Framework Programme 7

"Future Media Internet Coordination action"

Contract no.: 249065

Deliverable D1.2
Reports on organisation and results of the TFs and FCNs group meetings (Version 2)

Project Acronym	NextMEDIA					
ICT Project Number	FP7-249065					
Project URL	www.fi-nextMEDIA.eu					
EU Project Officer	Mr. Yorgos Kaifas					
Project Coordinator	**Name**	Federico Alvarez		**Affiliation**	UPM	
	Email	gcisneros@etsit.upm.es	**Phone**	+34-91 336-7344	**Fax**	+34-91 336-7350
Deliverable Name	Reports on organisation and results of the TFs and FCNs group meetings. Version 2.0					
Code name	D1.2					
Nature	Report		**Distribution Type**	PU		
Responsible Author(s)	**Name**	Maria Zampoka, Anastasios Zafeiropoulos, Petros Daras, Theodoros Semertzidis		**Affiliation**	CERTH/ITI	
	Email	daras@iti.gr	**Phone**	+30 2310 464160 ext. 277	**Fax**	+30 2310 464164
Abstract (for dissemination)	This document describes the activities of the Task Force and the FCN group					
Keywords	FMI-TF, FCN, FIA					
Contractual Date of Delivery	31/10/2011					
Status	Draft					
Quality assurance readers	Federico Alvarez			Theodore Zahariadis		
result	Ok			ok		

Table of Contents

EXECUTIVE SUMMARY

This deliverable 'D1.2: Reports on organisation and results of the TFs and FCNs group meetings. Version 2.0', describes the activities performed by nextMEDIA beneficiaries during the second year of the project's lifespan towards realising the first objective of the project:

- to support the current initiatives organised by the EC, such as the "Future Media Internet Task Force" and the "Future Content Networks" group and be the bridge between them and the other Future Internet Assembly groups (such as RWI, MANA, Identity & trust, FIRE)

In order to realise the aforementioned objective, nextMEDIA activities during this period can be classified into four main categories:

- Future Internet Assembly (FIA) - related activities
- Future Content Networks (FCN) - related activities
- Future Media Internet – Task Force (FMI-TF) - related activities
- FIA Book 2011 and 2012

The main highlights of nextMEDIA's work in the aforementioned groups are the following:

- Participation and organisation of BO Sessions in FIA Ghent, FIA Budapest and FIA Poznan.
- Coordination of the FCN group and input to FIA workshops.
- Development of a white paper (as an outcome of the FMI-TF).
- Participation in the editorial team of the FIA 2011 Book.
- Participation in the editorial team of the upcoming FIA 2012 Book.

Disclaimer

The NextMEDIA Consortium consists of the following partners:

No	Participant name	Participant short name	Role	Country
1	Universidad Politécnica de Madrid	UPM	Coordinator	Spain
2	ATOS Origin	ATOS	Contractor	Spain
3	Centre for Research and Technology Hellas	CERTH	Contractor	Greece
4	CREATE-NET	CREATE	Contractor	Italy
5	Queen Mary University of London	QMUL	Contractor	UK
6	Synelixis Solutions Ltd	Synelixis	Contractor	Greece

Partners list

1 INTRODUCTION

The aim of the 1st Activity of nextMEDIA is to coordinate and support the Future Media Internet related activities. Towards this aim two are the main objectives of the project:

- to support the current initiatives organised by the EC, such as the "Future Media Internet - Task Force" and the "Future Content Networks" group and be the bridge between them and the other Future Internet Assembly groups (such as RWI, MANA, Identity & trust, FIRE), and
- to set up and coordinate, together with the EC, a new think tank, namely the "Future Media Internet Architecture" Think Tank with the aim to reinforce the leadership of the EU in this field.

In order to realise the aforementioned objectives, nextMEDIA activities during this period can be classified in four main categories:

- Future Internet Assembly (FIA) related activities
- Future Content Networks (FCN) related activities
- Future Media Internet – Task Force (FMI-TF) related activities
- Future Media Internet Architecture – Think Tank (FMIA-TT) related activities

In each of these categories nextMEDIA had initially set SMART Objectives (SO), so as to better assess the progress of its actions. All of them are reported in detail, in this deliverable.

Finally, two more activities were initiated by the EC and nextMEDIA partners are heavily involved in. These are:

- FIA Architectures (FIArch)
- Future Media Internet Architecture (the final FMIA white paper is reported in D1.4)
- FIA Books 2011 & 2012

This deliverable describes nextMEDIA's progress in:

- Future Internet Assembly (FIA) related activities
- Future Content Networks (FCN) related activities
- Future Media Internet – Task Force (FMI-TF) related activities
- FIArch related activities
- FIA Books

2 Future Internet Assembly Workshops and FCN-related activities

During this reporting period, nextMEDIA was very actively involved in participating in the organization of the 6th FIA Workshop (16-17 December 2010, Ghent, Belgium). More specifically, Theodore Zahariadis (Synelixis) and Petros Daras (CERTH) are among the organizers of the BO Session "Search as an architectural component". Moreover, Federico Alvarez (UPM), Ebroul Izquierdo (QMUL), Theodore Zahariadis (Synelixis) and Petros Daras (CERTH) are participating in the organization of the BO Session "Architecture"

Moreover, nextMEDIA beneficiaries were active in contributing to the 7th FIA workshop which was held in Budapest, Hungary on 18-19 May 2011. nextMEDIA partner QMUL organised the session: "Interactive Media Experience". It should be noted that speakers and panelists of this session were members of the FMI-TF and the FCN group. Moreover, the FCN member UCL with the support of nextMEDIA organized the session: Information Centric Networking. nextMedia beneficiaries actively participated at this session.

Finally, nextMEDIA beneficiaries significantly contributed to the 8th FIA workshop which was held in Poznan, Poland on 25-26 October 2011. More specifically, Paul Moore (ATOS) was the organiser of the Session: "Networked Media Roadmap", where the results of the roadmap drafted in nextMEDIA was presented. Among the presenter has been Paul Moore (ATOS), Federico Alvarez (UPM), Theodore Zahariadis (SYN) and Oscar Mayora (CREATE). Tomas Piatrik (QMUL) was among the main speakers of the Session: Standardization - "Debate on the role for the standardisation WG ". Theodore Zahariadis (SYN) was among the organizers of the Session "Architectures" where he presented the FIArch results and the draft version of the "Future Internet Architecture Design Principles". Th. Zahariadis was also one of the chair and organizer of the FIA Poznan Closing Plenary panel "On Future Internet Architecture". Finally, Federico Alvarez (UPM) gave a presentation concerning the new FIA Book 2012.

2.1 FIA Ghent

The 6th FIA workshop was held in Ghent, Belgium on 16-17 December, 2011. nextMEDIA participated with its own stand with posters and leaflets and all consortium beneficiaries explained to the attendees the scope and the objectives of the project.

Two of the nextMEDIA beneficiaries (Petros Daras and Theodore Zahariadis) participated in the teleconferences organised by the EC towards orginising some of the BO sessions, which took place in Ghent. More specifically:

- Petros Daras (CERTH) and Theodore Zahariadis (Synelixis) were co-organisers of the BO session: *"Search as an architectural component; "*
- Theodore Zahariadis (Synelixis), Federico Alvarez (UPM), Petros Daras (CERTH) and Ebroul Izquierdo (QMUL) helped with the organisation of the BO session: *"Architectures"*

The organisation of the above mentioned BO Sessions implies selection and invitation of speakers, agenda preparation and set content of the sessions. Below the complete description of the "Search" session is given along with the outcome of the session.

2.1.1 Session VIII: Search as an architectural component

Chair: Loretta Anania (EC– DG INFSO),
Th. Zahariadis (Synelixis), J. Domingue (Open University), P. Daras (ITI), A. Galis (UCL)

Objectives

As the FIA activities evolve, it turns out that there are going to be different stratums that support the Future Internet. All these stratums have different types of resources and also virtual representations. At the network stratum, we may consider as resources the nodes themselves (e.g. routers, servers, printers, terminals, etc.) and their physical characteristics (e.g. processing power, network interfaces, routing capabilities, memory, caching capabilities, traffic, etc.). At the Service stratum, we may consider the services, the service components and their APIs and interfaces as resources. At the Content Stratum, the different types of content (e.g. text, pictures, voice, video of different types and formats, slices and sub) can be considered as resources. Finally, any piece of information or any application (including social networks and link open data links) may also be considered as a resource.

The initial objective of this session was to highlight the search and discovery issues of different resources at the different stratums. This is a very broad topic. Quite different mechanisms (even philosophy and language) are currently used to discover/mine, describe, index and retrieve resources at each stratum. Due to time restrictions, the session was focused only in the area of content searching and retrieval, which may be the most challenging ones as the content is and will grow much faster than any other resource and the search engines need in most cases to extract and combine information rather than just discover it.

Presentations

• Introduction and context	Loretta Anania	EC – DG INFSO
• Search as an architectural component: searching for a new paradigm	Francesco Nucci	Engineering
• Next Generation Search	Ricardo Baeza-Yates	Yahoo!
• Visual Search as an architectural component	Alexis Joly	INRIA
• Discussion	Moderator: L. Anania (EC) Panel: R. Baeza-Yates (Yahoo!) F. Nucci (Engineering) A. Joly (INRIA) J. Domingue (Open University)	
• Conclusions- Discussion	Loretta Anania	EC– DG INFSO

*The presentations are available on the FIA Ghent website (*http://fi-ghent.fi-week.eu/slides/*)*

Summary of Presentations

Search as an architectural component: searching for a new paradigm
(Francesco S. Nucci – Engineering R&D Lab, Director European Projects)

"Search" is not limited to everyday's experience of searching the web but it is a *must* feature of business intelligence applications for the enterprise. The size of digital archives has grown enormously in many application domains (e.g. enterprise, news agencies, TV broadcasters, advertising agencies,...) the characterization of their interactions (i.e. messages, events, etc.) and their distribution. Moreover, content is increasingly going to be Multimedia based: combinations of text, audio, still images, animation, video and interactivity into a single form. As a result and based on various analysis 50% of the applications will include a search facility as a primary interface for end users.
This need for search engines poses a number of challenges, namely:

- Lack of a unified framework for multimodal content search and retrieval
- Lack of Dynamic and Scalable Indexing techniques for searching over the network
- Lack of user-centric and context-aware S&R framework
- Lack of efficient tools for searching Intelligent Content

Dr. Nucci concluded that in the current Internet we are using some core services – such as search engines. Others, e.g., to provide geo-information, people search or social networking, have seen tremendous growth in recent years. Mostly we are using these services in isolation from each other, e.g., via independent websites and user interfaces. Some services – like search – are starting to become integrated but here a significant increase can be expected.

Next Generation Search
(Dr. Ricardo Baeza-Yates, VP of Yahoo! Research for EMEA & Latin America)
Content is increasing at very high rates. Even in 2007, the published content was more than 4GB per day, however the private data is even much higher (user generated content more than 80GB per day, private text ~3TB, upper bound of typed text ~700TB). This creates specific trends for search engines: User Generated Content (quality vs. quantity), Social Networks, Real time content creation (people + physical sensors). On the other hand also the search engines are evolving, moving from mining into text into identifying what are the user's task and context. This affects not only the retrieved information but also the way to present that to the users.
Dr. Baeza-Yates concluded that we are moving from a web of pages to a Web of Objects. Objects are people, places, businesses, restaurants … (named entities), which have attributes (missing, noisy, etc). Search engines should be intelligent enough to find and retrieve content objects based on the context and the user need. The key feature in search engines will be the user experience (information + presentation).

Visual Search as an architectural component
(*Alexis Joly, INRIA*)
Visual Search supports already very important applications such as TV channels/archives searching, copy detection (beyond DRM issues like contents links), large scale object retrieval. The next steps in visual search will be visual objects mining,

linking visual contents at the object level, visual query suggestion and visual based events tracking. The visual object's model in the Future Internet it is expected to have neither concepts nor low level features, but support visual objects represented as independent entities.

Panel Presentations and Discussions
Some conclusions based on the discussions are that the term "searching" has quite different usage and meaning in each stratum (networks, content, services). Moreover, there are quite different mechanisms to discover information, so we should be very careful as the term is evolving. On the other hand, it is obvious that discovery of resources should be inherently supported by Future Internet Architecture.

Another important topic was the conflicting issues between privacy, data security, personalization and user aggregation. Everyone agrees that privacy and security are very important issues. Yet, in order to increase the personalized behavior of the Search Engine more info has to be extracted so privacy is challenged.

Finally the issue of open source search was discussed and proposed as one of the lessons learned by Engineering in Pharos project.

2.1.2 Session V: Architecture Group

Chair: Isidro Laso Ballesteros (EC– DG INFSO), *Theodore Zahariadis (Synelixis)*

Objectives
The objective of this session was to present the activities of the FIArch group towards a Future Internet Architecture, collect feedback and comments from the FIA community and involve more experts presenting their point of view in the activities towards a Future Internet Architecture.
The FIArch Experts Reference Group is composed of representatives of the most relevant FP7 research projects in relation to FI architectures and renowned experts from industry and academy covering in a complementarily way all areas related to the Future Internet Architecture. The work of the group is coordinated by the FP7 CSA projects in the area of Future Internet and supported by the EC Units D1: Future Networks, D2: Networked Media Systems, D3: Software & Service Architectures & Infrastructures, D4: Networked Enterprise & Radio Frequency Identification (RFID) and F5: Trust and Security. The aim of the FIArch group is to focus on a few key architectural issues and contribute to an EC research roadmap towards Future Internet Architecture. As a first concrete step, the FIArch group has been working on the identification and categorization of the "Fundamental Limitations of Current Internet" that could eventually prevent a good functioning of foreseen Future Internet applications.
In this FIA session, the current progress was presented and feedback from the FIA research community was received.

Presentations

• Introduction and context	Paulo de Sousa	EC – DG INFSO
• Rationale and Methodology	Dimitri Papadimitriou	Alcatel-Lucent
• Fundamental Limitations of Current	Theodore Zahariadis	Synelixis

Internet		
• Internet Architecture and Innovation	Isidro Laso Ballesteros	EC– DG INFSO
Open forum (5 minutes each): • R. Nejabati (University of Essex) • W. Colitti (Vrije Universiteit Brussel) • W. Burakowski (Warsaw University) • Ioan Toma (STI)	Moderator: F. Alvarez (UPM) Panel: D. Papadimitriou (Alcatel-Lucent), S. Haller (SAP) H. Tschofenig (NSN) J. Clarke (TSSG) L. Nixon (STI International) P. Moore (Atos Origin)	
• Next steps and wrap-up	Isidro Laso Ballesteros	EC– DG INFSO

*The presentations are available on the FIA Ghent website (*http://fi-ghent.fi-week.eu/slides/*)*

Summary of Presentations

Rationale and Methodology (Dimitri Papadimitriou)
http://fi-ghent.fi-week.eu/files/2010/12/1435-Dimitri-Papadimitrio.pdf

The global Future Internet is a complicated structure that cannot be created by a linear process of engineering and technological design. In order to identify the Fundamental Internet Limitations, the FIArch group is following a 4 steps methodology. Step 1 is to identify the motivations and the design objectives of the FI Architecture, Step 2 is to define common architectural principles, step 3 is to specify the architectural components and finally Step 4 to put all components into a common model. The goal is to identify what an architectural "limitation" is and characterize it with quantitative and qualitative arguments.
FIAch has defined as ***"fundamental limitation"*** of the Internet architecture a functional, structural, or performance restriction or constraint that cannot be resolved with current or clearly foreseen paradigms as far as our understanding/knowledge goes. On the other hand, ***"challenging limitation"*** is a functional, structural, or performance restriction or constraint that could be resolved (as far as our understanding/knowledge goes) by replacing and/or adding/removing a component of the architecture that would in turn change the global properties of the Internet architecture. Moreover, the following terms have been used: "***data"*** to refer to any organized group of bits a.k.a. data packets, data traffic, information, content (audio, video, multimedia), etc., and "***service***" to refer to any action performed on data or other services and the related API.

