

Future Internet Enterprise Systems (FInES) Cluster

Position Paper

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“You could not step twice into the same river; for other waters are ever flowing on to you.”

Heraclitus, Greek philosopher (540 BC – 480 BC), On the Universe

Courtesy of Mr Gérald Santucci, European Commission

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Editors

Man-Sze Li, IC Focus

Mehmet Kürümlüoğlu, Fraunhofer Institut für Arbeitswirtschaft und Organisation

Margaretha Mazura, European Multimedia Forum

Roelof van den Berg, Erasmus Research Institute of Management

Contributing Projects and Initiatives

FP7 COIN, <http://www.coin-ip.eu/>, in particular Sergio Gusmeroli, Claudia Guglielmina, Man-Sze Li, Andrew Faughy and Marco Conte

FP7 COMMIUS, <http://www.commius.eu>, in particular Enrico Morten

CIP DEN4DEK, <http://www.den4dek.org/blog/> in particular Jesús Gabaldon

FP7 iSURF, <http://www.srdc.com.tr/isurf/>, in particular Asuman Dogac

FP7 K-NET, <http://www.k-net-fp7.eu>, in particular Rui Neves-Silva

FP7 SPIKE, <http://www.spike-project.eu>, in particular Oliver Gmelch and Günther Pernul

FP7 SYNERGY, <http://www.synergy-ist.eu/>, in particular Keith Popplewell

FP6 CoVES, <http://www.coves-project.org>, in particular Mehmet Kürümlüoğlu

FP6 ImportNET, <http://www.importnet-project.org/>, in particular Milan Marinov

FP6 LEKTOR, <http://www.lexerator.eu>, in particular Margaretha Mazura

FP6 OPAALS, <http://www.opaals.org/>, in particular Paolo Dini

FP6 SUDDEN, <http://www.sudden.biz>, in particular Nikolay Mehandjiev

INTEROP-VLab, <http://www.interop-vlab.eu/>, in particular Michele Missikoff, Raul Poler, Ricardo Goncalves, Keith Popplewell, Pontus Johnson, Paul Johannesson, Martin Zelm, Kurt Kosanke, Kai Mertins and Frank-Walter Jaekel, under the coordination of Guy Doumeings

TAHI, <http://www.theapplicationhome.com/>, in particular Stephen Pattenden

Additional Contributing Experts

Raphael Giesecke, Helsinki University of Technology

Ricardo Goncalves, UNINOVA

Claudia Guglielmina, TXT e-solutions

Dirk-Michael Harmsen, DMH Consulting

Norbert Jastroch, MET Communications

Fenareti Lampathaki and Yannis Charalabidis, Greek Interoperability Centre

Anton Lavrin and Miroslav Zelko, Technická Univerzita v Košiciach

Michele Missikoff, CNR LEKS-IASI

Stephen Pattenden, Telemetry

Luigi Telesca, CREATE-NET

Javier Vázquez Salceda, UPC

All participants of the knowledge cafés organised for the FInES Cluster Meeting, 16 June 2009, London

European Commission support

Carlos Ruano Sánchez

European Commission contact point

Cristina Martinez, Head of FInES Cluster, EC, cristina.matinez@ec.europa.eu

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All public versions of this document, including all materials submitted by contributors, are available at

http://cordis.europa.eu/fp7/ict/enet/fines-positionpaper_en.html

Key References of FInES Cluster

FInES Cluster Projects

http://cordis.europa.eu/fp7/ict/enet/ei-projects_en.html

Enterprise Interoperability Research Roadmap

http://cordis.europa.eu/fp7/ict/enet/ei-research-roadmap_en.html

Value Proposition for Enterprise Interoperability Report

http://cordis.europa.eu/fp7/ict/enet/ei-isg_en.html

FP7 ICT Work Programme 2009-2010 (Objective 1.3)

ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2009-10_en.pdf

1. Introduction

On 19 February 2009 the Future Internet Enterprise Systems (FInES) Cluster was launched by the European Commission in Brussels. The FInES Cluster is an evolution of the former Enterprise Interoperability (EI) Cluster. It brings together constituencies of three major research streams supported by the Commission over a number of years - EI, Enterprise Collaboration and Digital Ecosystems. The combined research domain of FInES is now one element of the overall research field of the Future Internet (see description on page 13), with a specific research focus on ICT adoption and usage by enterprises.

The FInES Cluster has the following proposed vision statement: *The full potential of the Future Internet is accessible to, relevant for, and put to use by European enterprises including SMEs. The Internet thus becomes a universal business system on which new values can be created by competing as well as collaborating enterprises - incumbent as well as new - through innovation in a level playing field, with sustainable positive benefits for the economy, society and the environment.*

The present document is the first collective output of the FInES Cluster to establish a common baseline for the development of the Cluster. It has four purposes:

1. To analyse the current economic context from the perspective(s) of **European Enterprises**;
2. To provide a contribution on the **vision, nature, shape and requirements of Future Enterprises** in complement to the above;
3. To support the **re-orientation of the FInES Cluster** in light of the new entrants;
4. With reference to the current (2009-2010) and the next (2011-2013) FP7 ICT Work Programmes, to input to the **context for the research work of Objective 1.3**.

The scope spans three inter-related areas - Future Internet, a new generation of ICT-enabled enterprise systems, and sustainable businesses. Importantly, while the issues raised are global, the focus is European, and the underlying perspective is business-driven.

