Future Internet Enterprise Systems (FInES) Cluster

Research Roadmap

Version 1.3

9 November 2009

For Public Comment and Consultation with all Interested Stakeholders

Editorial remark

Due to the large volume of contributions received and the available time for preparing the present first draft of the document, the FInES Research Roadmap Task Force did not have the opportunity to process all the contributions in full. The incorporation of the relevant contributions received will continue in the preparation of the next version of the Roadmap.

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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/???? (EC to complete)

Key References of FInES Cluster

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

FInES Cluster Position Paper
http://cordis.europa.eu/fp7/ict/enet/fines-positionpaper_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

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0. Introduction

You never change things by fighting the existing reality.

To change something build a new model that makes the existing one obsolete.

Buckminster Fuller

0.1 General Scope and Objective of the document

The FInES Research Roadmap aims at defining new research challenges and identifying major opportunities and research lines for the FInES research domain. Such research lines are motivated by a long-term, highly innovative vision, with 2025 as time horizon[1].

The Roadmap builds upon the baseline established in existing key Cluster reference documents, and mainly on the context, vision, proposals, and recommendations articulated in the FInES Cluster Position Paper, Final Version (V3.0), published by the European Commission (EC) in September 2009. The Position Paper has expressed the first global vision and policy and research recommendations following the re-orientation of the FInES Cluster, which has brought together constituencies of three major research streams: Enterprise Interoperability, Enterprise Collaboration, and Digital Ecosystems. The research roadmap builds on the consolidated overall context, by addressing and extending the identified research priorities on a more detailed level. Furthermore, the research roadmap intends to address ICT-based enterprise innovation with a futuristic, even provocative, perspective; leading if necessary to incremental and emergent or radical and revolutionary changes in thinking, practices, products, processes, or organizations.

The FInES Research Roadmap is a collective effort of all interested stakeholders in FInES. Its preparation is spearheaded by the FInES Research Task Force, under the overall coordination of the FInES Cluster. The document that will be produced at the end of this activity will be an input to the next FP7 ICT Work Programme 2011-12.

0.2 Scope of the FInES Domain

The Future Internet is expected to give rise to new opportunities of creativity and innovation, enable new forms of participation, further catalyse the formation of networked enterprises and business ecosystems that span from a territorial reality to the whole world, thereby ushering in a new generation of enterprise systems. Future Internet Enterprise Systems (FInES) describes a field of activity with the aim to enabling enterprises, including SMEs, by means of ICT, to exploit the full potential of the Future Internet. The Internet thus is seen as 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. Individual enterprise systems of the future are likely to be leaner, more adaptive, flexible, portable and open. They need to enable value innovation at the business level. They also need to deliver value beyond economic value and drive innovation that meets a set of business objectives and sustainability concerns much broader than those of today, including societal and environmental objectives.

It is important that FInES builds on existing reality, analyzing emerging economical behaviors and considering the current globalization trends and the new market places (e.g. India, China, the Middle East). Also, it is imperative for us to assess the current effectiveness and the potential improvement moving away from classical enterprises models and common business practices.

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[1] We believe that more short/medium-term studies are better performed in an industrial context (e.g., by consultancy agencies).

The FInES Cluster has already proved the capacity to contribute to this elaboration with a wealth of multiple disciplines, the awareness of the inter- and intra-enterprise complexity, and the understanding of the interdependencies among different business and socio-economic areas. Several are the open questions regarding the model of future enterprises and their characteristics, the ICT trends and the future solutions, the relevance of the latter for enterprises and the costs and benefits for their adoption. And, as the final key question, how much value the future enterprise will be able to deliver to customers, and the society at large, thanks to the adoption of new ICT solutions.

0.3 The adopted method of work

The approach

One of the main concern of the task force, at the beginning of the work, has been to avoid a technology-driven approach, i.e., to start from the emerging (and foreseeable) technological innovations and to figure out how to use them at best in the future enterprises. Conversely, we preferred to proceed decidedly with an enterprise-oriented approach, i.e., to figure out what kind of enterprises we can envisage in the future, what will be their characteristics, and how future ICT solutions will be able to support the envisaged future enterprises. This approach lead to a "top-down" organization of the work, with a layered structure of key questions, sketchily reported in the Figure 1, to which this report will try to answer.