Currently FIArch has made progress in Steps 1 and 2, and the next challenge is Step 3, which will identify the architectural components (i.e. procedures, data structures, state machines, etc.) together with the characterization of their interactions (i.e. messages, events, etc.) and their distribution.

Fundamental Limitations of Current Internet (Theodore Zahariadis)
http://fi-ghent.fi-week.eu/files/2010/12/1445-Zahariadis-FIArch-Ghent-20101215.pdf
Since its creation, the Internet is driven by a small set of fundamental design principles rather than a formal architecture that is created on a whiteboard by a standardization or research group. Moreover, the necessity for backwards compatibility and the trade-off between Internet redesign and proposing extensions, enhancements and re-engineering of today's Internet protocols are heavily debated. FIArch has tried to identify and

analyse the presumed problems and limitations of the Internet starting from the basic networking layers upwards.
The emergence of new needs at both functional and performance levels, the cost and complexity of Internet growth, the existing and foreseen functional and performance limitations of the Internet's architectural principles and design model put the following base functionalities under pressure:

- ***Processing/handling of "data":*** refers to forwarders (e.g. routers, switches, etc.), computers (e.g., terminals, servers, etc.), CPUs, etc. and handlers (software programs/ routines) that generate and treat data.
- ***Storage of "data":*** refers to memory, buffers, caches, disks, etc. and associated logical data structures.
- ***Transmission of "data"***: refers to physical and logical transferring and exchange of data.
- ***Control*** of processing, storage, transmission of systems and functions: refers to the action of observation (input), analysis, and decision (output) whose execution affects the running conditions of these systems and functions.

The fundamental limitations in each one of these categories were presented. Moreover the high-Level and low-level Design Objectives were highlighted. The conclusion was that extensions, enhancements and re-engineering of today's Internet protocols may solve several challenging limitations. Yet, addressing the fundamental limitations of the Internet architecture is a multi-dimensional problem. Improvements in each dimension combined with a holistic approach of the problem space are needed.
More info on the FIAch work may be found at:
http://ec.europa.eu/information_society/activities/foi/research/fiarch/index_en.htm
http://ec.europa.eu/information_society/activities/foi/docs/current_internet_limitations_v9.pdf

Internet Architecture and Innovation (Isidro Laso Ballesteros)
http://fi-ghent.fi-week.eu/files/2010/12/1515-ISIDRO_IA-and-Innovation.pdf
This presentation was based on a paper prepared by an industrial driven task force from the Future Internet Architecture Group. It contained information about different, and sometimes contradictory, viewpoints about the evolution of the Internet Architecture. The key message of the presentation is that the Internet Architecture is a new policy tool (no longer only a matter of techies) and that it could be used by policy makers to shape the future EU economy by favoring some industry sector while perhaps hindering others. The presentation reviewed a number of application areas (telephone, eCommerce, Social Networks, community-driven content, collaboration environments, Web-based business services, cloud-based enterprise computing, on-line banking, etc) and highlighted how the innovation is hindered by current interner architecture.
The presentation concluded that the decision makers need to know the importance of Internet architecture for all economic industries. The evolution of the Internet affects all economic actors, benefiting some industrial players while perhaps hindering others. Thus any steps taken towards modifying the Internet, whether in terms of technology and architecture or whether in terms of governance can be seen as a policy tool for modifying the economic situation in Europe. We must be aware of the tradeoffs that any changes in the Internet may bring. An increase in security on the net could, for example, foster innovation in health or policing or citizen services. But, unfortunately, this

increase in security could hinder innovation in some other areas such as social networking, peer-to-peer or content aware networks.
Some of the issues to be taken into account for future Internet design include:

- Measure and comprehend before considering modification of successful principles
- Quality of Service for Critical Applications
- Relaxed Layering and Security
- A Framework for Intermediary Common Services
- Transport Layer Innovation
- Application Component Eco-System for Continued Application Innovation
- Long-Term Disruptive Approaches

Policy makers should consider these and other Internet architectural design decisions and considerations, as another possible policy tool that can have far reaching positive effects in the European economic space and that allow innovation to increase leading to more and better jobs for Europeans.
More info may be found at:
http://ec.europa.eu/information_society/activities/foi/library/docs/p3-aiai-2010.pdf

Panel Presentations and Discussions
The panel was moderated by Dr. Federico Alvarez and interested members of the audience presented their point of view. Among the one that had expressed their interest:

- R. Nejabati (University of Essex)
  http://fi-ghent.fi-week.eu/files/2010/12/1535-2-Reza-Nejabati_sfv2.pdf
- W. Colitti (Vrije Universiteit Brussel)
  http://fi-ghent.fi-week.eu/files/2010/12/1535-3-presentation_fia_colitti.pdf
- W. Burakowski (Warsaw University)
  http://fi-ghent.fi-week.eu/files/2010/12/1535-4-System-IIP-FIA-Ghent-ver1.pdf
- Ioan Toma (STI)
  http://fi-ghent.fi-week.eu/files/2010/12/1535-5-SOA4All-FIArch-Ghent2010.pdf

Some conclusions based on the discussions are that the Future Internet Architecture should be designed very carefully in order to ensure global acceptance. Flexibility should not be sacrificed in the pursuit of performance, while security will play a very important role. This means that the model for the Reference Architecture should not sacrifice the openness of the internet and its ability to evolve in order to get short-term performance.

2.2 FIA Budapest

During this reporting period nextMEDIA beneficiaries were active in contributing to the 7th FIA workshop which was held in Budapest, Hungary on 18-19 May 2011. nextMEDIA partner QMUL organised the session: Interactive Media Experience. It

should be noted that speakers and panelists of this session were members of the FMI-TF and the FCN group.

Moreover, the FCN member UCL with the support of nextMEDIA organized the session: Information Centric Networking. nextMedia beneficiaries actively participated at this session. Finally, nextMEDIA participated in organization of the standardization session where nextMEDIA outcomes and supporting activities in standardization has been presented.

Minutes from these workshops are given in this section.

2.2.1 Interactive Media Experience

Organizers of the session were: Prof E. Izquierdo, G. Feher

Prof. Ebroul Izquierdo made an introductory presentation for the session and presented the Keynote speakers. The first keynote speech was from ***Prof. Nandia M. Thalmann*** (University of Geneva, Switzerland), entitled "Virtual Humans". Prof. Thalmann presented the work of their lab on virtual humans and autonomous agents towards a new approach of not just 3D models of humans but fully functional entities.

- user centric wearable
- presents some visionary scenarios
- the wearable interacts to all electronic devices around us
- augmented i-jacket-> -using i-glasses gets input (and also gets 3D augmented data - e.g. a child running there ...)
- also the i-jacket gets input (visual, auditory, tactile)

The second talk was given from ***Prof. Peter Eisert*** (HHI, Germany) about "3D video Processing". In the presentation various technologies of 3D processing where presented towards a more ubiquitous 3D video applications.

The third keynote speech was given from ***Peter Kovacs*** (Holografika, Hungary), entitled "3D Media accessibility through mobile devices".

Finally, a panel discussion moderated ***from Prof. Noel O'Connor*** took place. The panelists where: ***Nadia M. Thalmann*** (University of Geneva, Switzerland), ***P. Eisert*** (HHI, Germany), ***Z. Korcsok*** (iPont, Hungary), ***P. Kovacs*** (Holografika, Hungary), ***E. Izquierdo*** (QMUL, UK), ***G. Feher*** (BME, Hungary)

Most of the discussion was about the autonomous virtual humans and the virtual identity that all avatars should have in order to act on behalf of the actual human user. Part of the audience was also interested to learn more about the future of holographic technologies presented by Holografika.

2.2.2 Information Centric Networks

Organizers / moderators of the session:

- George Pavlou, University College London, UK. (g.pavlou@ee.ucl.ac.uk)
- Spiros Spirou, Intracom Telecom, Greece. (spis@intracom.com)

The session started with an introductory presentation from George Pavlou about the state of the art on Information Centric Networking and definitions on the area. Then he pointed out some key issues for the future Internet.

- The network grows to an unmanageable size
- Even if optical fiber infrastructure is wider the network reaches its limits
- CDNs and p2p: make the server totally transparent to the user. This is the first step towards the information oriented communication
- Current content naming and security issues. Replication is not easy. We need transparency.
- Another issue is the security of the actual content and not the channel though which we transfer the data (current practice)
- Paradigm shift. From resources sharing to sharing content.
- We should also support not only content access but also services, voice etc.

Challenges

- Scalability
- Security
- Manageability
- Incremental deployment
- Novel business models

Then, each one of the panelists made a 5-min position statement on high-level issues of ICN. The panelists where: ***Prof. Torsten Braun*** (University of Bern, Switzerland), ***Prof. Ebroul Izquierdo*** (Queen Mary University, UK) and ***Bruno Kauffmann*** (R&D Engineer, FT/Orange, France).

Next, a moderated discussion took place, with Q&A between moderator and the panelists.

Finally, EU projects presented their position statements. The EU projects presented are:

- ALICANTE, Evangelos Markakis, Technological Educational Institute of Crete, Greece.
- COMET, Francisco Javier Ramon Salguero, Telefonica R&D, Spain.
- CONVERGENCE, Andrea Detti, University of Rome Tor Vergata, Italy.
- ENVISION, Miguel Rio, University College London, UK.
- PURSUIT, Arto Karila, Helsinki Institute for Information Technology, Finland.
- SAIL, Börje Ohlman, Ericsson Research, Sweden.

Synelixis was represented by Nikos Nikolakis. The main discussion was on the decision evolutionally vs. revolutionary architectures on ICN. Most of the participants agreed that an evolutionary approach is viable since none of the big Internet companies would like to through all their costly equipment away.

2.2.3 Standardisation Session

Organizers / moderators of the session:

- Franc Le Gall; f.le-gall@inno-group.com
- Jean-Charles Point; pointjc@jcp-consult.com

Agenda

5 min	Agenda and session objectives	F. Le Gall (inno)
60 min.	Possible "cross-cutting" pre-standardisation tracks: **Introductory speech: landscape of pre-standardisation and standardisation, possible paths for projects (15-20 min)** · IoT research and standardisation	Mod. : Jean Charles Point (JCP Consult) Didier Bourse (Alcatel Lucent) Patrick Guillemin (ETSI, Strategy and New Initiatives), IERC, CASAGRAS2,
	· Management and Future Networks	Alex Galis (UCL) - UniverSELF
	· Cloud computing	Daniel Field, (Atos Origin) –SIENA
	· Architecture	Dimitri Papadimitriou (Alcatel-Lucent)
	· Media	Tomas Piatrik, NextMEDIA
35 min	**Closing panel**: Pre-Standardization on Future Internet. Does it have to be exclusively at any specific entity? Which of the tracks look most promising? Are the chosen tracks too broad, should they be more focused? Are there too many tracks? Role of contributing projects in the decision process	Mod. : Franck Le Gall Dimitri Papadimitriou (Alcatel-Lucent) Henrik Abramowicz (Ericsson) + open discussion
10 min	**Conclusions and further work**	Franck Le Gall

Session Outline

The FIA Conference in Valencia 2010 raised the importance of standardisation as an exploitation path for Future Internet research but also highlighted the need for specific standardisation methods so called pre-standardisation, which offer a lighter and iterative process better tailored to interactions with the research community. Since then, a undefined FISA standardisation working group has been formed with the objective to coordinate standardisation related activities at FIA level. At its kick-off, in undefined

ICT2010 , it underlined the fact that the (pre)standardisation process goes well beyond project timeframe so the projects do not directly 'produce a standard' but can only contribute to standardisation activities which has to be run and maintained independently, in standard forming groups. This implies long term individual commitments of organisations (academic and industry) to these standards forming groups.

Session outcome

The session focused on the issue of pre-standardisation, which is the main interest of most R&D European projects; standard bodies have well identified this need by creating pre-standard or incubator groups within their structure. The session tried to answer some questions related to Future Internet pre-standardisation: how to increase the contribution of research projects to the pre-standardisation process, what should be pre-standardised in the short term, where and in which timeframe?

The main organisation addressing to Future Internet issue is IRTF; as examples, ETSI has recently successfully set-up ISGs; ITU and W3C have created focus groups / incubator groups. The purpose of the session was to identify a number of pre-standardisation topics in the area of Future Internet that are general enough to attract many industrial participants and yet strict enough to come out with pre-standards in a reasonable time.
In order to reach this goal, the session first reminded the different paths to technology adoption through pre-standardisation and then looked at operational and pragmatic approaches increasing the contribution of research to valuable (pre)standards. After this a number of candidate pre-standardisation topics have been be presented, coming from the FIA community. Didier Bourse first reminded that to be successful, a standard need to have the support of industry and match the timing and needs of the market. The following presentations allowed identifying that pre-standardisation activities permit to explore different pathways, so increasing chances to meet the previously defined requirement. The work of FIarch on Future Internet architecture was presented by Dimitri Papadimitriou; he required the collaboration of the different FI areas to succeed to define a generic architecture. Before initiating the panel session Henrik Abramowicz reminded general observations for a standardisation process to be successful.

During panel, the need to clearly identify what is meant by Future Internet standardisation has been questioned and no consensus was obtained. While a majority of panellist were thinking that this would be a lengthy and inefficient effort, Alex Gallis defended the need to clearly differentiate the Current Internet from the Future one and advocated the classification efforts having been made in ITU. Tomas Piatrik (QMUL) has presented nextMEDIA role in the FISA support group and underline nextMEDIA achievements in FIA sector, including all nextMEDIA organized Working discussions groups. Furthermore, he presented NextMEDIA analysis results of interests in standardization from the project in Networked Media sector. The conclusions from the closing panel identified the pre-standardisation tracks that should be the main focus for the further collaboration.

2.3 FIA Poznan

The 8th FIA workshop was held in Poznan, Poland on 25-26 October, 2011. All consortium beneficiaries participated to this workshop.

The agendas of the session along with their descriptions, where nextMEDIA beneficiaries were either organisers or speakers are given below.

2.3.1 Session 5: The future of Networked Media and the Internet: Facts, Reflections and the Road Ahead

Chair of the Session – Paul Moore (Atos)
Shepherd of the Session – Christophe Diot (Technicolor)

Session Outline
The session divided into several parts where specific areas dealt with in more detail with the perspective of 2 different speakers in each followed by a Q&A session with the audience.

Introduction - Paul Moore (Atos, Spain) representing the Coordination Action NextMedia presented the different speakers and set the scene.

Architecture - Krzysztof Kurowski (PSNC Poland), Theodore Zahariadis (Synelixis, Coordinator FIArch Working Group)
In this section different perspectives on the needs and requirements and future evolution of Future Internet Architecture e presented. In order to get software performance and scalability, algorithms and application characteristics as well as the hardware and interconnect architectures must be designed and applied in harmony, especially when networked multimedia platforms are considered. Should the FIArch be evolutionary or revolutionary (or both)?

3D – Krzysztof Kurowski (PSNC Poland), Ebroul Izquierdo (QMUL, Coordinator of NoE 3DLife)
Virtual worlds, 3D video, 3D multiview, simulators, gaming, etc. are now a part of everyday life for many people on the Internet but there are still many, many very difficult challenges whether in terms of search or network efficiencies or real time rendering, etc. This session examined future scenarios and challenges in the area of 3D.