Taking the current economic context (and especially the global financial and economic crisis) as a starting point, the document provides context analysis and assesses the potential impact of that context on the research domain of FInES. Taking account of the changing contexts and in anticipation of the requirements of future enterprises, the document articulates a vision for FInES 2025. It makes recommendations that support the definition of research priorities for FInES as an integrated research domain and proposes related actions.

In line with the European Commission's Future Internet research initiative, the document has a reference timeframe up to 2025. But, importantly, **the articulation of a long term vision goes hand in hand with targeting short and medium term capabilities to support industry, as recovery from the current crisis begins**. This standpoint guides the development of the document, and is reflected in the contents of the recommendations.

The document has two main target audiences:

- Research projects and researchers in the FInES Cluster and beyond
- All other stakeholders of FInES (see description on page 13).

The document takes stock of and builds out from the achievements of the EI Cluster of the past 5 years, including the vision of the Enterprise Interoperability Research Roadmap, the analysis of the Value Proposition for Enterprise Interoperability Report, the achievements of the Digital Ecosystems Cluster, and the relevant available research results of the Cluster projects.

The contents in the sections below are based on contributions from projects and organisations linked to the Cluster and interested parties. The contributions received are consolidated into **Annex I**.

To fully cover its scope, the document also draws on a large collection of external sources identified by the contributors, the Commission and the editors. These reference sources are listed in **Annex II**.

The outputs of the knowledge cafés organised for the FInES Cluster Meeting, held on 16 June 2009 in London, are incorporated. A summary of the knowledge café discussions is given in **Annex III**.

Notes to identify specific references or to substantiate the text are provided in **Annex IV** (individual notes are numbered sequentially; the numbers are placed between square brackets in the text).

The development of the document is under the overall coordination of the FInES Cluster. Successive draft versions have been published by the Commission for open consultation. The document is prepared by four voluntary editors.

2. Context Analysis

Economic and Business Context

In 2008 Europe was shaken by the global financial crisis and faced the biggest recession since the 1930s. In February 2009, for the Euro Zone, the European Commission adjusted its forecasts from 2% to 4% contraction for the economy. Although EU Member States were affected at different levels to different degrees and started to recover, one issue is clear: the crisis goes far beyond the visible economic turmoil. It is an existential crisis of values that so far have been undisputed in most European countries. Without prejudice to microeconomic views that tend to dissociate the crisis from day-to-day business, one must draw lessons from the economic downturn in day-to-day business too, and appreciate it as an opportunity towards sustainable value creation.

Thus, the economy as a whole and each single stakeholder will have to rethink their founding values involving new factors such as energy shortage and climate change. Environmental and energy measures need to become part of mainstream business practices, and be supported by and fully integrated into next generation enterprise systems to avoid a global collapse as a result of inconsiderate pollution and use of energy.

In its mid-term review of i2010, the European Commission reported that many parts of the EU still lagged behind in adopting ICTs [1]. According to the Commission's latest 2009 report on i2010, only 12% of total enterprise turnover is made online, an improvement of a mere 2 percent with respect to 2005. Thus, the actual implementation of use of ICT in business processes, especially those involving relations with customers and suppliers, remains limited [2].

Critical times are always opportunities for change. This view is shared by most of the stakeholders [3,4]. The Future Internet may provide a viable path towards the required changes and the implementation of novel business practices. Specifically, it must deliver for enterprises.

Collaboration networks already play a key role in business. They may be further developed as a driving force for the change. There are a multitude of advantages attributed to such networks:

- Value chain streamlining (better integration and new opportunities arising from the interaction of partners and customers)
- Opening up new markets through domain-specific knowledge of individual partners
- Alliance between complementary partners
- Use of economies of scope (cost reduction by joint activities)
- Use of economies of scale (cost reduction by increasing a company's output)
- Critical mass through aggregation of the partners (e.g. public tender offers).

Cross-industry collaboration and new business partnerships are emerging, e.g. for content aggregation and distribution [5]. The overarching aim of the collaboration is to provide motivation to work together in new ways, across disciplinary boundaries, and between all stakeholders. The concept of the Knowledge Economy recognises that physical value (wealth) creation chains depend also on the intellectual capability to design products and manufacture systems. As product life cycles are shortened, and the technological content of products explodes, the ability to design both products and their manufacturing systems becomes a major proportion of economic activity. In manufacturing but also more generally for the economy as a whole, where knowledge becomes a defining attribute, knowledge is considered to be itself a commodity; and there is a knowledge exploitation chain, which has an interesting duality with the conventional physical value chain.

Policy Context

At the European Commission High Level Conference, “Industrial Competitiveness and the Role of Policy in Difficult Times” in March 2009, President Barroso underlined “the chance for setting new priorities and stimulating the renewal of the industrial sector. At Community level, the European industrial policy provides the right framework for actions that target sustained competitiveness while avoiding short-sighted interventionist moves” [6]. Thus, he acknowledges the need for a growth-inductive political and regulatory environment without too much State involvement. This approach is in line with the observations from project contributions. The cross-stakeholder cooperation is emphasised by eBusiness W@tch: “The main barrier for ICT adoption by SMEs appears to be a lack of awareness of the possibilities and benefits that ICT could offer; ... Again, this requires multi-national cooperation between governments, industry representatives (e.g. chambers of commerce) and the ICT industry.” [7].

More than 99% of Europe’s enterprises are SMEs [8]. However, there is one caveat if SMEs are to benefit from ICT: make a differentiation! The notion of “SME” is far too broad to easily address the needs of all encompassed in it. Depending on the sectors, the structures and size, needs of SMEs are both varied and complex, as is their innovation level. There is a need to re-think the “SME paradigm” and the policy approach to effectively support SMEs as the engine of the European economy.