Societal **Vision and Values**	What will be the socio-economic context in which the future enterprises will operate?
Future Enterprises **Grand Objectives**	What will be the desirable qualities that will characterise future enterprises?
FInES **Research Challenges**	Having identified a set of desirable qualities, what will be the research lines aimed at developing *future enterprise systems* able to support them?
Future Enabling Technologies	What are the best ICT solutions, and the ICT research lines, to be developed to support the above FInES?

Table I – The FInES Research Roadmap stack

The activities and team organization

The report is based on the work of the FInES Research Roadmap Task Force and the contributions of the FInES Cluster members. The activities have been organised in four phases. Phase 1, focused on the Chapters 1 and 2, will be concluded with the consolidation of this document, expected at the end of November. Phase 2 will focus on the Chapters 3 and 4, expected by mid December. Phase 3 will produce a final draft, merging and integrating the outcomes of the two previous phases, by the end of the year. Then, Phase 4, will consist in the consolidation activities, that will take place after an extensive consultation and refinement process.

The contributions will be collected, integrated, and organised by the FInES RR Task Force, composed by Michele Missikoff (Rapporteur), Paolo Dini, Samia Drissi, Antonio Grilo, Rui Neves-Silva, facilitated by the Head of the Cluster, Cristina Martinez, and the Co-Chair of the Cluster, Man-Sze Li.

0.4 Content of the document

In order to achieve the aim of the Research Roadmap as described above, the document is structured into six chapters.

In Chapter 1, after this Introduction, the document starts by defining the Vision and Values in accordance with the scope of and ambition for the FInES Cluster, aiming at anticipating the paradigms and concepts that will characterize the future European knowledge society. The socio-economic drivers, the role of ICT on value production, but also the relationships among the different cultures and constituencies that will exist, will be considered. In this sense, this chapter aims at drawing the main lines of a possible future context in which the enterprises will operate.

Chapter two is reporting the Grand Objectives, represented by the a number of desirable qualities (e.g., transparency and accountability, sustainability) that will characterize the future enterprises. To better organize the presentation, the above qualities are suitably clustered and labeled. E.g., a Green Enterprise is characterized by the respect of the environment. Each of the proposed labels intends to provide a high level description of a specific dimension of the future enterprises, their role in the society, and how they may operate and produce value in future. The description indicates a number of objectives that need high quality multidisciplinary research to be achieved.

Chapter three addresses the Research Challenges that need to be tackled in the next decade, to proceed towards the Grand Objectives described in Chapter 2. At this level, the research needs to fight the cultural and disciplinary fragmentation to provide integrated, socio-technical solutions. This chapter will also consider, among the Research Challenges, the main blocking factors that, once good innovations are made available, prevent enterprises to adopt them.

Chapter four addresses more specifically innovative ICT solutions, including methodologies, that will be needed to support the achievement of the Research Challenges. Here there will be also an effort to identify what are the ICT solutions that, being considered strategic for the future enterprises, are generally not sufficiently addressed in the perceivable ICT innovation trends.

Chapter five intend to identify the most advanced ICT solutions available today, with particular attention to the key achievements of past projects, provided in the form of a state-of-the-art review. The objective is to promote the reuse of existing advanced solutions. The past experience teaches us that there are cases where existing solutions can be either directly used or easily extended, avoinding to undertake a new development from scratch. The outcome of this chapter can be contrasted with the outcome of the previous chapter, to derive important indications on the ICT research directions useful for future enterprises.

Chapter six provides overall conclusions and recommendations. Specifically, it will recap the main indications stemming from the Research Roadmap elaboration, focusing also on the results that may be achieved in implementing the recommendations in this Research Roadmap, as a starting point for guiding future research initiatives.