Connected TV - Ralf Neudel (IRT, Editor "NEM Strategic Research Agenda "), Federico Alvarez (UPM, Coordinator of NextMedia)
In this session, the focus was put on portraying the evolving landscape of Connected TV in Europe. A technology overview was presented and the current market situation in Europe explained including a quick outlook on future trends and open challenges in this domain.

Social Media - Oscar Mayora (Create-Net), Paul Moore (Atos)
It is becoming more and more difficult to clearly separate the social networks from the media internet. Google is Google search but it is also Youtube and Google+. Facebook's goal is to become the gateway to internet media (Spotify and Netflix now available from inside Facebook for example.) Is Daily Motion a social network or a video platform? Social media are rapidly expanding to business media as companies

come to realize the power and efficiencies of social media to resolve many of today's business problems.

Business Models and Wrapup - Paul Moore (Atos)
More and more the question of business models is coming to the fore in any discussion of the Future Media Internet. The battle between Apple, Google, Facebook, Amazon, etc. for the hearts and minds (but especially wallets!) of internauts over the next 10 years is partly a struggle for technological supremacy but just as important will be the struggle for business model supremacy.

Session outcome
The results of a questionnaire survey were presented, which revealed the fact that Research Challenges such as "*3D content generation leveraging emerging acquisition channels*" and "*Immersive multimedia experiences*" appear to be in the mid-term future interest while "Content with memory and behaviour" is believed to be a challenge in the long-term. In order to support such technologies, the network design has to adapt 3-D content, link different heterogeneous devices and create new models for content distribution involving social and user contextual aspects.

Moreover, bringing rich-media experience to home users, the "Connected TV" conception has to deal with many different challenges in order to become a standard in the TV industry. Hybrid Broadband TV can deliver the specifications to this field of research. Currently, only 3 EU countries are operating the HbbTV technology while there exist 7 more where they are on a trial or service-announcement phase.
Finally, an extended talk was given for a "Participatory Sensing World" of an IoT network where the Real World and the Online World should be bridged. The huge amount of user data that is available through billions of mobile devices and different social networks, like location, activities, posts to social networks, surroundings environment, behavior etc., can lead to new application scenarios and emerging technologies like management of emergency services, monitor of environment and pollution, healthcare, games and entertainment

2.3.2 Session 1.3: Standardisation

The workshop was split in 2 parts. The first half contained traditional presentations and a roundtable discussion. The second half focused on interactive discussion and edition of the on-line website.

Problem Statement and Objectives of the workshop

- Purpose of the workshop was to:
- Review progresses of the FIA standardisation working group
- Review strategic objectives of the working group
- Debate on the available on-line content
- Suggest next steps

Session organisers:
FIA standardisation Working group
(http://fisa.futureinterneteu/index.php/FIA_Standardisation_Support)

Target audience:

- Industrial participants of research projects
- Standardisation development organisations
- European Technology platform members and representatives
- Projects clusters members and representatives

Agenda

Part I: FIA standardisation working group – review of progresses and context evolution

- FIA standardisation WG: review of objectives and progresses, Didier Bourse, (Alcatel-Lucent)
- The Future Networks cluster activities: Key take away, from ETSI Future Networks technologies workshop #2, Gaby Lenhart (ETSI)
- 15 min FI PPP plans for standardization coordination, Mikko Riepula (TivitAalto)
- Interacting with ETPs, Walter Waterfeld from NESSI
- Debate on the role for the standardisation WG, Tomas Piatrik, (QMUL)

Part II: Collective review of on-line content

- Organisation and purpose of web content Lyndon Nixon (STI International)
- Interactive review of website content: fitting presentation to project needs, Jean-Charles Point (JCP Consult)
- Concluding remarks Franck Le Gall (inno)

Session outcome

The main goal of the session was to answer some important questions related to Future Internet pre-standardisation: what are the good practises and traps to be avoided to exploit research results through standardisation activities, what are the foreseen contributions (roadmap) of research projects to pre-standardisation activities, and what interactions should be built at FIA level?

Didier Bourse started the session by recalling the history of the FIA related activities and the general context. He reminded that to be successful, a standard need to have the support of industry and match the timing and needs of the market. The following presentations allowed identifying that pre-standardisation activities permit to explore different pathways, so increasing chances to meet the previously defined requirement.

Gaby Lenhart (ETSI) presented the Future Networks cluster activities in ETSI and the outcome of the ETSI Future Networks Workshop. Jani Kaarlejarvi (Tivit) presented FI PPP plans for standardisation coordination. It was agreed that direct drafting of standards by projects is not the only way to go. There is a need to provide proofs of concept, technical validation and evaluation of testability for developing standards and that test platforms such as the one provided under the FIRE initiative or the upcoming FI-PPP may play a key role in the future. Complementarities with the work set-up by Standard Organisations to welcome research work such as IRTF or ETSI ISG could be seek in that respect and is certainly to study further. Finally it was highlighted policy requirements are also an important driver to produce standards.

Tomas Piatrik (QMUL) has closed the main part of the session presenting the goals of the FISA group and the road ahead. He highlighted the benefits that community can get from the support group in creating standards. To give an example of creation process ,

he presented some existing and recent standardisation groups from NextMEDIA expertise such as IETF CDNI WG and ETSI ISGs. The focus of this part of the presentation has been put on the NextMEDIA proposal on creating the ETSI ISG on Future Internet Architectures. The presentation has triggered long discussions from the audience about the role of the standardisation WG and future steps. During these discussions, the need to pursue pre-standardisation related awareness raising actions has been underlined. The objective to rapidly document the situation has been set to the FIA standardisation working group. This mapping exercise needs to be achieved in partnership with projects' clusters and European Technology platform activities. It has been recognised that Future Internet standards are made from a myriad of inputs and that direct contribution from projects is essential to achieve all these goals but also that these could not happen without a business understanding within projects.

2.3.3 Session 2.4: Architectures

Future Internet Key Architectural Challenges

Session organisers: Theodore Zahariadis (Synelixis, Greece), Dimitri Papadimitriou (Alcatel-Lucent, Belgium), Alex Galis (UCL), Bernhard Plattner (ETH, Switzerland), Paul Smith (ULANC, U.K.), Laurent Ciavaglia (Alcatel-Lucent, France), Gerard Nguengang (Thales, France), Panagiotis Demestichas (University of Piraeus, Greece), Miguel Ponce de Leon (TSSG, Ireland)

Problem Statement and Objectives of the workshop

Society increasingly depends on communication networks in general and the Internet in particular, for just about every aspect of daily life. Consumers use the Internet to access information, obtain products and services, manage finances, and communicate with one-another. Businesses use the Internet to conduct business with consumers and other businesses. Nations rely on the Internet to conduct the affairs of government, deliver services to their citizens.

This session presented 4 key architectural aspects for Future Internet (FI) followed by a panel on the key design tasks in FI research and development: FI functional elements; key architectural challenges; main tussles in FI; how to evaluate an architecture for FI. The results of this session are planed as a research orientation for the FI design. The 4 presentations are as follow:

1. "Design Principles for Future Internet" - This presentation will start from the current Design Principles that govern the Internet and analyse which are still valid and are challenged. Then based on the FIArch group work, it will try to analyse and argue which Design Principles should be preserved, which should be modified/adapted to the Future Internet foreseeable needs and which seeds of new principle(s) could govern the next steps towards the Future Internet Architecture. The aim of this presentation is to provide to the FIA community the progress of the FIArch group and collect feedback/comments.

2. "The Importance of Resilience in the Future Internet: Framework, Mechanisms

and Experiments"- With this increasing dependence on the Internet the consequences of networked service disruption become more significant. The personal and professional life of individuals, the economic viability of businesses and organizations, and the security of nations are directly linked to the resilience, survivability, and dependability of the Global Internet. Ironically, the higher dependence on services renders Internet more vulnerable to problems. Mobile wireless Internet access is more susceptible to the challenges of time-varying, weakly connected channels, and unpredictable delay. The Internet is an increasingly attractive target to recreational crackers, industrial espionage, terrorists, and information warfare. In the same time, it is recognised that the Internet largely relies on isolated tweaks and patches, rather than on coherent systematic approach, to cope with these challenges. In this presentation, we will address this issue and introduce a framework for quantifying the impact of different types of challenges and failures on normal network service operation. Resilience metrics and classes of network resilience and policies to control and increase resilience will be discussed. The outcome should ease the understanding of network engineers about resilient networks and services. The talk will also look into mechanisms and algorithms that should become part of a network infrastructure so that the requirements identified at the framework level are met. We will also describe the currently on-going and planned experiments that eventually will show the viability of our approach.

3."Management of Future Internet" - It is commonly recognized that traditional network management schemes are not the most efficient approach for addressing the complexity associated with the Future Internet. Autonomics, applied in network and services management, appear as the most viable way forward. However, despite the significant research efforts and achievements in this field, the adoption is not yet as widespread as it could be. In this direction, a pragmatic approach is to start by addressing actual manageability problems encountered by operators (this is the approach taken currently by the EC project UniverSelf). The tackling of operators' problems can lead to a Unified Management Framework (UMF). This presentation will provide a concise description of the UMF design in terms of core, reusable and cohesive functional blocks and interfaces, which derive from operator problems and high-level principles and goals, such as the unification/federation of diverse autonomic solutions and technology domains, the governance of autonomic infrastructures and services, as well as the embodiment of autonomic solutions (intelligence) into the management ecosystem. The talk will address the relation of UMF with various legacy network management standards and emerging concepts like: Self-Organising Networks, Autonomic/Cognitive schemes, etc. The talk will present UMF features that are essential to be present in the Future Networks architecture.

4. "Experiences with Implementing RINA - Recursive Inter Network Architecture" - The Internet is only a network of collaborating networks, a catenet, a concatenation of networks. It is not an efficient inter process communication system as it has missed the key property of layering that early researchers/developers had understood in the late 70's. The Internet sees layering primarily as a means for creating modules within a system. And while it is true, that the concept of layers came from its use in operating systems for this purpose, the use of layers in networks is far more fundamental. The distributed nature of layers in networks creates the major and dominating property not found in a single system "a layer is first and foremost a locus of shared state, of a given scope across multiple systems". This is why the more we look

at the nature of layers in the Internet, the more we find signs that the Internet is a variant of the telephony beads-on-a-string model. It is fundamentally not a layered architecture, it is the DOS of its time. With RINA [we are more interested in investigating an Internet of collaborating networks. RINA adopts the principle that "networking is interprocess communication (IPC) and only IPC", as all the entities executing in computing systems are processes, networking can be seen as distributed inter-process communication. Although in the Internet for many years, a layer was synonymous with a single data transfer protocol of some form, RINA recognises that it is important to have both network management and layer management.

This talk aims to raise questions about our knowledge and assumptions of a new modern networking platform, while seamlessly leaving the old Internet intact. It shall also show the many benefits of implementing RINA in a cloud computing environment, which include, bounding router table size, allowing mobility and multicast to scale, and highlight better security and data management.

Agenda
Introduction FI Architectural Topics and Systems

- "Design Principles for Future Internet"
- "The Importance of Resilience in the Future Internet: Framework, Mechanisms and Experiments"
- "Management of Future Internet"
- "Experiences with Implementing RINA - Recursive Inter Network Architecture"
- Panel Q&A - what are the key design challenges in Future Internet research and development

Session outcome

The Architecture of the FI should be designed by principles which follow Software Engineering rules where the infrastructure embeds intelligence, is programmable and is Software Defined. Current network model relies on uncoordinated internet nodes where the intelligence is located at the ends, so the KISS principle (Keep It Simple, Stupid) should be replaced by the KII (Keep It Intelligent). Moreover, ITU-T Y.Recommendation 3001 has to be met, where "Future Networks" are Service, Content, Data and Environment –Aware. Resilience is another key aspect that FI should follow and in order to achieve this, information among the infrastructure should be shared, rising new issues regarding privacy and energy concerns. This way, trade-offs may need to be made with respect to resilience.

In order to manage and monitor the FI, a Unified Management Framework is been proposed by the UniverSelf Cosnortium . UMF is a framework that will help to produce the unification, governance, and "plug and play" of autonomic networking solutions within existing and future management ecosystems. It includes a repository of guidelines, patterns, models, specification and IT tools to support the development of UMF compliant systems. UMF will have impact on Telecommunication Operators, as it enables the management of complex networks, services and automated processes; to Vendors: as it enables the design of hardware and systems that can easily and quickly

being integrated with third-party systems; and to the System Integrators: as it facilitates the integration of new hardware and software elements into the telco operators' environment.

Next, a recursive approach of using network structures that implement the Inter Process Communication standard, called RINA, was presented which uses recursive layers under the assumption that the ends are relative. There is a separate mechanism from policy which supports multiple functions. Also design principle for complete naming scheme and addressing architecture supports mobility and multihoming. Security, integration of connectionless and connection-oriented networking and separation of port allocation from synchronisation in the transport protocol are principles that the RINA approach uses.

Finally, in this session, participants had the chance to vote and provide feedback to the FIArch group experts regarding crucial questions on Network Design Principles and Challenges. Management took the majority of participants' votes as the main FI functional element, followed by service awareness and content/data awareness. Functional flexibility/elasticity was voted as the most important key characteristic architectural challenge followed by virtualization of resources and optimization. The main tussle that was pointed by this voting was economics vs functionality vs extensibility.

An interesting discussion took place in the final section which was mainly concentrated on the different issues that need to be addressed during implementation. Security was a concern about the new design principles and how will be it implemented in order to protect the network and its privacy. Moreover, will computational resources of low-end devices with limited capabilities be adequate to implement IPC-based, RINA approach? All panelists agreed that advancing from design to implementation phase, will definitely require a lot of time. RINA however is proved to work, under early implementation in test-beds.

It is worth to mention that a Bluetooth voting system was set up, so that each participant could express his/her opinion by voting at one multiple-choice question after the end of each presentation.

2.3.4 Closing Panel: Future Internet Architectures

Panel moderator: Theodore Zahariadis (Synelixis)

Problem Statement and Objectives of the workshop:

Currently there are two approaches towards Future Internet: the evolutionary one, which considers an evolution of today's Internet and the revolutionary (or clean slate) one, which foresees Future Internet having radical different characteristics and structure of what we consider as "internet" today. Each approach has the advantages and disadvantages, the pros and cons, the arguments for and against.

Yet, it is a common belief that Future Internet should have some inherited characteristics such as "openness", "security" and "flexibility" and support new innovative applications and services that range from immersive personalized communications to critical infrastructures and energy grids network support. The purpose of the session is to analyse which characteristics of the Future Internet Architecture should be fundamental.

Initially, the moderator will initiate the session and introduce the 4 invited speakers. Then the invited speakers will present the Future Internet Architecture from 4 different points of view:

- Dr. Dimitri Papadimitriou (Alcatel-Lucent) will present his point of view on the Future Internet Architecture, as it is constrained by a network-wide/global-level architecture.

- Dr. Pau (UCLA) will consider some networking approaches world-wide (including hinds to NSF research) and give emphasis on the pros and cons of evolutionary and revolutionary architectural approaches, and discuss architectural issues regarding mobile services.

- Prof. Müller (TU Kaiserslautern) will present some consideration on the Future Internet Architecture from a Service-Oriented point of view. Interaction between today's cloud computing and Future Internet architecture will be considered. Emphasis will be given to the Future Internet Architecture as an ecosystem, which includes networks, services, policies, humans….

- Dr. Mohr (Nokia Siemens Networks) will present the Future Internet Architecture requirements from a smart energy point of view, putting emphasis on the mobility requirements (e.g. Future Internet and electric cars).