Alongside rethinking the approach to SMEs, the regulatory environment will have to accommodate old fundamental rights and new needs. A holistic view will be necessary to accommodate the changing scientific, economic, business and social environment. It will be up to the decision-makers and lawyers together with all stakeholders to strike a *healthy balance* in the quickly changing Knowledge Society, e.g. reconciling IP protection with the sharing paradigm of the Internet, the fundamental right of privacy with user-centred services, or trust and security with open access in a Virtual World, to mention just a few. There is, therefore, a major challenge to involve legislators outside the scope of the law to understand the opportunities and mechanisms of the “next generation of the knowledge society”, and take these into consideration while revising existing or drafting new regulations.

Social and Societal Context

The Information and Knowledge Society, in particular facilitated by the Web 2.0 social media, radically changes the way people communicate with each other, voice their opinion, generate content and interact with physical, legal or web entities. The FInES Cluster recognises this development of changed interaction and communication between humans, the human-machine relationship, the opportunities ICT offers (e.g. e-inclusion, “better” ageing) and its parallel inherent danger (e.g. enlarging the digital divide, unrestricted monitoring) etc. The domain therefore includes social and societal challenges where they fall directly into the scope of this Position Paper or where they have a direct impact on policy and research recommendations.

Technology Context

The EU has put forward free movement of knowledge as a fifth freedom available to all, no matter where it is situated. While scientific and technical knowledge is crucial for the competitiveness of the ICT sector, promising technologies alone will not provide the competitive edge for enterprises. More must be done to stimulate investments in enterprises’ intangible assets. The regulatory environment is part of the business or socio-economic environment and technology must support it.

For instance, the infrastructure of semantically enriched seamlessly accessible distributed information that will be incorporated in the Future Internet leverages sophisticated creation and (digital) delivery of individualised combinations of products and services, increasingly in the form of “experiences” that are provided in an ambient personalised environment. Increased abilities to obtain insights into the behaviour and preferences of individuals, for instance through more tracking and tracing of the precise use of goods and services associated with the proliferation of the Internet of Things (see description on page 14), will dramatically raise the opportunity to offer the customer exactly what is needed at precisely the desired moment, either explicitly “on demand” or

(increasingly) based on prior knowledge. Of course this also creates challenges to privacy protection and thus may entail new, innovative regulatory actions.

Further decrease of location or mobility as obstacles to collaboration will enable enterprises to offer individualised solutions more and more through dynamic virtual organisations that originate in networks of firms. Various projects in this domain are already directly devoted to this change and they stress that they expect that the Future Internet will make it much easier for companies to find each other, integrate their systems very quickly and thus create a secure environment to exchange sensitive information. There are indications that enterprise systems will become part of “a cloud” (see description on page 13) for ubiquitous, ad-hoc use. But a variety of technical challenges needs to be addressed to achieve this, such as those related to flexible (re)configuration of enterprise system functionality, technical barriers to access, better scalability, the combination of very open systems that make it easy to include “outsiders” in the community but at the same time are very secure for “insiders” etc. These challenges need to be augmented to accommodate new possibilities of collaboration.

Scientific Context

The European Commission is supporting research on a scientific foundation for Enterprise Interoperability by the creation of a Task Force that aims to join this initiative with similar ones around the world [9].

Moving forward, there is a need to consider the scientific foundation for FInES. According to one project contribution [10], the complex, multi-faceted and multi-scale structure of socio-economic actors, agents and institutions makes it very difficult to identify causal links that apply reliably to different regional, national or cultural contexts. It is suggested that there are, however, some “meta-characteristics” which, when shared by different socio-economic systems in different contexts, lead to similar indicators of stability and productivity. These meta-characteristics relate to issues of governance, transparency, accountability and democratic processes, as well as how they can be most effectively supported by ICT. The role of scientific research should therefore be to advance our understanding of this correlation, by expanding the specialised languages we use in different domains of activity in order to build “bridges of understanding” between the many different stakeholders.

3. Vision: Future Internet based Enterprise Systems 2025

The shaping of FInES, which is part of the European research programme, is within the context of the European research with its strategic focus on the Future Internet, alternative paths to ICT components and systems, and ICT for sustainable developments [11]. Additionally, the global conditions coinciding with the launch of FInES have a strong impact on the assessment of enterprise needs and the vision for future enterprises. Global economic crises may be short term developments; however, they occur within social transformation [12]. Enterprises, enabled by and appropriately equipped with ICT, are a key engine for that transformation. This goes beyond any specific crisis.

This section first identifies the key impacts from the context analysis (Section 2) on the research domain of FInES. Taking into account those impacts and looking ahead, it provides an outlook for European ICT and the future of enterprises, and concludes with a vision statement on FInES 2025.

3.1 Impact on the Research Domain of FInES

The crisis has triggered a re-examination of the strategic direction that guides the research domain of FInES. The impacts are discussed in relation to six broad areas.

Next Generation Knowledge Society and the Future Internet

In the context of the economic and financial crisis, it is important to remember the central role played by the production and take up of ICT in driving innovation, productivity and growth. ICT can contribute to a better handling and more swift recovery from the crisis. In addition to recovery, Europe must look and move forward and stay on course in realising the Next Generation Knowledge Society. This involves moving beyond the competitiveness of the ICT sector, and

making ICT at the service of its users, who turn invention into innovation and use. The theme Future Internet is today broadly recognised as having key social and economic impact and the potential to drive the European competitiveness of tomorrow. But the Future Internet as a set of technologies alone is not a panacea for the problems confronting enterprises. In order to equip European enterprises with short and medium term capabilities, and to overcome Europe's competitiveness deficit in the long run, Future Internet technologies need to be adopted by enterprises and applied to enterprise systems. The innovation facilitated by technologies must be led by technology users, of which European enterprises are among the most important constituencies. EU Future Internet research must fully embrace the application dimension and enterprise systems as one key aspect of that dimension.