1. Vision and Values

1.1. The Big Challenge

The FInES Cluster has a strong focus on the business perspective, especially on those aspects and processes of the enterprise that rely on ICTs. Therefore, as we try to imagine what form the research challenges of the next 10-15 years will take in this area, we need to keep in mind the interdependence between enterprises and the information and communication technologies they rely upon and, more importantly, how this interaction can continue to generate ever-increasing amounts of new kinds of socio-economic value. We take 'value' to mean the more traditional objectives of the neoliberal agenda for Europe, such as higher employment, greater competitiveness, and economic growth, as well as other less well-defined and quantifiable categories such as quality of life, social cohesion, educational standards, equal opportunity, and so forth. Furthermore, the interdisciplinary research nature of the FInES Cluster projects justifies the asking of deeper questions regarding our ability to communicate across epistemological barriers, about the social construction of shared values, and about the democratic processes through which such social construction can be harmonised (Dini et al., 2009).

In other words, in the FInES Cluster we can optimise the technology to improve its own functional characteristics, we can innovate the business models to maximise value generation in the presence of new technologies and emerging new paradigms such as the Future Internet or, indeed, we can also 'move the goal posts' and innovate the definition of 'value'. In this chapter we propose a vision for the FInES Research Roadmap built precisely around the challenge for European research to find a constructive balance between these three interdependent areas of research intervention, if we wish Europe to remain competitive in a world that is changing at an ever-increasing rate. We pay more attention to the third of these three perspectives because all the evidence points to its greater transformative and even disruptive potential.

The chapter is organised in two main parts. We begin with a somewhat arbitrary collection of concepts and examples whose purpose is to characterise current trends in new media development and use. We believe that these trends constitute an 'engine of change' whose understanding will help us to predict or imagine what the enterprise and its systems will look like in 2025, which is addressed in the second part of the chapter.

1.2. Emergence of Virtual Individualism as a Driver of Innovation in the Future Internet

In the following sub-sections we propose a framework for interpreting current Web 2.0 trends, which we see as increasing in importance over the next 15 years. This part of the chapter should be seen mainly as a commentary that does not wish to appear normative, but simply suggestive of possibilities. In particular, we are postulating that, since the development of the online economy and society follows largely Western values and principles, Individualism as understood from the point of view of Modernity will remain the dominant driver of social change online. As a consequence, as our online social identities venture into the economic spaces increasingly defined by the online knowledge economy, new technologies, new organisational forms, and new models of the enterprise will emerge. The second part of the chapter will therefore build on the ideas presented in this section to present a possible view of enterprise systems in the Future Internet in 2025. Figure 1.1 shows a graphical map of this section.