- A discussion will follow on the different architectural issues, not only between the panel participants but also between the participants. The panel will close with a very brief wrap-up.

Agenda

Time	Speaker	Subject
11:30 – 11:35	Th. Zahariadis (Synelixis)	General introduction to the session
11:35 – 11:45	D. Papadimitriou (Alcatel-Lucent)	How Future Internet Architecture is constrained by the network-wide/global-level architecture?
11:45 – 11:55	G. Pau (UCLA)	Future Internet Architecture: Network Evolution or Revolution?
11:55 – 12:05	P. Muller (TU Kaiserslautern)	Future Internet Architecture & Cloud Computing: A Service-Oriented approach.
12:05 – 12:15	W. Mohr (NSN)	Future Internet Architecture and Smart Energy
12:15 – 12:30		Q&A – Discussion

Session outcome

Dimitri Papadimitriou (ALCATEL-LUCENT) introduced the idea of modularization into the Design Principles of FIArch. While diagnosability, scalability, security, protection, flexibility and evolutivity are design objectives that they have not yet been covered, modularization can help in order to circumvent the internet architecture limits. Modularization can provide modules connected by means of realization relationships that supply their behavioral specification. They can also be distinguished between general and specialized modules and can also be dynamically bind at running time

Moreover, Content Centric networks have to rely on a solid FI architecture. Reliability, resilience and trustworthiness are some of the key points that were indicated during the closing session. Giovanni Pau from UCLA proposes to build from scratch and forget IP, while the number of layers needs to be reduced. He focused on specific design principles, mentioning that mobility and security must be built into the architecture and finally discussed the end-to-end principle.

A different approach was presented by Paul Mueller from ICSY. He stated that the problem of current internet is fundamental in the time of creation and that it is hard for new technologies to be implemented into the current technology. The basic idea is to apply Software Engineering methods to design new software architecture for the Internet core. SOA principles should be applied to communication systems. A communication system based on the SOA paradigm includes services that are self-

contained, defines explicit interfaces and interaction between elements of the architecture and minimizes assumptions about other services. In general, the dynamically interacting services can replace the concept of layers in current internet.

Werner Mohr from NSN, completed the series of the presentations concerning about energy consumption and device efficiency. In Germany, the integration of the energy network and ICT by means of Future Internet capabilities, services and procedures enables new services and business models. The IT market will push hard the industry and the stakeholders for quick implementation of the first FI capabilities. Smart grid and smart homes are the applications with high requirements and big challenges.

A discussion ended up with this topic which allowed participants to interact with the panelists. Questions about time-schedule of implementation of these design objectives received mixed answers, focusing on Mr Werner Mohr's answer that by the end of this decade, the Energy System will be integrated with the ICT leading to the first implemention of these goals. Moreover, a conversation regarding complexity of modularization took place, where a participant focused on the impact that will have a modularized system, on simplicity principle.

3 Future Content Networks group

The Future Content Networks (FCN) group has as main aim to identify, qualify and highlight the impact that both media and networks (networked media) may have on a Future Internet environment.

Its concrete objectives are:

- To disseminate the goals of the cluster by participating in many Break-out sessions in FIA events, and
- To assist in organising new horizontal sessions and inviting well known scientists for giving key-note speeches in FIA events.

The clear goal of nextMEDIA was to enlarge the FCN group with the participation of more industrial members, so as to be active in FIA events, as it was a clear request by the nextMEDIA reviewers. Therefore, the role of FCN was:

- Contribution to the FCN Session & Contribution to the different BO sessions so as:
  - to identify new goals for the upcoming FIA workshops,
  - to contribute/participate to the different FIA Break-Out sessions,
  - to identify/propose new horizontal sessions that might be of interest for the FIA attendees,

3.1 FCN Meetings

The third FCN meeting took place in Ghent, Belgium. The fourth FCN meeting was held in Budapest, Hungary and the fifth FCN meeting was held in Poznan, Poland, all in parallel with the FIA workshops. Numerous teleconferences took also place prior to the FIA workshops so as to ensure industrial participation to FIA.

The participants of all FCN meetings can be seen in the table below. Participants from SMEs and Industry are in bold:

No	Participant Name	Affiliation
1	Federico Alvarez	UPM
2	Petros Daras	CERTH
3	Theodoros Semertzidis	CERTH
4	Anastasios Zafeiropoulos	CERTH
5	Theodore Zahariadis	Synelixis
6	**Paul Moore**	**ATOS**
7	Oscar Mayora	CREATE-NET
8	Tomas Piatrik	QMUL
9	Ebroul Izquierdo	QMUL
10	Naeem Ramzan	QMUL
11	**Adolfo Rosas**	**Telefonica**
12	**Pierre-Yves Danet**	**FT/Orange**
13	**Peter Stollenmayer**	**Eurescom**
14	Jari Ahola	VTT
15	**Irene Lopez**	**Tekniker IK4**
16	Antonio Camurri	University of Genoa
16	George Pavlou	University College London

17	Rafaelle Bolla	University of Genoa
18	Alberto Jose Gonzalez	i2CAT/UPC
19	Dimitris Protopsaltou	University of Geneva
20	**Cezary Mazurek**	**PSNC**
21	**Vincent Leroy**	**Yahoo**
22	**Barla Cambazoglu**	**Yahoo**
23	Yiping Chen	CNRS – Labri
24	**Susanne Kuehrer**	**A1 Telekom Austria**
25	Tobias Burger	Salzburg Research
26	**Sergios Soursos**	**Intracom Telecom**
27	George Pavlou	University College London
28	Miodrag Temerinac	Uni- Novistat
29	Paul Walland	IT Innovation
30	**Yves-Marie Le Pannerer**	**Technicolor**
31	**Francesco Nucci**	**Engineering**
32	**Ricardo Baeza-Yates**	**Yahoo**
33	**Dimitri Papadimitriou**	**Alcatel-Lucent**
34	**Stefan Haller**	**SAP**
35	**Hannes Tschofening**	**NSN**
36	**G. Feher,**	**BME, Hungary**
37	**Z. Korcsok,**	**iPont, Hungary**
38	**S. Spirou,**	**Intracom Telecom, Greece**
39	**V. Souza,**	**Ericsson**
40	**F. Salguero**	**Telefonica R&D**
41	**Laurent Ciavaglia**	**Alcatel-Lucent**
42	**Gerard Nguengang**	**Thales**
43	**W. Mohr**	**NSN**

FCN participants/members

With respect to the Smart Objectives of this action:

- *Two meetings per year of the FCNs group (either physical or through Audio Conferences) at least two months before each FIA event.* Three FCN meetings were completed successfully
- *Representation of at least 2 nextMEDIA beneficiaries to the EC organised FIA caretakers meeting (at least 2 per year).* All nextMEDIA beneficiaries participated in conference calls for preparing FIA workshops
- *Number of participants >15*. DONE
- *Number of non-nextMEDIA participants >7*. DONE
- *The participants will be representatives of both the Academia (~70%) and the Industry (30%). The experts will be representatives of the projects that currently participate or will participate in the FCNs group*. DONE

4 Future Internet Architecture Group (FIArch)

After completion of the Future Internet Fundamental Limitations document (March 2011), the FIAgroup moved to the next step which is the definition of the Future Internet Design Principles. The group moderator (Theodore Zahariadis) has prepared a Call for contributions which has been broadly distributed. As a result 12 high quality replies have been received.

Dr. Zahariadis organized two PhCs on 9 and 13 May 2011, where all contributions were evaluated by the group members. Though there were different opinions, it was decided that contributions would be presented at the FIArch workshop.

The FIArch Group 3rd workshop on the Design Principles took place in Brussels on 23 May 2011 at the EC premises. The workshop agenda may be found at section 4.1. One may notice that also the DG INFSO Director Dr. Megan Richards participated at the workshop.

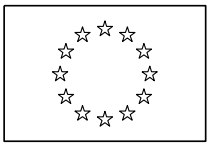
The presentations and the technical discussions had high technical quality and were summarized by Th. Zahariadis (Synelixis) and D. Papadimitriou (Alcatel-Lucent). Synelixis prepared a summary and meeting minutes which were distributed and a second round of contributions was initiated.

Synelixis prepared the first draft of the FIA Design Principles document, which was circulated on 16/7/2011. After a pooling, 5 PhCs were organised on:

- 29 June
- 28 July
- 9 September
- 16 September

Via the PhCs a pre-final version of the Design Principles was formed, which was discussed in a face to face meeting that took place on 23 September 2011 in EC premises in Brussels. The agenda and participants of the workshop are shown in section 4.2. The 23rd September workshop was followed by off-line discussion and the final draft of the FIArch Design Principles document was presented on the Future Internet Assembly (FIA) Poznan event on 24-26 October 2011.

4.1 3rd FIArch Workshop Agenda



EUROPEAN COMMISSION
Information Society and Media Directorate-General

Converged Networks and Services
Networked Media Systems

Brussels, 23 May 2011

Venue: Av. Beaulieu 25, 0/S1. 1160 Auderghem

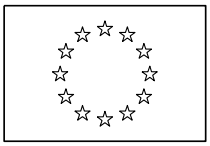
3rd FIArch Workshop Agenda

10:00-10:10	Introduction • Motivations and Objectives • Positioning (wrt to the FIArch work flow) • Timeline & Targets	I. Laso (EC)
10:10-10:50	Background material • Current principles/Brief overview incl. application of these principles • Mythology and facts	D. Papadimitriou (Alcatel-Lucent)
10:50-11:00	Break (15min)	
11:00-11:50	Open floor presentations • Each presenter 7 minutes • 15 minutes Q&A	Mod: S. De Panfilis • S. De Panfilis (Engineering) • I. González Alonso (Univ. of Oviedo, Spain) • P. Muller (TU Kaiserslautern, Germany) • I. Papafili (AUEB, Athens) • K. Howker (TSSG, UK)
11:50-12:30	Open floor presentations • Each presenter 7 minutes • 12 minutes Q&A	Mod.: D. Papadimitriou • E. Grasa (i2CAT Foundation) • Th. Zahariadis (Synelixis) • W. Chun (ETRI, Korea) • R. Kantola (Aalto Univ., Finland)
12:30-12:45	Internet Architecture - a policy tool for innovation?	Megan Richards (Director, DG INFSO)
12:45-13:00	Ongoing International Activities on Internet Principles?	Andrea GLORIOSO (EC)
13:00-13:25	Open floor presentations • Each presenter 7 minutes • 16 minutes Q&A	Mod.: D. Papadimitriou • P. Martinez (Murcia Univ., Spain) • K. Tutschku (Vienna Univ, Austria)
13:25-14:30	Lunch	
14:30-15:00	• Summary of the contributions • Arguments and Analysis	Th. Zahariadis (Synelixis) D. Papadimitriou (Alcatel-Lucent)
15:00-15:15	Break	
15:15-16:30	Open Discussion	Moderator: K. Howker (TSSG)
16:30-17:30	Desicions on the Next Steps (45min) • Results & Objectives • Structure & Outline • Timeline	Th. Zahariadis (Synelixis)

Participants:

Bartoz Belter	PSNC
Christian Timmerer	Alpen-Adria-Universität Klagenfurt (AAU)
Daniel Piret	SYNERGETEK
David Griffin	UCL
Dimitri Papadimitriou	Alcatel-Lucent
Eduard Grasa	i2CAT Foundation
Federico Alvarez	UPM
Henrie Gouraud	INRIA
Ioanna Papafili	AUEB, Athens
Ioannis Koufoudakis	Synelixis
John Cosmas	Brunel University
Keith Howker	TSSG
Kurt Tutschku	Vienna Univ. Austria
Marco Masetti	Softeco srl
Maurizio Cecciti	Telecom Italia
Mika Rantakokko	Center of Internet Excellence, Finland
Paul Muller	TU Kaiserslautern
Pedro Martinez Julia	Murcia Univ. Spain
Petros Daras	CERTH
Pierro Corte	Engineering
Raimo Kantola	Aalto Univ, Finland
Stefano De Panfilis	Engineering
Theodore Zahariadis	Synelixis
Tomas Piatrik	QMUL
Wen Chun	ETRI, Korea

4.2 4th FIArch Workshop Agenda



EUROPEAN COMMISSION
Information Society and Media Directorate-General

Converged Networks and Services
Networked Media Systems

Brussels, 23 September 2011

Venue: Av. Beaulieu 25, 0/S 5

4th FIArch Workshop Agenda

10:30-10:40	Introduction • Motivations and Objectives • Positioning (wrt to the FIArch work flow) • Timeline & Targets	I. Laso
10:40-11:00	Section 1 & 2 (Definitions)	D. Papadimitriou
11:00-11:15	Break (15min)	
11:15-13:00	Section 3-4	Th. Zahariadis Editing Session
13:00-14:00	Lunch	
14:00-15:00	Section 5 -Ioanna Papafili - Pedro Martinez Julia	D. Papadimitriou Editing Session
15:00-15:15	Break	
15:15-16:30	Sections 5 (Cont.) - Eduard Garsia - Paul Muller - SOFI expert.	D. Papadimitriou Editing Session
16:30-17:00	Decisions on the Next Steps • Results & Objectives • Structure & Outline • Timeline	Th. Zahariadis

Participants:

Dimitri Papadimitriou	Alcatel-Lucent
Eduard Grasa	i2CAT Foundation
Ioanna Papafili	AUEB, Athens
Keith Howker	TSSG
Paul Muller	TU Kaiserslautern
Manfred Hauswirth	DERI
Theodore Zahariadis	Synelixis
Tomas Piatrik	QMUL

4.3 Other activities

- A FIArch group email reflector has been created and updated/managed by Synelixis.
- A template and call for contributions for the Future Internet Architecture Design principles contributions has been created.
- Synelixis has updated the FIArch Group web site frequently

5 Future Media Internet-Task Force

During the first reporting period the Future Media Internet Task Force (FMI-TF) prepared and published the white paper: "Future Media Internet Research Challenges and the Road Ahead", April 2010

In this reporting period the TF prepared the white paper: "Social Networks Overview: Current Trends and Research Challenges", European Commission, Networked Media Unit, Information Society and Media, ISBN 978-92-79-18923-4 doi:10.2759/1559, Nov 2010

Moreover, the TF prepared the report "Research Challenges, Applications Areas and Business Models". This document has been produced by a discussion forum of experts in the area of media Internet, namely the Future Media Internet – Task Force (FMI-TF). The FMI-TF aims to shape the research agenda and outline the research challenges in Future Media Internet in the years to come, to map these research challenges to specific application areas taking into account the industrial point of view and finally, to identify potential business models and business benefits that could address these challenges.

The complete report can be found in Annex I.

The TF meetings which were held in this reporting period towards realising the aforementioned reports and white papers were the following:

30 November 2010, Brussels in EC premises, in parallel with the Fall 2010 concertation meeting. The focus of this meeting was on:

- Classifying the identified research challenges (short/mid/long term)
- Identifying application areas per research challenge with special focus on the Industrial view on how this research can be applied
- Identifying generic business models to realize the research challenges
- Setting the scene for the book on Media Internet.

The meeting agenda is shown below:

Tuesday, 30/11/2010, Brussels		
Time	**Topic**	**Presenter/Moderator**
15:30-15:40	Welcome from the EC	Isidro Laso-Ballesteros
15:40-16:30	White paper presentation & Classification of the identified research challenges	Petros Daras
16:30-17:15	Application areas per research challenge with special focus on the Industrial view on how this research can be applied	All
17:15-17:25	Coffee break	
17:25-17:50	Generic business models to realize the research challenges	All, moderated by Federico Alvarez
17:50-18:30	Business benefits	All, moderated by Petros Daras

18:30-19:00	Discussion on next actions /Time plan +AOB	Petros Daras
	Close of the meeting	

13 April 2011, Trento Italy. The main objective of the meeting was to identify the relevant research areas with respect to Future Media and Content-Centric networks with particular emphasis on Media.

