructure for nomadic personal communication area. The most important network services must be provided by dynamically adapting the network devices security policy on the basis of the capacity provided by the available devices and the network "choke points".

The nomadic terminal security policy enforcing must be based on the evolving threat and vulnerability scenario as revealed by a number of information source. Finding a trade-off in the security measures so to achieve SIP efficiency and SIP security for VoIP.

A very interesting goal is to identify a technique to allow a user application communicate with a peer user application using statements according to a formally specified restricted language so that, as long as the statements chosen by the user are compliant with the specified language, messages cannot be associated to their sender (full anonymity), while the special processing output of the statement performed by the sender application is also a strong evidence that may be used to demonstrate (non-repudiation) who is the actual sender when the original statement does not comply with the specified restricted language.

Privacy and trust requires components both in the service provisioning platform, e.g. to ensure user data integrity and for payment, and the network to prevent interception. Trust is an extremely important asset when dealing with consumers.

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

The majority of content producing revenue today is protected by a contractual and infrastructural framework (DVDs 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 require 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 behaviour 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 makes of these contents while simultaneously preserving their individual and social rights.

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

There is a long way to go in this area at the technological layer, 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 (streaming of audio, video) still in a very immature state; innovating in concepts like portable licence or licences 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 needs. 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 lack some properties that may be interesting for Telcos: standards based, reusable on different platforms and in different 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 is 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, and 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

DRM requires interoperable components all over the delivery chain. The service provisioning must take into account which rights are assigned to content. The network must ensure integrity while the terminals must make sure, that the consumer has the rights to access a certain piece of content in a specific way. The "personal identification module" might play an important role in separating the rights from the terminal.

2.5.3. 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. Here, we will see a close relation between content and service creation and the capabilities emerging inside the terminals. An example, currently changing broadcast dramatically is the personal video recorder (PVR).

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. 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

Although several different standards are used for interactive services with digital TV, an interchange standard (portable content format - PCF) has been also defined. The only candidate for a common middleware for digital TV set-top boxes, MHP (multimedia home platform) is unfortunately beset by licensing problems and its success is now doubtful. A set of common middleware standards with reasonable usage conditions for a wider range of applications would be a worthwhile goal

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. Techniques such as MIMO (multiple-input, multiple output), which can offer higher capacity and more robust reception, should be investigated.

Digital switchover will yield a 'digital dividend' of released spectrum. Possible applications are more standard definition TV multiplexes, terrestrial broadcasting of HDTV, and TV broadcasting to mobile and handheld receivers. Handheld reception requires high field strength, so broadcasting to handheld receivers will require much denser networks of transmitters than used for broadcasting to fixed receivers.

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.

Standards for digital radio are available for Band III and L-band (DAB) and for the bands below 30MHz (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.

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.

2.5.4. 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. Significant work was recently devoted to scalable coding schemes in MPEG (SVC) with the central finding, that it is indeed possible to design scalable codecs with almost no performance loss compared to simulcast. Also first

attempts were made to develop descriptions for fast transcoding in the compressed domain (MPEG-21). However, those approaches require to be integrated into a complete infrastructure.

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, colour reduction, adaptation of number of audio channels, 2D/3D conversion etc.).
- Buffer models for real-time trans-coding (data rate must be changed seamlessly).

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 loosely 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 signalling. 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.

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).

2.5.5. 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.

A first taste of the challenges to come with heterogeneous services, networks, and terminals is the delivery of MMS, where MNOs are forced to implement transcoding units.

2.5.6. 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 behaviour, 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 behaviour 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 behaviour 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,
- 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.
- Collaborative definition of ontology for audiovisual contents coming from the community of relevant experts and collaborative viewers have to be taken into account in order to add more semantics and enrich the description of audiovisual content.
- Collaborative generation of metadata, such as collaborative tagging for audiovisual contents, is also a topic that should be addressed.
- 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 behaviour to changing situational conditions. Metadata seem to represent a key building block to achieve context awareness by enabling high-level context modelling/reasoning and context-dependent behaviour specification. Another emerging research direction relates to the possibility of integrating also metadata (rules) that dynamically limit the behaviour 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 modelling 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 decision engines, 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.

2.5.7. 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.

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.

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. The semantic analysis of very large scale document collections is not easy; techniques that work with 1,000,000 documents in laboratories may fail when dealing with more than 10,000,000,000 documents in the Internet.

2.5.8. 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 audiovisual (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.

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 (e.g.: news anchor) and speech-to-text transcription in very favourable conditions. Currently the analysis consists of the automatic determination of a set of low-level parameters forming feature vectors that are subsequently classified into meaningful categories.

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.

2.5.9. 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 behaviours, 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 modelling 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 Modelling Ontology (WSMO) and the Semantic Web Service Initiative (SWSI), which aim at overcoming some of the expressive limitations of previous modelling 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 behaviour. 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 behaviour. 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.

2.5.10. 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 modelling languages have to be developed.

2.5.11. 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 behaviour significantly. We need to go further in believable, expressive rendering, better co-articulation rendering and synchronization of

audio and Non Verbal Behaviour (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 assistants they can be Embodied Conversational Agents (ECA) with dialogue and non verbal behaviour capabilities. They can also be used to represent humans for inter-personal, collaborative applications (from professional applications to games). In any case they must convey information and be believable in the human-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 powerful 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.

2.5.12. 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 likely to be perceived by the user

over the head or behind. This causes many consumers to reject 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.

2.5.13. 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-lingual 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.

2.5.14. 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 (e.g.: vision, hearing/speaking, touch) or not (e.g.: 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 behavioural 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), behaviour 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.