Tackling environmental and energy issues

The crisis has challenged business practices. There is a strong need to develop leaner ecosystems and thus reduce the trial-and-error consumption (of all kinds of resources both natural and processed). Environmental and energy measures need to become part of mainstream business practices, and be supported by and fully integrated into next generation enterprise systems. The exercise of corporate responsibility needs not be considered as a discretionary cost, but a trigger for enterprise innovation.

Making the Future Internet accessible for SMEs

The crisis highlights once again the vulnerability of SMEs. One of the strongest research challenges will be to abstract the complexity associated with the Future Internet functionality and opening it to the millions of European SMEs who do not have dedicated IT staff, and are not interested in technology developments per se, but only in the way these developments can help them achieve competitive advantage and sustainable development.

Promoting user-centred products, services and tools

The crisis reinforces the view of the IT sector as a service sector serving needs. FInES research needs to clearly focus on the needs of enterprises as beneficiaries of ICT solutions. Future scenarios, enabled by Future Internet technology, should critically include a novel *user-centred approach* to the design, development and commercialisation of new products and services. In this scenario the active participation of the user community in the product creation process supports the alignment between stakeholders/user expectations, needs and product specifications. The product and service cycle (consumer insight, conceptual design, product design, production and marketing) should be developed and exploited as a unique development process where the user community is designing its own product and at the same time is marketing it.

Supporting Future Internet and FInES via standardisation

In a climate of uncertainty triggered by the crisis, standardisation has an even more critical role in providing a stable foundation, or a level playing field, to facilitate innovation and ultimately deliver choice for end users. In order to usher in new economic opportunities, standardisation is the more important to remove artificial (trade) barriers and the norms associated with old structures and obsolete business models. While the positive impact of open standards is generally recognised, the approaches for standardisation have to be refocused; otherwise it can also turn out as a blocking point in future R&D. Standardisation can be valuable when specifying a future-oriented reference framework and the implementation methodology to guide the development of innovation services and applications that meet the general as well as more specific needs of enterprises.

A new way of doing business

Several aspects have emerged in society which are likely to trigger profound changes; the crisis sharpens the debate on the changes that are needed. These aspects include: (a) sustainability, (b) relations between enterprises, their employees and customers, and (c) involvement of all stakeholders. Regarding the first, oil depletion, waste management, social tensions and over-consumption are forcing us to rethink the society we know and pay special attention to wealth and value creation. Regarding the second, employees are no longer seen as workforce or tools in a business, but have become real knowledge assets for the enterprises. The way in which the new

generations relate and use ICT, i.e. being part of “digital generations/natives”, will deeply affect companies, probably enabling the appearance of new business models. Customers are increasingly no longer passive consumers of goods and services, but having an active role in the value chain from conception to marketing, even becoming part of the innovation processes. Regarding the third, it is increasingly recognised that enterprises operate in a social and economic context. Therefore, there is a need to acknowledge the wider interests in how enterprises operate, and the issue of effective communication with stakeholders. All this may lead to a re-consideration of what is to be understood by the terms “organisation”, “team”, “product”, “employee”, and indeed “enterprise”.

3.2 An Outlook for European ICT

According to Viviane Reding, the European Commissioner for Information Society and Media, there are three main drivers in ICT [13]:

- Social networks - a shift from “Web 2.0 for fun” to Web 2.0 for productivity and services, in particular “Web 2.0 networking” in the business world;
- The Internet of Things - new classes of application will come to life, combining information from the virtual world with perception of the physical world, and supported by a powerful open service infrastructure (of which distributed “cloud” computing capability is an example in that direction);
- The mobile Internet - the emergence of a wireless Web is becoming a reality.

Taking into account the external factors enterprises may be confronted with in the future, the state of the Internet 15 years ahead from now may be characterised by an evolution and revolution of the existing technologies. Such developments may trigger continuous as well as discontinuous innovation in enterprise environments. Specific hypotheses of future ICT that significantly impact on enterprises may include:

- Pervasiveness of the Internet, offering the ability to connect to any person at any location and any time, allowing enterprises to act solely on a virtual basis, dramatically lowering the entry barrier to business sectors, and fostering new business forms and ecosystems;
- Widespread availability of portable and easily configurable “light-weight” tools and customisable “rich Internet applications”, which enterprises can dynamically as well as rapidly deploy to handle combinations of material and immaterial goods, leading to a fundamental change in the way that a business may be run;
- Transformation of the Internet “infrastructure” beyond today’s basic network connectivity to encompass service interoperability, and from wire-based access to wireless access, meeting the real-time demand for bandwidth, services, knowledge and collaboration arrangements;
- A break-through in the Internet’s security, reliability, quality of service and its general trustworthiness, leading to an Internet that is fit for all.