- The topics of interest for the TF were:
  - to report the SoA in these areas including existing standards, relevant commercial systems, and potential limitations
  - to propose new research challenges,
  - to identify potential applications and impact of these challenges

The meeting agenda is shown below

	Wednesday, 13th April 2011, Trento	
Time	**Topic**	**Presenter/Moderator**
14:00 – 14:15	Meeting objectives	Federico Alvarez
14:15 – 14:45	Presentation of the results of the questionnaires	Petros Daras
14:45 – 15:45	Discussion on the priorities (applications, business benefits and models) for short-mid research challenges: a) Content and context fusion for improved multimedia access b) Multimedia, multimodal and deformable objects search	All
15:45 – 16:00	Coffee break	
16:00 – 17:40	Discussion on the priorities (applications, business benefits and models) for mid-long research challenges: a) 3D content generation leveraging emerging acquisition channels b) Immersive multimedia experiences c) Content with memory and behavior	All
17:40 – 17:50	Discussion on next actions	All
17:50 – 18:00	Wrap-up and conclusions	Petros Daras / Federico Alvarez

After this meeting two more teleconferences were held to finalise the report

All TF members are shown in the table below:

No	Participant Name	Affiliation	e-mail
1	Federico Alvarez	UPM	fag@gatv.ssr.upm.es
2	Petros Daras	CERTH	daras@iti.gr

3	Theodore Zahariadis	Synelixis	zahariad@synelixis.com
4	Paul Moore	ATOS	paul.moore@atosresearch.eu
5	Oscar Mayora	CREATE-NET	oscar.mayora@create-net.org
6	Qianni Zhang	QMUL	Qianni.zhang@elec.qmul.ac.uk
7	Ebroul Izquierdo	QMUL	ebroul.izquierdo@elec.qmul.ac.uk
8	Marco Pellegrini	CNR	marco.pellegrini@iit.cnr.it
9	Hassnaa Moustafa	FT/Orange	hassnaa.moustafa@orange-ftgroup.com
10	Xavier Anguera Miro	Telefonica	xanguera@tid.es
11	Amar Aggoun	Brunel University	amar.aggoun@brunel.ac.uk
12	Noel O'Connor	DCU	Noel.OConnor@dcu.ie
13	Gaël Richard	IT Paris	gael.richard@telecom-paristech.fr
14	David Griffin	University College London	d.griffin@ee.ucl.ac.uk
15	Ralph Traphoener	EMPOLIS	Ralph.Traphoener@empolis.com
16	Aggelos Katsaggelos	Northwestern University	aggk@ece.northwestern.edu
16	Dimitris Protopsaltou	University of Geneva	Dimitris.Protopsaltou@miralab.unige.ch
17	Hyoung Joong Kim	Korea University	khj-@korea.ac.kr
18	Alexandros Nanopoulos	University of Hildesheim	nanopoulos@ismll.de
19	Peter Stollenmayer	EURESCOM	stollenmayer@eurescom.eu
20	Marian Ursu	Goldsmiths, University of London	m.ursu@gold.ac.uk
21	Doug Williams	BT	doug.williams@bt.com
22	Francesco De Natale	University of Trento	denatale@ing.unitn.it
23	Isidro Laso Ballesteros	European Commission	Isidro.LASO@ec.europa.eu

It should be noted that the results of the work of the TF are beyond the SOs which were set in the DoW.

6 FIA Books

nextMEDIA beneficiaries were active either as editors of FIA Books or as contributors. More specifically:

The book on "Future Internet Assembly 2011: Achievements and Promising Technology" was published by Springer, Series: Lecture Notes in Computer Science, Vol. 6656,Subseries: Computer Communication Networks and Telecommunications

Domingue, J.; Galis, A.; Gavras, A.; Zahariadis, T.; Lambert, D.; Cleary, F.; Daras, P.; Krco, S.; Müller, H.; Li, M.-S.; Schaffers, H.; Lotz, V.; Alvarez, F.; Stiller, B.; Karnouskos, S.; Avessta, S.; Nilsson, M. (Eds.) 1st Edition., 2011, XVI, 465 p.

nextMEDIA beneficiaries Federico Alvarez, Petros Daras and Theodore Zahariadis are among the editors (and reviewers) of this book. More information can be found at: http://www.springer.com/computer/communication+networks/book/978-3-642-20897-3

It should be noted that members of nextMEDIA published the following book chapters:

- "Towards a Future Internet Architecture", Theodore Zahariadis, Dimitri Papadimitriou, Hannes Tschofenig, Stephan Haller, Petros Daras, George D. Stamoulis, and Manfred Hauswirth

- "Scalable and Adaptable Media Coding Techniques for Future Internet" Naeem Ramzan and Ebroul Izquierdo

- "Semantic Context Inference in Multimedia Search", Qianni Zhang and Ebroul Izquierdo

The book on "Future Internet – from the technological promises to the application in the field"

The call for papers is shown below. Federico Alvarez is leading this endeavour.

FIA book 2012

Future Internet – from the technological promises to the application in the field

The Future Internet Assembly (FIA) is a success. FIA is a unique bi-annual event that brings together the participants of over 100 projects from a number of units in the EU Framework Programme 7 to share scientific and technical results and to discuss cross-domain research topics around the notion of creating new Future Internet technologies, applications and services, with a global world-wide view.

FIA began in the Spring of 2008 in Bled, Slovenia, and Spring 2012 will see the ninth FIA in Copenhagen. As with prior Spring FIAs, we are producing a book that aggregates both the results achieved in the Future Internet domain, and the possibilities of what we can expect in a near-medium term.

The previous FIA books are:

- *Towards the Future Internet: A European Research Perspective (2009)*

- *Towards the Future Internet: Emerging Trends from European Research (2010)*
- *Future Internet Assembly 2011: Achievements and Technological Promises*

Early on in the FIA time line we realised that a number of key elements were required to ensure success:

- *Cross-domain discussions: on both core technical issues (such as FI architectures, FI services, FI experimentation, mobile FI or Internet of Things) and on horizontal issues such as socio-economics, privacy, trust and identity.*

- *Engagement with the application areas of the Future Internet and the users: to move from the FI technologies to sectors where innovation can be improved by the Future Internet technologies*
- *Provide results which are applicable in the day to day life.*

In structuring the book, we suggest to cover the following topics with an orientation to the results provided.

- *Future Internet Foundations: covers the core cross-domain technical and horizontal topics. The chapters under this section are: Architectural Issues; mobile Internet, Cloud Computing, Socio-Economic Issues; Trust and Identity; Search and Discovery; and Experiments and experimental design.*
- *Future Internet Areas: the technical domains associated with the Future Internet, mainly but not limited to Networks; Services; Internet of Things; Content; and Inter-area Issues.*
- *Future Internet Application Areas: user areas and communities, where Future Internet can boost their innovation capabilities. The chapters under this section are: Smart Cities; Smart Energy; Smart Health; Smart Environment; Smart Transportation, Logistics and Mobility; Smart Manufacturing; Smart Agriculture, and Tourism.*
- *Future Internet infrastructures: covering experimentation and results in real infrastructures in the FI domain.*

Submission

Submission and acceptance of chapters will be done through rigorous peer review to ensure originality, timeliness, relevance, and readability. We encourage the authors to send full chapter proposals for revision. Authors of accepted proposals will then be invited to submit camera ready chapters which will be subject to further acceptance, review, and revision.

Dates

- *2012-01-10 – Full paper submission*
- *2012-02-17 - Notification for the accepted chapters*
- *2012-03-12 - Camera ready chapters*
- *2012-04-07 - Book published (temptative)*

Editors - TBC

Federico Alvarez, John Domingue, Susana Avesanna, Frances Cleary, Petros Daras, Alex Galis, Anastasius Gavras, Srdjan Krco, Dave Lambert, Volkmar Lotz, Hennig Muller, Michael Nilsson, Burkhard Stiller, Anne-Marie Sassen, Georgios Tselentis, Theodore Zahariadis,

7 REFERENCES

[1] www.fi-nextMEDIA.eu

ANNEX 1. Research Challenges, Application Areas and Business Models

"Future Media Internet Task-Force"

Report

Research Challenges, Applications Areas and Business Models

Acronym	FMI-TF
Group URL	www.fi-nextmedia.eu / http://www.gatv.ssr.upm.es/nextmedia/index.php/nextmediagroups/fmi-task-force
Document Name	FMI-TF
Abstract (for dissemination)	This document attempts a mapping of the Future Media Internet research challenges to potential applications areas and business models.
Keywords	Future Media Internet
Date	16/09/2011
Status	Draft
Version	0.3

EXECUTIVE SUMMARY

The Future Internet (FI) is expected to be a communication and delivery ecosystem, which will interface, interconnect, integrate and expand today's Internet, public and private intranets and communication networks of any type and scale, in order to provide highly demanding services to humans and systems in an efficient, transparent and secure manner.

This complex networking environment may be considered from various interrelated perspectives: the networks & infrastructure viewpoint, the services viewpoint and **the media & information viewpoint**.

This document has been produced by a discussion forum of experts in the area of media Internet, namely the Future Media Internet – Task Force (FMI-TF). The FMI-TF aims to shape the research agenda and outline the research challenges in Future Media Internet in the years to come, to map these research challenges to specific application areas taking into account the industrial point of view and finally, to identify potential business models and business benefits that could address these challenges.

Introduction

Nowadays, Internet is the most important information exchange ecosystem. It has become the core communication environment not only for business relations, but also for social and human interaction. The immense success of the Internet has created even higher expectations for new applications and services, which the current Internet may not be able to support. Advances in video capturing and encoding have led to massive creation of new multimedia content and applications, providing richer immersive experiences such as 3D videos, interactive environments, network gaming, virtual worlds, etc.

The Future Internet (FI) is expected to be a holistic information exchange ecosystem, which will interface, interconnect, integrate and expand today's Internet, public and private intranets and networks of any type and scale, in order to provide efficiently, transparently, timely and securely any type of service (from best effort information retrieval to highly-demanding, performance critical services) to humans and systems.

This complex networking environment may be considered from various interrelated perspectives: the networks & infrastructure perspective, the services perspective and the media & information perspective. ***The Future Media Internet is the Future Internet viewpoint that covers the creation, delivery, in-the-network adaptation/enrichment and consumption of media over the Future Internet ecosystem.***

The Media Internet supports professional and novice content prosumers and is at the crossroads of digital multimedia content and Internet technologies. It encompasses two main aspects: Media being delivered through Internet networking technologies (including hybrid technologies) and Media being generated, consumed, shared and experienced on the web. The Media Internet is evolving to support novel user experiences such as immersive environments including sensorial experiences beyond video and audio (engaging all human senses) that are adaptable to the user, the networks and the services.

In this rapidly evolving environment, the aim of the Future Media Internet – Task Force is to build a discussion forum for experts in the area of media and networks, which will brainstorm, analyse, debate, agree and propose research challenges covering the creation, delivery, in-the-network adaptation/enrichment and consumption of media over the Future Internet ecosystem.

This report is organized as follows. Section 2 presents the identified research challenges along with their classification to short/mid/long term. In Section 3 the potential application areas and related business models are analysed, which can realise these challenges. Finally, Section 4 attempts a mapping of the Future Media Internet research challenges to specific application areas and business benefits that are expected to occur.

The overall editing and homogenization has been provided by the nextMEDIA CSA project consortium.

Future Media Internet – Research Challenges

As stated earlier, this report focuses on the Media & Information viewpoint over FMI without neglecting, however, the importance of the novel network-related characteristics that Future Internet will embed.

Recently [1], experts of the FMI-TF suggested the following research challenges as relevant to FMI:

- ***Scalable multimedia compression, transmission, concealment.*** The popularity of Multimedia applications that are related to video transmission, ranging from multimedia messaging to TV broadcasting, is rapidly increasing. So does the variability of communication networks' characteristics (e.g., packet loss, delay, and throughput) and receiving devices' capabilities (e.g., resources). In this context, coding and transmission technologies, able to engineer the content to meet demanding and variable application requirements, are critical.
- ***Network coding and streaming.*** Network coding is an emerging paradigm for media and generic data communication in complex networked environments such as the Internet. It offers a more general approach to media delivery than that of conventional communication networks by assuming that, in advanced future media networks, nodes will be able to process and code media streams and not just route them. Its implication in the design of the FMI is crucial since it has the potential to dramatically increase the network transmission capability.
- ***Content and context fusion for improved multimedia access.*** Content and context fusion technologies have been used in several environments such as TV, mobile media, etc. They can be separated into the technologies to capture the user behavior and profile, and the systems to perform content and context fusion.
- ***3D content generation leveraging emerging acquisition channels.*** Content creators always look for new ways to improve their content and add new sensations to the viewer experience. High Definition video has been the latest innovation in the area of content enrichment and 3D is the next single greatest innovation in film-making. However, those novel forms of content have not yet found their way into small and medium size content creation companies, moving the experience from cinema halls and cinema projectors to the everyday household environments and computers.
- ***Immersive multimedia experiences.*** Traditionally, research on multimedia has provided information to the user primarily through just two sensory modalities - sound and vision. Although there is a growing interest in other types of sensory interaction such as haptics, sound (comment: but sound is one of the two "old" modalities not an "other type") and in general more immersive experiences of multimedia, the topic (comment: which topic?) is still under-researched. This statement is even more valid for research on aspects related to the integration, display and transmission of multisensory information enriching the multimedia experience.
- ***Multimedia, multimodal and deformable objects search.*** Multimedia content, which is available over the Internet, is increasing at a rate faster than the respective increase in computational power and storage capabilities. Internet capacity will approach the amount of yota (10 power 24) bytes in 2010. Such a tremendous amount of content cannot be processed and indexed by the current

computational power unless personalised and user-centric mechanisms are implemented so that only the content of interest is delivered to the end-users.

- ***Content with memory and behavior.*** In the area of 3D, virtual worlds and gaming, advances are needed to increase the level of realism and interactivity. By adding to virtual characters and virtual objects memory and behavior will lead to the transition from the "smart content" to the "intelligent content".

The aforementioned research challenges are believed to be the main pillars towards exploring new possibilities for boosting individual and social creativity and productivity in a Future Media Internet environment. Their classification to short/mid/long term is given in the table below.

Table 1: Future Media Internet Research Classification

Research challenge [1]	Short	Mid	Long
Scalable multimedia compression, transmission, concealment	X		
Network coding and streaming	x	X	
Content & context fusion for improved multimedia access	x	X	
Multimedia, multimodal and deformable objects search	x	X	
3D content generation leveraging emerging acquisition channels		X	x
Immersive multimedia experiences	x	X	x
Content with memory and behaviour		x	X

As can be seen in the table above, the effort to classify the research challenges in short/mid/long term results in the identification of four different groups of challenges.
The first group consists of only one research challenge area, namely "Scalable multimedia compression, transmission, concealment". Research challenges within this area are expected to be on their peak in the very short term; that is in the next 3 years.
The second group consists of three challenge areas: "Network coding and streaming", "Content & context fusion for improved multimedia access", and "Multimedia, multimodal and deformable objects search". Research challenges within those areas are expected to span across the short (next 3 years) and mid term and reach their peak in the mid term; that is, in the next 4 to 5 years.
The third group consists of two areas: "3D content generation leveraging emerging acquisition channels" and "Immersive multimedia experiences". Research challenges within those areas are expected to reach their peak on the mid term (next 4 to 5 years) and continue to span in the long term; that is beyond 2015.
The fourth and last group consists of one research challenge area, namely "Content with memory and behaviour". Research challenges within this area are expected to span across the mid and long term and reach their peak in the long term; that is, not earlier than 2015.

[1] x denotes minority votes while X denotes majority votes.

Application Areas and Business Models

In one of its previous documents [1] the FMI-TF has identified six novel application areas that are expected to allow users to enhance human-media and human-human communications in the Future Internet:

1. **Immersive and 3D Applications**: new physically strong experiences (exertion games, realistic simulation and training, new entertainment experiences, personal enriched communications as tele-presence) enabled through sophisticated representations of virtual and real worlds.
2. **Multisensory Media Integration**: simultaneous stimulation of different senses beyond audiovisual content (tactic or smell) will also impact Human perception.
3. **Augmented Media Experiences**: the enrichment of the physical world perception through the interaction with elements of the virtual-world/digital-content will modify the perception of reality and enable new services.
4. **Enriched Group to Group Communications**: modification of the concept of reality through end-to-end games and collaborative work with remotely located teams will be extended to involve verbal/non-verbal communications and interaction with devices and objects.
5. **Contextualized Media Consumption**: a selective FMI information consumption will depend on the context (personal profiles, media type, location, devices, etc) to present information.
6. **Real-Virtual Worlds Search and Delivery**: new applications will include searching facilities enabling multimedia/multimodal search for both the real (objects) and the virtual (data) world.

Similarly, a series of related business models has been identified:

1. **Knowledge-Media Integration**: Content value can be increased by integrating knowledge into media and thus making them easy to access, contextualized, reusable, secure, protected, etc.
2. **Human-based Computation**: Make people work for you with appropriate incentives (e.g., social everywhere).
3. **Personalized Advertisements**: Telecom companies can enhance their content deliverance mechanisms (e.g., IPTV) with personalized advertisements.
4. **Advanced Search Models**: Companies active in multimedia-content delivery (e.g., internet radios) can enhance their customers' experience by providing advanced ways for searching and using content databases.
5. **Social Avatars**: e-Commerce companies can utilize Avatars that adapt their behavior according to the needs of the customers.
6. **Differentiated Quality/Pricing Media Services.**
7. **Shift towards Infrastructure Providers**: Current business models, based on advertising, are skewed to the application/service providers who act as eyeball providers to advertisers. End users pay ISPs and they separately pay for content (sometimes indirectly through advertisements). Infrastructure providers (such as ISPs) could obtain a fair return on investment by adopting business models that include a closer relationship and interaction between them and the media/content/application/service creators, owners, providers and publishers.

8. **Raise Entry Barriers**: Solutions and platforms could provide a relatively low barrier to entry (including open access) for smaller and new organizations in order to improve the opportunities for innovation and rapid technological development.

Mapping

In this section we will attempt a mapping of the Future Media Internet research challenges to specific application areas and, for the research areas that are of short or mid term interest, to related business models and expected benefits.

Table 2 below presents the aforementioned mapping for short/mid term research challenges.

Table 2: Mapping for the short/mid term research challenges.

Research Challenge	Application Areas	Business Models	Business Benefits
Scalable multimedia compression, transmission, concealment	~Entertainment ~CCTV surveillance ~Video Communications/Interactive TV ~Telepresence ~Internet-based media distribution ~Television ~Games	~Differentiated Quality/Pricing Media Services ~Network providers selling knowledge of the network capability to content providers to inform them of the coding schemes	~Network and service provider: o Improved cost: quality quotient for content distribution o Improved support for flexible multiplatform distribution e.g., handover from a HD TV screen to a mobile low-definition screen
Network coding and streaming	~Entertainment ~CCTV surveillance ~Video Communications/Interactive TV ~Telepresence ~Internet-based media distribution ~Television ~Games ~Media distribution over ad-hoc and P2P networks	~Shift towards Infrastructure Providers	~Network provider: o Improved bandwidth allocation o Better quality for a limited network capacity ~Service Provider: o More robust/reliable services
Content and context fusion for improved multimedia access	~Multimedia consumption and generation with emphasis on its surroundings (e.g. in mobile applications) ~Content preservation ~Security ~Personalized/Social TV	~Targeted advertisements ~Differentiated Quality/Pricing Media Services	~Network providers: o Better management of resources o Context awareness allows for network optimisation ~Service providers: o Content personalisation leads to tailored media services ~Content providers: o Content adaptation and enrichment
Multimedia, multimodal and deformable objects search	~Creation of next-generation search engines spanning the web and the real world ~News ~Sports ~Journalistic services (for news producers)	~Targeted advertisements ~Differentiated and personalised services ~Prosumer social networks	~Service & Content providers: o Better search = better provision of long tail content and services o Improved user generated content

	~Serious games ~ Guides (e.g., museum, sightseeing, maps) ~Media stores ~Social media ~E-Learning & Edutainment ~Personalised healthcare services ~Homeland security/defense		creation o Real time media search for large user archives

Table 3 below presents the identified application areas for mid/long term research challenges. It should be noted that business models/benefits could not been identified.

Table 3: Application areas for the mid/long term research challenges.

Research Challenge	Application Areas
3D content generation leveraging emerging acquisition channels	~Manufacturing ~Health ~Video games ~Tele-presence ~3D content production ~3D-TV & 3D Cinema ~Virtual/Mixed reality ~Homeland security/Defence ~Interactive event coverage (sports, concerts, theatre, etc.) – free viewpoint 3DTV
Immersive multimedia experiences	~Tele-presence ~Social tele-experiences (e.g. live concerts) ~Tele-learning and tutoring ~Health (e.g. elderly people care) ~Games ~Mixed environments
Content with memory and behaviour	~Gaming ~Health (e.g. elderly people care) ~Guides ~Personalized services ~Edutainment e-Learning ~Autonomous media objects composition

References

[1] http://www.future-internet.eu/uploads/media/FMI-TF-White_paper_042010_01.pdf

[2] www.geni.net/netse_about.html

FMI-TF members

No	Participant Name	Affiliation	e-mail
1	Federico Alvarez	UPM	fag@gatv.ssr.upm.es
2	Petros Daras	CERTH	daras@iti.gr
3	Theodore Zahariadis	Synelixis	zahariad@synelixis.com
4	Paul Moore	ATOS	paul.moore@atosresearch.eu
5	Oscar Mayora	CREATE-NET	oscar.mayora@create-net.org
6	Qianni Zhang	QMUL	Qianni.zhang@elec.qmul.ac.uk
7	Ebroul Izquierdo	QMUL	ebroul.izquierdo@elec.qmul.ac.uk
8	Marco Pellegrini	CNR	marco.pellegrini@iit.cnr.it
9	Hassnaa Moustafa	FT/Orange	hassnaa.moustafa@orange-ftgroup.com
10	Xavier Anguera Miro	Telefonica	xanguera@tid.es
11	Amar Aggoun	Brunel University	amar.aggoun@brunel.ac.uk
12	Noel O'Connor	DCU	Noel.OConnor@dcu.ie
13	Gaël Richard	IT Paris	gael.richard@telecom-paristech.fr
14	David Griffin	University College London	d.griffin@ee.ucl.ac.uk
15	Ralph Traphoener	EMPOLIS	Ralph.Traphoener@empolis.com
16	Aggelos Katsaggelos	Northwestern University	aggk@ece.northwestern.edu
16	Dimitris Protopsaltou	University of Geneva	Dimitris.Protopsaltou@miralab.unige.ch
17	Hyoung Joong Kim	Korea University	khj-@korea.ac.kr
18	Alexandros Nanopoulos	University of Hildesheim	nanopoulos@ismll.de
19	Peter Stollenmayer	EURESCOM	stollenmayer@eurescom.eu
20	Marian Ursu	Goldsmiths, University of London	m.ursu@gold.ac.uk
21	Doug Williams	BT	doug.williams@bt.com
22	Francesco De Natale	University of Trento	denatale@ing.unitn.it
23	Isidro Laso Ballesteros	European Commission	Isidro.LASO@ec.europa.eu

Table 4: Future Media Internet Task Force – Members List.

ANNEX 2. Social Networks: Current Trends and Research Challenges

November 2010

Coordinated by the "nextMEDIA" CSA.
Supported by the Future Media Networks cluster

European Commission
Information Society and Media

Disclaimer: This document does not necessarily represent the official position of the European Commission.

Executive Summary

The emergence and popularity of online social networks in recent years has changed the Internet ecosystem leading to a more collaborative environment. Nowadays, hundreds of millions of Internet users participate in social networks, form communities, produce and consume media content in revolutionary ways. There are very successful EU online Social Networks that account for more than 200 Mio registered users. They would benefit from working together with other relevant EU players to increase their own competitiveness and the competitiveness of the whole EU economy. A partnership among EU partners successfully active on the web (e.g. social networks, gaming, broadcasters, ICT users, incumbent ICT industry and academia) would certainly contribute to increase the competitiveness of EU industry on the web. The partnership would design measures (research, skills, regulatory, access to capital, etc.) to overcome the bottlenecks in order to increase the competitiveness of EU industry on the web.
This paper focuses on the research and technological measures to be adopted. It investigates online social networks as an emerging multidisciplinary research field that bridges social science and multimedia computing. It reflects the consolidated opinion of the members of the NextMEDIA project and the Future Media Networks (FMN) cluster with the collaboration with well known experts, under the guidance of the Networked Media Systems Unit of the Information Society and Media Directorate General of the European Commission.
The paper reviews the current state-of-the-art in selected aspects of social networks and presents a set of open research challenges related to online social networks. The challenges suggest that significant further research is required in the following areas:

- Social graph analysis
- Social media search and management
- Exploiting social graphs
    - for predicting traffic demands and dimensioning media applications
    - for personalising search and recommending content
- Identity algorithms
- Mobile social networks
- Social ranking and opinion sites
- Business and social networking
- Architectures for open and federated social network platforms

The aforementioned fields of research challenges are only few of the dozens of research challenges that the research community faces towards the quest for a ubiquitous, intuitive and secure social web.

Introduction

Social Networks have undergone a dramatic growth in recent years. Such networks provide an extremely suitable space to instantly share multimedia information between individuals and their neighbours in the social graph. Social networks provide a powerful reflection of the structure and dynamics of the society of the 21st century and the interaction of the Internet generation with both technology and other people. Indeed, the dramatic growth of social multimedia and user generated content is revolutionising all phases of the content value chain including production, processing, distribution and consumption. It also originated and brought to the multimedia sector a new underestimated and now critical aspect of science and technology: social interaction and networking. The importance of this new rapidly evolving research field is clearly evidenced by the many associated emerging technologies and applications including online content sharing services and communities, multimedia communication over the Internet, social multimedia search, interactive services and entertainment, health care and security applications. It has generated a new research area called **social multimedia computing**, in which well established computing and multimedia networking technologies are brought together with emerging social media research.

Social Networking Internet services are changing the way we communicate with others, entertain and actually live. Social Networking is one of the primary reasons that many people have become avid Internet users; people who until the emergence of social networks could not find interests in the web. This is a very robust indicator of what is really happening online. The Web 2.0 era passed leaving behind great strength to the end-users. Nowadays, users (also known as prosumers[2]), both produce and consume significant quantities of multimedia content. Moreover, theis behaviour when combined with Social Networking (i.e. communication between users through online communities) has formed a new Internet era where multimedia content sharing through Social Networking Sites (SNSs) is an everyday practice. More than 200 SNSs of worldwide impact are known today and this number is growing quickly. Many of the existing top web sites are either pure SNSs or offer some social networking capabilities[3].

Except for the well known "first tier" social networks with hundreds of millions of users that span in the entire world, there are also many smaller social networking sites that are equally as popular within the more limited geographical scope of their membership, within a city, country or continent, for example. There are also many vertically oriented communities that gather users around a specific topic and thus, they have many dedicated members[4].

Facebook[5] is ranked as one of the most visited sites in the world, with over than 500 million subscribed users to date. Moreover, Friendster[6] is popular in Asia, Orkut[7] in Brazil and Vkontakte.ru[8] in Russia. On top of that, there are dozens of other purely social networks with vibrant communities, such as Vznet[9] (~17 Mio users), Xing[10] (8 Mio users), Badoo[11] (>70 Mio users), Netlog[12] (> 70 Mio users), Tuenti[13] (8 Mio users),

[2] http://en.wikipedia.org/wiki/Prosumer
[3] http://www.alexa.com (accessed Nov 2010)
[4] http://www.research-write.com/2010/02/social-networking-by-the-numbers.html
[5] http://www.facebook.com/
[6] http://www.friendster.com/
[7] http://www.orkut.com/
[8] http://www.vkontakte.ru/
[9] http://www.vznet.net/
[10] https://www.xing.com/
[11] http://badoo.com/
[12] http://netlog.com/

Barrabes[14], Hyves[15] (> 10 Mio users), Nasza Klasa[16] (> 11 Mio users), LunarStorm[17] (> 1.2 Mio users), Zoo[18] (~1 Mio users), Sapo[19], DailyMotion[20], VBOX7[21], iwiw[22] and so on. There are also many vertically oriented communities that gather users around a specific topic, such as Last.fm[23] for music or Goodreads[24] for books. Finally, many mobile social networks appear to fill the gap and detach social networks from desktops. Some of them are aka-aki[25], itsmy[26], brightkite[27] and mobiluck[28], to name a few.

Not all social networks are oriented to non-professional users. LinkedIn[29] with over 80 Mio users or Viadeo[30] with 30 Mio and Xing are mostly oriented in establishing professional connections between their users and initiate potential business collaborations.

The rapid growth in popularity of social networks has enabled large numbers of users to communicate, create and share content, give and receive recommendations, and, at the same time, it opened new challenging problems. The unbounded growth of content and users pushes the Internet technologies to its limits and demands for new solutions. SNSs have the audience to claim their place in the primetime if they solve the challenges they face. Twitter's[31] "fail whale" (twitter's downtime icon) became a social media brand thanks to the frequent twitter's outages when (and not only) worldwide events take place. Facebook gets severe criticism due to privacy concerns. Such challenges are present in all other SNSs to a greater or lesser extent.

Considerable amount of effort has already been devoted worldwide for problems such as content management in large scale collections, context awareness, multimedia search and retrieval, social graph modelling - analysis and mining, etc.

This paper aims to draw the state-of-the-art and identify the research challenges that emerge from the Social Networking reality.

The rest of the paper is organised as follows: Section 3 presents the state-of-the art in selected areas of current Social Networks and their unique features. In Section 4 the provisional research challenges are analysed. Finally, conclusions are drawn in Section 5.

Current situation in selected areas of Social Networks

In this chapter, the current situation in selected areas of SNSs, is described as they have been highlighted by the authors of this paper. It should be noticed that the purpose of this chapter and the paper in general, is not to give an exhaustive and thorough state-of-the art in each and every area. Other areas should not be excluded. Yet, we highlight the

[13] http://www.tuenti.com/
[14] http://www.barrabes.com/home.asp
[15] http://www.hyves.nl/
[16] http://nk.pl/
[17] http://www.lunarstorm.se/
[18] http://www.zoo.gr/
[19] http://www.sapo.pt/
[20] http://www.dailymotion.com/
[21] http://vbox7.com/
[22] http://iwiw.hu/
[23] http://www.last.fm/
[24] http://www.goodreads.com/
[25] http://www.aka-aki.com/
[26] http://www.itsmy.com/
[27] http://www.brightkite.com/
[28] http://www.mobiluck.com/
[29] http://www.linkedin.com/
[30] http://www.viadeo.com/
[31] http://twitter.com/

areas that have been selected as the most important ones and give the interested readers 'the first step' for their further research.