Preliminary discussions within the FInES Cluster have identified the following key technologies that will support the Future Internet, organised into two groups:

- Technologies of particular relevance for the server side: Internet of Services (IoS); Internet of Things (IoT); Internet of Knowledge (IoK); Cloud Computing Interoperability for effective cooperation of different Internet resources; Methods and tools for Quality of Services; Advanced search and retrieval beyond Google, semantic engines, semantic annotations and ontologies; Business processes and enterprise modelling platforms; New architectures, inspired by bio-computing and autonomic computing
- Technologies of particular relevance for the client side: Mobile computing; Open ubiquitous access (intelligent monitor & control of access to information/services; authentication, authorisation, trust - on computer/on people - and security); Federated governance of Internet infrastructure and polycentric governance authorities; Advanced (customised) search and retrieval: natural language and advanced graphics (e.g. 3D); Business processes

and enterprise modelling: advanced interfaces and methodologies (also methods and tools for systematic approaches to enterprise management, i.e. Enterprise Engineering).

Furthermore the adoption of social networking, moving from fun to business, has been highlighted. Already, the shift to outsourcing IT has led to an increasing uptake of the “software-as-a-service”, which is projected to expand in spite - or because - of the economic downturn. Cloud computing has so far centred on “systems infrastructure as a service”. Over the coming years, an increasing array of application functionality is expected to become available as cloud services. Business semantics will improve, potentially tapping into collective intelligence, and be embedded into business logic. Convergence will extend beyond the technology domains today to convergence between business contexts, applications, semantics and Web 2.0/X.0 technologies; all mediated by services. In addition, the wide deployment of the utility-based service concept will further drive essential IT functions for enterprises down the value chain, ushering in a new generation of commoditised ICT services as part of the open Future Internet infrastructure. IoT will further extend the distributed computing paradigm, with enterprises having to manage massive surges of information generated by billions of devices. IoT enables the integration of all things around into the communication experience. It signals a move from the Internet as a communications medium to an information-centric Internet. Not only do future enterprise systems need to function in mobile environment and work with a new generation of endpoints (mobile devices). They will also have to be equipped to handle complex information management issues, such as information uncertainty, inconsistency, reconciliation, provenance, security, access and control, high data volumes etc on a vast scale unimaginable today. Knowledge management for the trading of extremely diverse and exceedingly high volume information assets may become part of the business norm, and moreover a key channel of access to enterprise collaboration.

For the long term future, preliminary discussions of the FInES Cluster have yielded a listing of visionary technology topics:

- Bio-computing paradigm/Autonomic computing: Future Internet should operate like biological systems with high level of autonomy and a self-regulating and self-learning behaviour mainly driven by constraints and incentives;
- Self management of complex systems;
- Information management by machines: information explosion will be mainly managed by machines for machines, and humans will be involved by exception or by will (Semantic filters and avatars);
- From Cloud Computing to what is beyond.

3.3 The Future of European Enterprises

Towards sustainable value creation

Enterprises will increasingly need to deal with an expanded notion of sustainability, encompassing economic, environmental, ecological and social dimensions. Current research [14] confirms that effective knowledge management leads to value creation with the potential to increase and sustain organisational innovation. In particular, sustainable development is hampered by the inability of making sense and exploiting effectively the large amount of knowledge generated by individuals across teams, projects, and organisations [15]. Sustainability-related knowledge may take several explicit forms, but it is also inherent in human actors’ skills, interactions, experiences, and lessons learned. Sustainable value creation is grounded in the appropriate combination of human networks, social capital, intellectual capital and technology assets, facilitated by a culture of change – it is the meeting point between business needs and community research [16]. But the notion of sustainability for future enterprises runs deeper. Economic sustainability alone is not sufficient. The operation of enterprises needs to be environmentally sustainable. In future, environmental sustainability may even become a prerequisite for enterprises to operate at all (e.g. The EU 2020 Environmental Objective). Social sustainability is also an emerging subject. At present, this ranges from better welfare for employees to corporate social responsibility to “giving something back to society of what the company profits”. The concept is expected to further develop in the coming years. In

general, there is a movement towards a broader concept of value creation beyond economic value, and defining new measurements for success beyond economic performance. Enterprises of the future will need to embrace the different perspectives of sustainability, because of ecological and societal pressure.

New business models for future enterprises

Market conditions are not static. Business transformation will continue and is likely to accelerate. ICT as an enabler contributes to change and drives social evolution. This leads to new products and services, new collaboration networks, new ecosystems, new markets and, above all, new value propositions of what enterprises may offer to customers. Successful business models of the future will be different from those of today, e.g. instead of selling cars, companies will be selling mobility or even the experience of mobility (“fun by driving”). User-centric services are expected to become more prominent. As enterprises become less organisational-driven and more customer-oriented, business models will be re-thought and re-focused. Business models also need to take greater account of intangible assets, including staff as knowledge assets more than a workforce. The present eBusiness era includes services such as multimedia context distribution, shared virtual environment, geographic information etc [17]. The new generation of ICT will create new business opportunities, and new opportunities will arise if more powerful Internet based connectivity and architectures are available (e.g. easy to use, ubiquitous, performant, adaptable to different user needs and devices, secure etc). Therefore the potential for novel business models needs to be explored. Sustainability issues will bring new business opportunities associated with the ground-breaking application of ICT. Flexibility, adaptability and portability of ICT solutions is essential to support enterprise re-organisation and re-configuration in changing market conditions as well as changing market structures, triggered by broadening business objectives. It is possible that the entire economic paradigm for business may change in the long run leading to a fundamental transformation of how businesses are capitalised, assets are determined, stakeholders are involved; in short, a transformation of the notion of enterprises and therefore also our understanding of and approach to business models.

Flexible and agile business processes

Classic business process modelling describes activities connected through various operators (e.g. Business Process Modelling Notation (BPMN)). Due to huge numbers of possible process variants, it is difficult to use only these languages for capturing flexible processes. Novel approaches are suggested to cope with the complexity of future networked enterprises which will be able to exploit a set of business services supporting collaboration and interoperability, based on the Future Internet connectivity. Ideally, the business process needs to become interactive, and the business flow needs to vary and evolve according to the behaviour of the actors who cope with the external (market) requirements. Another approach may be based on a high modularisation of the processes, enabling easy reconfiguration and adaptation. The final objective of enabling flexible and agile processes is to support inter- and intra- organisational collaboration and the creation of new successful joint strategies to address new business opportunities. Interoperability is a key to achieving this.

3.4 Vision Statement: Future Internet based Enterprise Systems 2025

The Future Internet will enable enterprises - or a new notion thereof - to interact with other entities within and outside the enterprises (e.g. customers, suppliers, employees/knowledge workers, business partners, public administrations etc) in a seamless way. Interoperability that is simple, affordable, accessible and reliable must be extended from techniques and tools to the whole of ICT systems for enterprises. Standalone innovations at the parts level need to be consolidated to deliver high impact innovation at the system level for enterprises. Specifically, the Future Internet will enable enterprises to:

- Be empowered by a new participative Web, hosting a new wave of services and using user-friendly technologies;

- Create new value by leveraging the Internet as the platform through which knowledge is exploited dynamically, experienced in the business context and represented in a radically different way;
- Have the required capability that enables and supports collaboration with other enterprises, new dynamic relationships, discovery of partnerships, new opportunities and markets, and the management of the new risks and uncertainties involved;
- Operate in a new set of business environments that provide support for quality measures, guarantees, persistence, safety, trust, arbitration and other mechanisms for reducing risks on both the customer and the provider side;
- Become the WYSIWYG [*What You See Is What You Get*] enterprise, where Web-based applications become as rich as their desktop equivalents.

4. The FInES Cluster: Proposals

4.1 Scope and Aims of the Cluster

The Cluster is a unique integrating focal point for EU-funded research projects and other relevant initiatives in the domain of Future Internet Enterprise Systems, as well as all stakeholders who have an interest in the domain. It is a window of the research projects into the relevant activities outside the Cluster and, conversely, the principal conduit for particularly European enterprises to connect with European research in this domain.

The aims of the Cluster include:

- To stimulate the interaction between the projects/initiatives in the cluster with a view to fostering synergy and complementarity in their work, encouraging comparison of their results, and defining comprehensive conclusions that transcend the outputs of the individual activities;
- To disseminate the RTD achievements of Cluster projects and initiatives and support the dissemination efforts of individual projects;
- To represent the Cluster projects in other appropriate settings including standardisation organisations, relevant research initiatives and policy forums, and support the efforts of individual projects in these areas;
- To act as a catalyst between the different stakeholders of the FInES research with an emphasis on the multi- and inter- disciplinary approach to FInES research and the cross-cutting nature of the research;
- To continuously broaden the critical mass of the Cluster by engaging with a wide spectrum of stakeholders.

4.2 Priorities for the Cluster

- The existing activity of the Cluster Taskforce on the Enterprise Interoperability Science Base will be strengthened by connecting with experts in other scientific disciplines and joining up with similar initiatives in other parts of the world. The momentum of recent steps in this direction will be maintained [18].
- The preparation of a FInES Research Roadmap that defines new research challenges for the FInES research domain will be launched. The Roadmap will build upon the baseline established in existing key Cluster reference documents (see page v), as well as the context, vision, proposals and recommendations articulated in this Position Paper.
- FInES research is one element of European research and one aspect of the federating research theme on the Future Internet. Accordingly, the main focus of the FInES research

on European enterprises should be appropriately reflected in the activity of the Future Internet Assembly (FIA) - the principal collaboration and coordination vehicle among EU funded research projects for contributing to European leadership in the Future Internet. Specifically, the possibility of a FIA working group that addresses enterprise issues and needs, including adoption of Future Internet technologies, will be explored and pursued.

- Dissemination of activities, knowledge and results internally within the Cluster projects will be stepped up. In addition, there will be pro-active promotion of the Cluster activities, achievements and recommendation through all channels available to Cluster projects and individual participants. These will include use of traditional dissemination channels as well as innovative use of digital media and Web 2.0 tools.
- Outreach to additional stakeholders outside the core FInES constituencies will be vigorously pursued. The Cluster will seek to act as an effective intermediary between all stakeholders on matters within the scope of FInES.
- To facilitate the implementation of the recommendations in Section 5 of this paper, the Cluster will use its network and its constituencies to promote the vision of the Cluster and engage support and commitment to help realise the recommendations.

5. Recommendations

5.1 Policy Recommendations

Clearly define the Future Internet to stimulate ground-breaking research

The Future Internet is a broad concept with relevance for many fields of research. To date a wide variety of projects have embraced it; in several fields, roadmaps and priorities have been adjusted to accommodate the perceived needs of, and for, the Future Internet. This adjustment has however taken place largely within existing fields only, creating a substantial risk that the transition towards the Future Internet will involve one partial solution after another while critical hurdles will never be adequately addressed. This is partly due to the fact that to date “the Future Internet” lacks concreteness - what it really means, how it differs from the current Internet, what exactly needs to be done to move from the current to the future Internet, and whether such a transition is needed at all, are subject to wide ranging interpretations and understanding. As a result, the Future Internet concept so far fails to encourage ground-breaking scientific research that is required to develop a truly new approach, both at the level of an innovative Internet infrastructure and at the level of radically different business models and approaches to value creation that make use of it. Development of such new approaches especially requires research across the existing fields. It is recommended that (a) the Future Internet is specified further; (b) fundamental challenges that need to be overcome to realise the Future Internet are identified; and (c) research efforts are re-directed towards addressing those fundamental challenges, with a greater emphasis on inter-disciplinary research, exploitation and adoption of research results, and rigorous assessment of the impact of the research beyond the research community.