Social graphs

A graph is a mathematical abstraction for modelling relationships between things. A graph is constructed from nodes (the things) and edges (the relationships). This mathematical tool that can model natural and artificial systems such as economy, deceases, power grids, etc. has been used by the anthropologists, sociologists and other humanities oriented academics. However, graph analysis and social network analysis are also valuable tools for studying the web and human behaviours of the web users.

Social network analysis may be applied in any web field where a graph may be constructed. From the appearance of social networking sites, users were forming graphs with their friends and this was the ideal source of fresh data to apply social network analysis. One of the most prominent issues in social networks is the formation or the identification of a network of nodes based on real world knowledge (school friends, colleagues etc.) or web extracted knowledge (they are part of the same online community, they like the same movies, etc.).

Social graph expansion

Social network analysis applied in the web by utilising the interconnected Web 2.0 blogs and their comments. Backlinks of posts and the blogroll (list of other blogs) of each blog constructed a graph that could provide some information. This structure was difficult to update, error prone (copy paste links, write urls, etc.) and the users had to have a web page or blog of their own.

Social networking sites created the tool that made relations easier to track and build. Now every user that has an account in a SNS can "tag" information and propagate it to that network. "Likes", "tweets", "diggs", etc. are one button actions that users perform while surfing the web in order to post a piece of information without leaving from the current web page.

Facebook open graph

Facebook Open Graph[32] provides an interface for interconnecting web pages with the Facebook social graph. The most common practice is to add a "Like" button near a media object in a web page and let users share their "Likes". When a user clicks the "Like" button outside the Facebook platform, a new connection is formed in the user's profile. This simple API has significant impact on the generated content in the Facebook platform considering the 500 million active Facebook users that surf the web and collect "Likes".

Microblogging

Microblogging websites are services, which enable their users to post small text messages that will update their personal profile and will also be delivered to their list of friends. Microblogging became extremely popular due to twitter, however other microblogging sites exist as well with similar functionalities. Twitter currently has approximately 190 million users and growing. After its extreme popularity and due to its flexibility and integration in several platforms (mobile phones, desktop apps, email alerts etc.) marketing experts invented a new tool for fast and targeted advertising. The statistics provided from pearAnalytis[33] study reveal that almost 44% of the posts are

[32] http://developers.facebook.com/docs/opengraph
[33] http://www.pearanalytics.com/blog/wp-content/uploads/2010/05/Twitter-Study-August-2009.pdf

spam and pointless, about 6% are personal or product advertising, while 3.6% are news and 37.6% are conversational posts.
However, there are many other microblogging services available. Tumblr[34] provides similar functionalities, however more focus on the design and styling is given. A more flexible microblogging solution is posterous[35] that provides a unique way to post small messages to various destinations. Posterous enables a user to connect his/her social networking accounts to the posterous platform and to deliver the posts also to other social networking sites or email addresses of choice. One very powerful feature that is relatively new for microblogging as well as for the social networking platforms is the ability for the user to post a message only to a selected group of friends or other recipients and not necessarily for the whole list of friends. A new mobile service that extends this feature and works on the boundaries of microblogging is GroupMe[36]. Users of GroupMe compile groups of their contacts and use a new unique telephone number to reach the group.

Identity algorithms and APIs
Identity algorithms are used to avoid the pollution of the social graph or provide easy access to potential users. In the process of opening their platforms to the outside world, SNSs embraced or build several APIs. The aims of these APIs are to engage more users, get more content from the web or ease the access of users and interlink their content in various sites. The following paragraphs of the subsection refer to such APIs and protocols that are used in most of the known SNSs or sites that provide third party social networking functionalities.

OAuth
OAuth provides a method for clients to access server resources on behalf of a resource owner (such as a different client or an end-user). It also provides a process for end-users to authorise third-party access to their server resources without sharing their credentials (typically, a username and password pair), using user-agent redirections[37]. Facebook platform uses OAuth 2.0 for authentication and authorisation in desktop as well as in mobile applications.

openID
OpenID is a protocol that provides easy sign up or sign in functionality for the users. Most of the widely known web and social networking sites use openID to provide their users with single sign in username and password. Sites like Google, Yahoo!, Face-book, MySpace[38], flickr[39], wordpress[40] and many others use it in order to allow users to enter without the discouraging registration forms and with a unique login for every service. By registering once, a user is able to access any service that supports openID with the same username-password pair that s/he used for the first service. Except for the above mentioned services that act also as openID providers, there are also dedicated openID providers such as claimID[41], myOpenID[42], etc.

[34] http://www.tumblr.com/
[35] https://posterous.com/
[36] http://groupme.com/
[37] http://oauth.net/ (accessed Nov 2010)
[38] http://www.myspace.com/
[39] http://www.flickr.com/
[40] http://wordpress.com/
[41] http://claimid.com/
[42] http://openid.net/get-an-openid/ (accessed Nov 2010)

Social media search and management in large scale

Social media search

Since the domination of social networking sites as the primary channel of communicating ideas and sharing media, new social search engines emerged. However, these search engines crawl the social networks and index the available content based only on text. Some of these keyword-based social search engines are: Spy [43], SamePoint[44], SocialMention[45], WhosTalkin[46], wikio.com.[47]

Spy is a web application that is updated in real time and provides the user with the ability to watch what is being said in a certain topic in specific social networking sites and blogs. SamePoint provides an easy interface for the user to select in which of the social networks to search for a keyword or topic. SocialMention works like Google alerts[48] but for social media. WhosTalkin is a social media search tool that allows users to search for conversations surrounding the topics that they care about the most. Wikio is a personalisable news page featuring a news search engine that searches media sites, blogs and the contributions of Wikio members.

Content management in large scale

In the scale that most of the prime social networks operate, even the most common operations are not trivial. The most powerful example is Facebook that has to handle almost 500 Million active users that share more that 3 billion photos per month and its servers should serve about 1.2 million photos per second[49].

For such volumes of content management becomes a very crucial issue. Here we refer to some technologies and tools that most of the social networks use in order to survive the torrents of queries.

Memcached[50]

Memcached is a distributed caching system that caches database queries in order to minimise the relatively slow database access. Memcached started from LiveJournal blogging and social networking site and released as open source. At this time Facebook runs thousands Memcached servers with tens of terabytes of cached data.

Custom compilers or special programming languages

Most of the social networking sites in the race to optimise their source base to the limits use custom compilers for the special needs of their hardware or use new special programming languages that fulfill their custom needs.

Some examples are "HipHop for PHP" which converts PHP to C++ in order to be compiled and run natively on the servers for better performance. Another example is Twitter that dropped ruby for its back–end servers and uses Scala[51], a new programming language that handled well the vast amount of parallel requests.

Haystack[52]

Haystack presents a generic HTTP-based object store containing needles (objects representations) that map to stored opaque objects. Storing photos as needles in the

[43] http://spy.appspot.com/
[44] http://www.samepoint.com
[45] http://socialmention.com/
[46] http://www.whostalkin.com/
[47] http://www.wikio.com/
[48] http://www.google.com/alerts/
[49] http://royal.pingdom.com/2010/06/18/the-software-behind-facebook/ (accessed Nov 2010)
[50] http://memcached.org/
[51] http://www.scala-lang.org
[52] http://www.facebook.com/note.php?note_id=76191543919

haystack eliminates the metadata overhead by aggregating hundreds of thousands of images in a single haystack store file. This keeps the metadata overhead very small and allows the user to store each needle's location in the store file in an in-memory index. This allows retrieval of an image's data in a minimal number of I/O operations, eliminating all unnecessary metadata overhead.

Cassandra[53]
Cassandra is a distributed storage system with no single point of failure. It's one of the poster children for the NoSQL movement (others are MongoDB, Redis etc.) and has been made open source (it becomes an Apache project). Cassandra is in use at Digg[54], Facebook, Twitter, Reddit[55], Rackspace[56], Cloudkick[57], Cisco[58], SimpleGeo[59], Ooyala[60], OpenX[61], and more companies that have large, active data sets. The largest production cluster has over than 100 TB of data in over than 150 machines.

Human powered and community question answering
Human powered systems emerged from the social networks, which provided the ability to the user to contribute with web content. Since artificial intelligence and computer vision problems were consistent, the researchers envisioned that the solution to unsolved problems was to harness the human intelligence. However, to engage users to answer questions, annotate image or proofread OCR extracted text for free had to have something as a reward. Towards this end the "games with a purpose" (GWAP) appeared. In a GWAP the user answers or solves difficult for a computer but easy for a human problems while s/he plays an online game.
In the same track, online community question answering sites provide a place that everyone can contribute by answering questions from other members. The answers are validated by a "start-based" system where the end user gives feedback whether the answer was helpful or not. Some of the well known community questions answering systems are yahoo! Answers[62] for general questions, stackoverflow[63] for questions on programming, serverFault[64] for server administrators and IT professionals or "Seasoned Advice"[65] for cooking professionals and many others.
A very interesting service is the Aardvark[66] search engine, which finds the most relevant person from the user's contact list and the entire community of the users to answer a question. Aardvark accepts questions in natural language (not just keywords) and uses a novel algorithm[67] in order to map the question to the most relevant recipient.

[53] http://cassandra.apache.org/
[54] http://digg.com/news
[55] http://www.reddit.com/
[56] http://www.rackspace.com/
[57] https://www.cloudkick.com/
[58] http://www.cisco.com/
[59] http://simplegeo.com/
[60] http://www.ooyala.com/
[61] http://www.openx.org/
[62] http://answers.yahoo.com/
[63] http://stackoverflow.com/
[64] http://serverfault.com/
[65] http://cooking.stackexchange.com/
[66] http://vark.com/
[67] http://vark.com/aardvarkFinalWWW2010.pdf

Mobility and geolocation

Location-based social networks allow members to share their location through GPS, Bluetooth, email or text messaging. The member of the network may also add comments about restaurants, allow friends to know where you are going, share information, or find friends that are few blocks away or even in the Café across the road.

Several mobile-only social networks have emerged, all with unique features that would potentially attract users. However, there is one feature that every mobile social network should have and this is physical presence detection and information exchange[68]. This is exactly the reason for porting a community in a mobile device and detach it from a desktop PC.

Some of the well known location based mobile social networks are: BrightKite[69], Aka-Aki[70], Mobiluck[71]. The mobile social network sites may be clustered in 6 main categories[72] based on their dominant features. These are:

1. The group texter: This service focuses on sending short, text-based messages in a group of people at once.

2. The radar: The radar knows where the user and his/her friends are. These sites support location-based services by keeping track of where the user's contacts are. Most of these sites allow the user to check if there is anyone close to a particular venue or location, while some of them actively alert him/her if any of his/her contacts are within a certain distance.

3. The Geotagger: These sites allow users to tag locations with images and information that appear on a world map. The user may tag favourite places for shopping, dining or any other activity and share these tags with their friends and the network.

4. The dating service: These sites are identical to their online counterparts. Users create a profile and they are matched with other users. Some also use radar features to alert the user if an interesting (according to the profile) person is nearby.

5. *The social networker*: These sites aim to be as similar as possible to online social networking platforms. Some of the well known SNS such as Facebook and twitter have also a mobile version.

6. The Media share: These sites share media files with groups of people.

There are also location-based social networks that are not targeting mobile devices only, such as picasa and flickr image geotagging services.

Social rankings and vertical social networks

Although these may not be considered as pure social networks, special attention should be given to the social sites which are dedicated to vertical markets such as the travellers community (for example tripadvisor[73], travbuddy[74] or dopplr[75]), films or music. These sites offer services opinion sharing by the users and they compute rankings. For example, dopplr allows its members to register their personal and business travel plans and get alerts for friends in same places, travel overlaps, or get travel advice from other travellers. One of the open issues is to establish methodologies and tools to distinguish

[68] Michael Arrington, Techcrunch.com, http://techcrunch.com/2007/09/11/the-holy-grail-for-mobile-social-networks/ (accessed Nov 2010)
[69] http://brightkite.com/
[70] http://www.aka-aki.com/
[71] http://www.mobiluck.com/en/
[72] http://www.gomonews.com/moso/
[73] http://www.tripadvisor.com
[74] http://www.travbuddy.com/
[75] http://www.dopplr.com/

between real and fake opinions on those social sites, which is applicable to social networks in general.
Another relevant social opinions exchange tool is the "social bookmarking", which main site is del.icio.us[76] with 9 Mio users who share and establish collections of bookmarks between users.

Business and Social Networking
Another area with huge growth potential is the use of social networks and/or social networking techniques for business whether it is for improving communications, for marketing or by deriving business intelligence. There are now many different solutions in the market for "Social Business Solutions" and large IT companies and consulting forms are starting to create new departments in this area.
Businesses are slowly coming to the realisation that traditional communication methods are often less effective than social networking.

Social Businesses
Intra company relations: The enterprise can be considered as a dedicated social network and all of the employees as members. In a social network the relationship between members is flat rather than hierarchal. This flat relationship between employees can foster collaboration, brainstorming and creativity.
"Social CRM": Just as with intra company relations, a more informal hierarchy can allow companies to work together in a more collaborative way.
Blogging: Blogging can be a very direct, and interactive, way for companies to relate to their customers, clients, shareholders, providers, etc. It is much more immediate and personal way to transmit news and information and to get feedback directly from the recipient.
Viral marketing (basically driven through social networks). In the last few years viral advertising has taken on a fundamental role in the marketing campaigns of many companies. An ad, new product or news item is directed to key persons who the company knows or suspects have an important social position on the net and especially within social networks. These persons pass on the ad or information to their contacts rapidly, if the key person has been chosen adequately it can soon reach thousands or even millions of people.

Social Analytic tools
The technique of data analysis of the communications in social communications (often referred to as the "social graph") is an extremely powerful tool for business. For example, analysis of relations and communications between members of a group or a community can show which are the most important ones (socially). This information can be vital when a viral marketing plan is being formulated or when a loyalty scheme is going to be implanted amongst a company's customers.
A great market has been opened to both the clients of the data analysis and to the researchers and developers of new solutions for the data analysis. Argyle Social[77], Trackur[78] and Radian6[79] are some of the examples of commercial tools which are used to analyse the data coming from social networks, profile the users and personalise the marketing strategies.

[76] http://www.delicious.com/
[77] www.argylesocial.com
[78] www.trakur.com
[79] www.radian6.com

Social Television

Social Television stands for technology that provides social interaction in the context of watching TV-programs or related to television content. It is a very active area of research and was named one of the 10 most important technologies by the MIT. Social Television is a fast growing market and multiple startups have recently appeared.

Social TV has been around for more than 10 years already but not till the rise of social networks it has become feasible, since it already encourages constant connection between members of the network and the creation of likely minded groups. Today's 18-28 years old access the internet more often than they watch television and a growing number among them is interested in having more social features integrated into their TV-experience. Furthermore 23 % of U.S. broadband users want to view online content from sites like YouTube or Flickr on their TVs. [80]

Social television is connecting viewers with their friends, families and people with same interests giving them a space to discuss and exchange recommendations. But how should this interaction be provoked? Demanding from the user to sit in front of his/her TV-Set using mouse and keyboard for interaction does not sound like the best solution. With Sonys release of its Playstation Move Controller all three major gaming platforms (Sony Playstation, Microsoft XBOX and Nintendo Wii) are now using alternative haptical user interfaces Additional drivers to use the Nintendo's Wii controller on Mac, PC or even on a Smartphone already exist for years[81], Microsoft's Kinect has been reported to be hacked just recently[82] and an open source solution for using Sony's Move controller on PCs[83] is on its way opening up an interesting research field of how to use these controllers as interaction devices for other purposes like controlling Social TV content.