Trust, safety, security, privacy, IP and regulatory environment

Trust, safety and security are key values in the business world; without them it is almost impossible to promote new and more complex business models taking advantage of Future Internet enterprise systems. Safety as guarantee of service/product availability, security as overall protection and trust in the processes and systems are necessary for promoting these new business paradigms. Therefore, Future Internet enterprise systems should provide accurate levels of trust, safety and security to all business participants in order to allow contracts and market transactions to take place.

New business scenarios and models leveraging the capability of the Internet have already been challenging existing IPR and privacy legislation for some time. There is a general view that the legislation needs to be revised.

There are however divergent views within the Cluster on whether new legislation would be needed. On the one hand, it is proposed that the stakeholders should bear more responsibility and ideally exercise self-regulation. Legislators, in revising the existing framework, should “look out of their legal box” and recognise and understand the (complex) needs of all players in the economy to strike a healthy balance. It is also suggested that it is up to the next generation of digital natives to find “ultimate solutions”. Until then, present legislators, as digital immigrants who have a limited vision of what is possible, should act by paving the way towards those solutions.

On the other hand, others in the Cluster call for a fundamental re-think of intellectual property, including patents. It is argued that the next generation of enterprise networks requires greater transparency and knowledge sharing between both individuals and enterprises. The use and exchange of knowledge needs to become more innovative as well as sustainable in a broad sense. Proponents of this view point out that the spirit of the patent system is not always observed. Also, existing legislation does not adequately accommodate the increasing role of intangible assets in enterprises [19]. A new regulatory framework is needed to enable and sustain a new Open Knowledge Model that encourages collaboration and innovation.

There is a further suggestion to create regulatory environment think tanks that allow all stakeholders to get together and have a look at the options.

Competition and lock-in

Some members of the Cluster are apprehensive that the network effect of the Internet might lead to globally spanning ICT-based “platforms” that lock-in users and amass unprecedented powers. There is a fear of a dark future where competition may not be sufficient to prevent the emergence of a small group of organisations that end up “controlling everything” ten to fifteen years from now. Cloud computing has been cited as an example where the infrastructure investment needed for clouds would lead to the (global) dominance of a few companies. These members therefore recommend an ex ante rather than an ex post approach to regulate the ICT sector, i.e. extending competition regulation to the ICT market by applying the provisions of Significant Market Power (SMP). These members further recommend that if clouds do become a basic infrastructure that underpins economic and social activity, then clouds are de facto providers of utility services and should be regulated as such.

SME concept

Targeted initiatives towards European SMEs should start to make a difference, for SMEs of different sizes and in different domains and on different innovation levels have very divergent needs. As main drivers of Europe’s economy, they deserve special attention. The recommendation is to keep an “umbrella” definition of SMEs, but to accept that their needs differ and thus, ICT solutions need to address and cater for these different needs and ambitions.

5.2 Research Recommendations

A new notion of “enterprise” and “enterprise network”

The established notions of, and assumptions about, an enterprise and an enterprise network require validation as regards whether they still fit in today’s reality, and how they may evolve in future scenarios and environments. New conceptual frameworks and tools may help to assist in this investigation and to deepen our understanding of change. Granted that future enterprises will be motivated to work together in new ways [20], various lines of research have been suggested, e.g. to acknowledge and incorporate the role of enterprise culture in enterprise collaboration, as an additional cultural dimension next to national culture; to interpret enterprise networks of the future as quintessentially knowledge networks, where knowledge is a commodity; to explore a potential “post-enterprise era”, where “the enterprise no longer exists” [21].

An ICT infrastructure that is fit for tomorrow’s enterprises

There is a majority view that future ICT is not only about value chain optimisation or efficiency, or differentiation, but increasingly about innovation and particularly value innovation. On this view, ICT should sustain a new kind of infrastructure which is also stable with an initial fixed set of

services, in order to enable enterprises to build their (business) infrastructure at low cost; that infrastructure should be the equivalent of the http protocol for business [22]. The utility concept of the ICT infrastructure, articulated in the Interoperability Service Utility (ISU) Grand Challenge of the Enterprise Interoperability Research Roadmap, should be further developed to support such new infrastructures. Both the notion and composition of such infrastructures need to be clarified and explored.

Defining and developing “Future Internet based Enterprise Systems”

There is also a majority view that future enterprise systems should be able, by interaction, to adapt to new perceived user needs [23]. These new design solutions should also foster the participation of all relevant stakeholders, with special emphasis on customers/consumers, and providing means for accountability and responsibility. Several technical challenges have already been proposed in connection with developing future systems – ranging from ensuring the quality of such systems, to systems that enable safety, security and privacy, to systems comprising self-managed applications, to FInES as a “system of systems” [24]. The systems and the associated R&D challenges must be better defined, with a clear target and verifiable value proposition for future enterprises [25].

Further evolution of the (Enterprise) Interoperability concept

Various wide ranging suggestions have been made to further develop the interoperability concept [26]. On the one side, there are those advocating furthering research on “Enterprise Interoperability” by building on existing EI domains [27]; on the other side, there are those arguing for “new” challenges - even perspectives - of interoperability and the associated impact on enterprise systems [28]. So far as Future Internet based enterprise systems are concerned, systems that are open, adaptive and integrated with innovation processes are expected to have particular requirements for interoperability [29]. Further study of this subject should be an aspect of the R&D of those systems, taking into account the recommendations already made by the Cluster [30]. Interoperability should be recognised as a spanning theme across all the domains of Future Internet research. Technological convergence, value chain re-configuration and re-alignment, as much as the emergence of new technologies, techniques, methods and know-how, all contribute to the possible need for a new perspective of interoperability that underpins Future Internet paradigms [31].

Standardisation

The adoption of standards should be promoted at multiple levels, in order to enable collaboration and cooperation of multiple systems in the Future Internet. The process of defining and adopting standards should be encouraged and promoted by all stakeholders, taking into account the new requirements for interoperability.

Multi-disciplinary research and fusing technology with business and policy research

FInES research should fuse technology with business and policy research, so that the technical outcomes directly contribute towards the success of particularly European enterprises. Technical R&D may not rely on static, broad business assumptions [32] without consideration of the post-economic crisis business scenarios, the changing economic paradigm that intersect with Future Internet developments, as well as a changing regulatory environment that calls for, e.g., transparency, greater accountancy and better governance, and environmental protection. Specifically, there should be a tighter coupling between technical R&D and business models with promising prospect. For example, the potential benefits of adopting Future Internet technologies should be demonstrated in realistic settings and evaluated with a credible model, as part of the research activity into such technologies.

Future enterprises and ICT adoption

Many suggestions made for improving the situation relate to the wide availability of simple, affordable, accessible and reliable tools. Proposals for specific target areas that research should focus in order to catalyse enterprise adoption of ICT include: collaborative, community based design and development of products and services; knowledge management and exploitation; finding (or supporting the user to find) new markets, new services, new products, new manufacturers; new social software platforms for enterprises; user involvement in product/service development and

definition; user mashups; general user participation and awareness; green computing including energy use, resource virtualisation and regulatory compliance. Accessibility and usability will be two key horizontal areas, in order to avoid exclusion and to facilitate and improve the experience of the user when using the Internet. Any Future Internet technologies and tools must be flexible, available at low cost, and easily adaptable to the business needs to have a chance of broad take-up.

Description of Key Terms

Clouds or Cloud Computing

“Cloud computing”, or simply “Clouds”, is a hot topic. Definitions abound. A much cited definition, developed by Vaquero et al (FP7/ICT RESERVOIR project), is: "Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs." The European Commission has convened an expert group in 2009 to discuss the topic. The report of the group, entitled “The Future of Cloud Computing - Opportunities for European Cloud Computing beyond 2010”, will be published in the coming months.

For interest, the (US) National Institute of Science and Technology has posted the following working definition: “Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential **characteristics**, three **delivery models**, and four **deployment models**.” Further details are at <http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v14.doc>.

FInES (Cluster) Stakeholders

In the FInES (formerly EI) Cluster report on Value Proposition for Enterprise Interoperability, published by the European Commission in 2008, the Cluster stakeholders are categorised as follows (in Section 1.5):

- *Users* – potentially all organisations and final end-users as individuals, customers or citizens
- *Providers* – vendors, integrators, application developers, service providers, and other “independent” providers
- *Intermediaries* – trade associations, industry consortia, multipliers, market consultants, and “commentators”
- *Public authorities* – policy makers
- *Standards organisations* – potentially including all of the above
- *Research community* – academia, research organisations, and potentially including all of the above.

The full report is available at http://cordis.europa.eu/fp7/ict/enet/ei-isg_en.html.

Future Internet

In her recent speech, entitled “Investing in a digital recovery: ICT and innovation driving growth”, delivered on 13 July 2009 at a European Commission Information Day, the EU Commissioner Viviane Reding describes the Future Internet as follows: “This Future Internet will feature almost unlimited bandwidth capacity, wireless access everywhere, potentially trillions of devices interconnected, integrated security and trust for all parties, and adaptive and personalised services and tools. It will open the door to a wide range of new business opportunities and will help us address even better our key societal challenges.” The full speech is available at http://ec.europa.eu/commission_barroso/reding/docs/speeches/2009/brussels-20090713.pdf. In a similar vein, a recent report of a high level vision panel on Future Internet 2020, published by the Commission, states that the Future Internet will be “much faster and smarter, more secure,

embracing not just information and content but also services and real world objects ('things'). The full report is available at: http://ec.europa.eu/information_society/activities/foi/library/epr.pdf. The Commission has made available a lot of resources on the "Future Internet", see http://ec.europa.eu/information_society/activities/foi/. Under the auspices of the EC, the Future Internet Assembly (FIA) was launched on 31 March 2008 for the purpose of collaboration and coordination among relevant EU funded research projects. These projects are signatories to the "Bled Declaration" on the Future Internet. See <http://www.future-internet.eu/> and http://ec.europa.eu/information_society/activities/foi/lead/bled/.

Internet of Things

Internet of Things is an integrated part of the Future Internet and could be defined as a dynamic global network infrastructure with self configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.

In the IoT, "things" are expected to become active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information "sensed" about the environment, while reacting autonomously to the "real/physical world" events and influencing it by running processes that trigger actions and create services with or without direct human intervention.

Interfaces in the form of services facilitate interact with these "smart things" over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues.

Source: 2009 CERP-IoT SRA