Social Gaming

Social Gaming is a term for games that are based on social interaction. By augmenting the game logic with social aspects players have to deal with each other in various ways to advance throughout the game. While social aspects have been part of massively multiplayer online role playing games (MMORPG) like World of Warcraft for quite a while already, the rise of Facebook and Co created the ground for a new field of games with social interaction as the main focus.

52% of the US adult population plays online games whereas 21% of this group is playing on a regular basis. [84] Just recently EA-Games announced the signing of a contract for five year partnership with facebook, producing online games for the world´s biggest social online platform using the new Facebook Credits system[85]. Playfish[86] and Zynga[87] are also sound examples of game development agencies that develop social games and use online social networks (Facebook, myspace, etc.) as their main distribution channels.

While games in 2009 were often rough-hewn affairs, with a focus on often-spammy viral techniques, 2010 has seen rapidly improving production values with the market

[80] http://www.parksassociates.com/press/press_releases/2009/mar10-socialnetworking.html
[81] http://www.ehow.com/how_2102972_control-computer-wii-remote.html
[82] http://www.engadget.com/2010/11/10/open-source-kinect-camera-driver-now-available-for-download/
[83] http://code.google.com/p/moveonpc/
[84] http://pewinternet.org/~/media//Files/Reports/2010/PIP_Nielsen%20Apps%20Report.pdf
[85] http://www.facebook.com/help/?page=1038
[86] http://www.playfish.com/
[87] http://www.zynga.com/

being taken over by international companies like Disney[88] and games like Farmville are played by millions of people.
For 2010 the sales volume of Social Gaming is expected to reach one billion US dollar, still a small number compared to the 19 billion dollar being awaited for the whole global online gaming market. But keeping in mind that last year´s sales volume only reached 500 million and in 2008 it only were a mere 100 million the tremendous speed of the growth of the social online gaming market becomes visible.[89] But these numbers also make an underlying problem of the social gaming market visible. Big companies, with the expectations of gaining high profit, are pumping a lot of capital into this sector. Some analysts already fear that a bubble is being created that sooner or later is going to pop[90]. Research projects aiming at the Social gaming market should keep an eye on dissemination possibilities beside of the usual distribution channels (Facebook and Co.) as well.

Social Networks - Research Challenges

This section presents selected open research challenges that are currently being investigated by the research community. The authors would like to make clear that these are only few of the dozens of research challenges that the research community faces towards the quest for a ubiquitous, intuitive and secure social web.

Avoiding fragmentation of the social graph through open cross-platform interactions

A major hindrance to exploitation of social network data is the fragmentation of the population of social network users into numerous proprietary and closed social networks. This issue is compounded by the fact that each new game or media application tends to build its own social network around it rather than building upon the rich data available about existing social relationships. Also applications are often restricted to execute within the confines of specific social network platform. A major research challenge, therefore, that would benefit the exploitation of social network graphs for future media networking, is in finding solutions to open up social network platforms to allow cross-platform information exchange and usage. Of course, reliable mechanisms to preserve privacy are an essential prerequisite.

Communities discovery and analysis in large scale online and offline social networks

As social networks will continue to evolve, discovering communities and constructing specific social graphs from large scale social networks will continue to be a dynamic research challenge [15].

Security by means of Social Networks Analysis

The information extracted from Social Networks proved to be a useful tool towards security. One example of an application related to security is the Analysis of terrorism [20], as for instance, the Analysis of the 9-11 Terrorist Network [21] . This study was done by gathering public information from major newspapers on the WWW and analysed it be means of Social networks. A major research challenge on social network analysis is also cyber surveillance for unlawful activities for critical infrastructure protection [21].

Social and Ethical Issues in a Networked World

As in every small or large community, online social communities face also critical social and ethical issues that need special care and delicate handling. Sharing of

[88] http://techcrunch.com/2010/07/27/playdom-acquired-by-disney-for-up-to-763-2-million/
[89] http://www.gamesbrief.com/2010/06/the-online-games-market-was-worth-15-billion-in-2009-and-will-grow-to-20-billion-in-2010/
[90] http://techcrunch.com/2010/09/17/social-gaming-hi5/

personal information, protection of child exploitation and many other problems have to be studied and answered appropriately [19].

Searching blogs, tweets, and other social media

Searching in blogs, tweets and other social media is still an open issue since posts are very small in size but frequent, with little contextual information and sometimes extremely temporal [4]. Moreover, different users have different needs when it comes to the consumption of social media. Real time search has to balance between quality, authority, relevance and timeliness of the content.

Human-powered community question answering and expert finding.

Human powered (aka crowdsourcing) systems gave promising solutions to problems that were unsolved for years. The research community should continue working on leveraging human intelligence to solve critical problems and answer questions that otherwise would be impossible to answer automatically [5][6]. Social networks contain immense knowledge through their users. However, it is not trivial to find the one that has the knowledge and is also available to share it [7].

Traffic prediction for dimensioning media applications

Investigation of how to exploit knowledge of social network relationships to predict how media consumption may be correlated between groups of users. This information can be used to dimension media servers and network resources to avoid congestion and improve QoE.

Social, mobile, pervasive content sharing and live media distribution

Since users act as prosumers, content sharing and distribution needs will continue to increase. Mobile phones, digital cameras and other pervasive devices produce huge amounts of data that users want to distribute if possible in real time [13] [14].

Spam, opinions and adversarial interactions in social media

Spam detection and advertisement detection are research challenges that need extra attention from the research community. Since users and data production increase, spam (irrelevant information) and advertisements will continue growing [1].

In addition, the importance of social networks to influence the opinions of the users should be protected with the adequate mechanism to avoid biased and fake opinions due to the relevance to the businesses.

Personalisation for social interaction

In order to improve social interaction and enhance social inclusion, personalization engines that locate peers with possibly common likes, dislikes or developing trends should be engineered. Towards more efficient search engines that will be able to serve the users only with relevant content, personalisation algorithms have to be studied in a greater extent.

Dynamics and evolution patterns of social networks, trend prediction

Research in dynamics and trends in social networks will provide more valuable tools for information extraction that may be used for content management and delivery, epidemic predictions or recommender systems[2][3].

Information diffusion in Social Networks

Research in Information diffusion is more than ever needed since the domination of social networks as a communication platform [16][17][18].

Use of Social Networks for business and marketing

Social networking introduced novel collaboration paradigms between network users and serious study is conducted on the use of such platforms for internal business purposes [11]. However, one of most prominent research challenges is how to use social networking for external communications, customer support and of course targeted marketing [12].

Social gaming and social television

Research is needed on better mass feedback mechanisms for both social gaming and social television. For social gaming as "serious game" is a research challenge.

Immersive Social Networks

Immersive social networks will be the future web platforms for social interaction, communication and infotainment. Immersion will provide an intuitive environment and enhance user experience in order to let the users socialize and interact in a more natural way.

Conclusions

This paper examined social networks as a new multidisciplinary research field that bridges social science and multimedia computing. It introduced the most important aspects of social networks by considering four main aspects: state of the art overview, trends, challenges and open questions. EU social networks, accounting more that 200 Million registered users, are able to improve competitiveness of European web industry by collaborating with established EU ICT industry and academia

The goal of this publication was to provide an initial base line to build a discussion forum on the most critical issues related to social networks. The outcomes of these discussions could feed into the research agendas of the European Union programmes for the near future.

References

[1] Benjamin Markines, Ciro Cattuto, and Filippo Menczer; "Social spam detection". In Proceedings of the 5th International Workshop on Adversarial Information Retrieval on the Web (AIRWeb '09), Dennis Fetterly and Zolt\&\#225;n Gy\&\#246;ngyi (Eds.). ACM, New York, NY, USA, 41-48. DOI=10.1145/1531914.1531924 http://doi.acm.org/10.1145/1531914.1531924

[2] Takeshi Sakaki, Makoto Okazaki, and Yutaka Matsuo; "Earthquake shakes Twitter users: real-time event detection by social sensors". In Proceedings of the 19th international conference on World wide web (WWW '10). ACM, New York, NY, USA, 851-860. DOI=10.1145/1772690.1772777 http://doi.acm.org/10.1145/1772690.1772777

[3] Lampos, Vasileios; Cristianini, Nello; "Tracking the flu pandemic by monitoring the social web," Cognitive Information Processing (CIP), 2010 2nd International Workshop on , vol., no., pp.411-416, 14-16 June 2010 doi: 10.1109/CIP.2010.5604088

[4] White, T.; Chu, W.; Salehi-Abari, A.; "Media Monitoring Using Social Networks," Social Computing (SocialCom), 2010 IEEE Second International Conference on, vol., no., pp.661-668, 20-22 Aug. 2010 doi: 10.1109/SocialCom.2010.102

[5] Rodrigues, E.M.; Milic-Frayling, N.; Fortuna, B.; "Social Tagging Behaviour in Community-Driven Question Answering," Web Intelligence and Intelligent Agent Technology, 2008. WI-IAT '08. IEEE/WIC/ACM International Conference on vol.1, no., pp.112-119, 9-12 Dec. 2008 doi: 10.1109/WIIAT.2008.138

[6] Li, G.; Li, H.; Ming, Z.; Hong, R.; Tang, S.; Chua, T.; "Question Answering over Community Contributed Web Video," Multimedia, IEEE, no.99, pp.1-1, 0 doi: 10.1109/MMUL.2010.47

[7] Jian Jiao; Jun Yan; Haibei Zhao; Weiguo Fan; "ExpertRank: An Expert User Ranking Algorithm in Online Communities," New Trends in Information and Service Science, 2009. NISS '09. International Conference on, vol., no., pp.674-679, June 30 2009-July 2 2009 doi: 10.1109/NISS.2009.75

[8] Walenz, B.; Gandhi, R.; Mahoney, W.; Quiming Zhu; "Exploring Social Contexts along the Time Dimension: Temporal Analysis of Named Entities," Social Computing (SocialCom), 2010 IEEE 2nd International Conference on, vol., no., pp.508-512, 20-22 Aug. 2010 doi: 10.1109/SocialCom.2010.80

[9] Yu-Ru Lin; Sundaram, H.; De Choudhury, M.; Kelliher, A.; "Temporal patterns in social media streams: Theme discovery and evolution using joint analysis of content and context," Multimedia and Expo, 2009. ICME 2009. IEEE International Conference on, vol., no., pp.1456-1459, June 28 2009-July 3 2009 doi: 10.1109/ICME.2009.5202777

[10] Trier, M.; Bobrik, A.; "Social Search: Exploring and Searching Social Architectures in Digital Networks," Internet Computing, IEEE , vol.13, no.2, pp.51-59, March-April 2009 doi: 10.1109/MIC.2009.44

[11] Fortino, A.; Nayak, A.; "An architecture for applying social networking to business," Applications and Technology Conference (LISAT), 2010 Long Island Systems , vol., no., pp.1-6, 7-7 May 2010 doi: 10.1109/LISAT.2010.5478285

[12] Yu Zhang; Zhaoqing Wang; Chaolun Xia; "Identifying Key Users for Targeted Marketing by Mining Online Social Network," Advanced Information Networking and Applications Workshops (WAINA), 2010 IEEE 24th International Conference on , vol., no., pp.644-649, 20-23 April 2010 doi: 10.1109/WAINA.2010.137

[13] Conti, M.; Delmastro, F.; Passarella, A.; "Social-aware Content Sharing in Opportunistic Networks," Sensor, Mesh and Ad Hoc Communications and Networks Workshops, 2009. SECON Workshops '09. 6th Annual IEEE Communications Society Conference on , vol., no., pp.1-3, 22-26 June 2009 doi: 10.1109/SAHCNW.2009.5172964

[14] Santos, R.O.; Fabris, F.; Martinello, M.; Marcondes, C.; "JoinUs: Management of Mobile Social Networks for Pervasive Collaboration," Sistemas Colaborativos, 2008 Simpósio Brasileiro de , vol., no., pp.224-234, 27-29 Oct. 2008. doi: 10.1109/SBSC.2008.14

[15] Prakash, B.A.; Seshadri, M.; Sridharan, A.; Machiraju, S.; Faloutsos, C.; , "EigenSpokes: Surprising Patterns and Scalable Community Chipping in Large Graphs," Data Mining Workshops, 2009. ICDMW '09. IEEE International Conference on, vol., no., pp.290-295, 6-6 Dec. 2009 doi: 10.1109/ICDMW.2009.103

[16] Bo Xu; Lu Liu; "Information diffusion through online social networks," Emergency Management and Management Sciences (ICEMMS), 2010 IEEE International Conference on , vol., no., pp.53-56, 8-10 Aug. 2010 doi: 10.1109/ICEMMS.2010.5563505

[17] Jin-Tao Tang; Ting Wang; Ji Wang; "Measuring the influence of social networks on information diffusion on blogspheres," Machine Learning and Cybernetics, 2009 International Conference on , vol.6, no., pp.3492-3498, 12-15 July 2009 doi: 10.1109/ICMLC.2009.5212771

[18] Apolloni, A.; Channakeshava, K.; Durbeck, L.; Khan, M.; Kuhlman, C.; Lewis, B.; Swarup, S.; "A Study of Information Diffusion over a Realistic Social Network Model," Computational Science and Engineering, 2009. CSE '09. International Conference on , vol.4, no., pp.675-682, 29-31 Aug. 2009

[19] Garcia-Ruiz, M.A.; Martin, M.V.; Ibrahim, A.; Edwards, A.; Aquino-Santos, R.; , "Combating Child Exploitation in Second Life," Science and Technology for Humanity (TIC-STH), 2009 IEEE Toronto International Conference, vol., no., pp.761-766, 26-27 Sept. 2009doi: 10.1109/TIC-STH.2009.5444398

[20] Uffe Kock Wiil, Jolanta Gniadek, Nasrullah Memon; Measuring Link Importance in Terrorist Networks. Social Network Analysis, 225-232. Ed. Nasrullah Memon, Reda Alhajj (Eds.): Interna-tional Conference on Advances in Social Networks Analysis and Mining, ASONAM 2010, Odense, Denmark, August 9-11, 2010. IEEE Computer Society 2010, ISBN 978-0-7695-4138-9

[21] Krebs Valdis. "Uncloaking Terrorist Networks." First Monday 7, no. 4 (March2002). http://www.firstmonday.org/issues7 4/krebs..

[22] Vaclav Snasel, Ajith Abraham, Khalid Saeed and Hameed Al-Qaheri, A Framework for Cyber Surveillance of Unlawful Activities for Critical Infrastructure Using Computational Grids, Editors: Sixth International Conference on Information Assurance and Security (IAS), USA, IEEE, ISBN 978-1-4244-7408-0, pp. 345-350, 2010.

Editors

Name	Affiliation	e-mail
Theodoros Semertzidis	CERTH/ITI	theosem@iti.gr
Petros Daras	CERTH/ITI	daras@iti.gr
Isidro Laso Ballesteros	EC	Isidro.LASO@europa.ec.eu

Contributors

Name	Affiliation	e-mail
Theodore Zahariadis	SYNELIXIS	zahariad@synelixis.com
Paul Moore	ATOS	paul.moore@atosresearch.eu
Federico Alvarez	UPM	fag@gatv.ssr.upm.es
Ebroul Izquierdo	QMUL	ebroul.izquierdo@elec.qmul.ac.uk
David Griffin	UCL	dgriffin@ee.ucl.ac.uk
Jeldrik Schmuch	ATOS	Jeldrik.schmuch@atosresearch.eu
Emilio Corchado	University of Salamanca	escorchado@usal.es