1.2.1 Control and Ownership in the Information Society

The average user would not appreciate their Ducati stopping in the middle of the motorway to download the latest service pack. Control is important in a capitalist economy founded on private property. And yet Linux users and developers do not mind that their ownership of the Linux OS on their machines does not exclude others from owning the same OS.
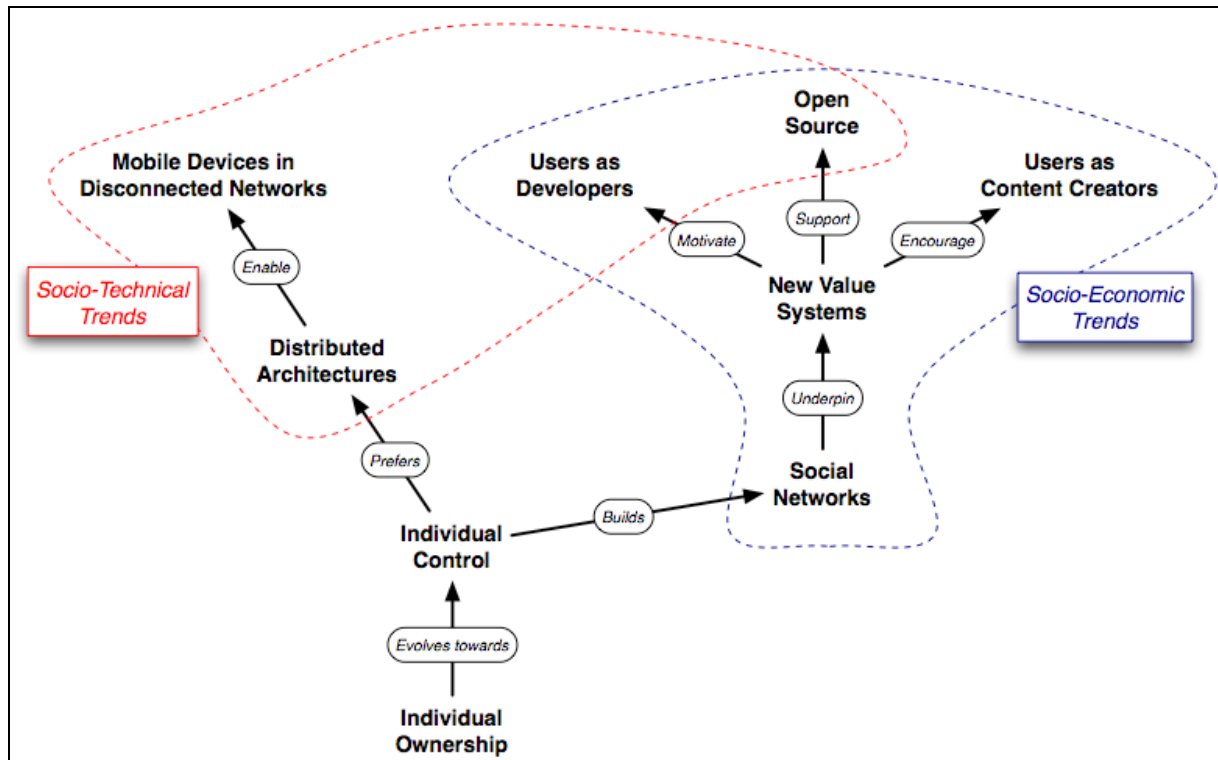
Figure 1.1: Characterisation of current trends in new media from an individualist viewpoint

> Developments in information societies pose interesting questions for market analysis. This is because, from an economic vantage point, information has peculiar characteristics compared to tangible goods. Information is intangible, non-rivalrous (one can give it to someone else and still possess it) and non-excludable (it cannot be taken back once it has been given and receivers can pass it on without giving it up). It is difficult, therefore, to analyse market dynamics where information plays a significant role because conventional economic models are not designed to take account of these features of information. (Mansell, 2009: 2)

In the information society and the knowledge economy the concept of ownership is slipping, but control is alive and well. Linux users relish the ability to control their OS down to its last bit. So perhaps control is becoming more important than ownership?

The reliance of the average aerospace engineer on FORTRAN 'numerical wind-tunnels' seemed unassailable as a use case for what computers were about in 1970s, until Winograd and Flores (1987) said that this was all wrong, computers were not about numbers, they were about communications. SMS messaging then showed how users indeed wanted to communicate, and were not going to be stopped by a hopelessly unfriendly and inefficient haptic interface.

So if users in the information society want to control their machines, and if their machines are about communications, perhaps users want to control their communications? This is not such an odd concept if one includes individual expression in the category of 'communications'.

Using text messaging and e-mail, the citizens of the information society at the end of the 20th Century discovered that they could interact with their social groups in new ways. It was but a short step to begin 'bending' the web to serve similar purposes: to communicate, to express one's opinions, to debate, to share photos and movies, to form social networks, to rediscover and keep in touch with long-lost high-school friends. The ability to shape and extend one's digital environment at home and at work was supported by unbelievably effective search and related tools. The drive to codify and organise knowledge was harnessed by community projects like Wikipedia. Some concern was expressed for privacy, and security assumed ambivalent connotations depending on whether one was

talking about the Windows OS or not. Figure 1.2 shows some of the elements of this unfolding process, according to a possibly oversimplified linear depiction of the evolution of the web.
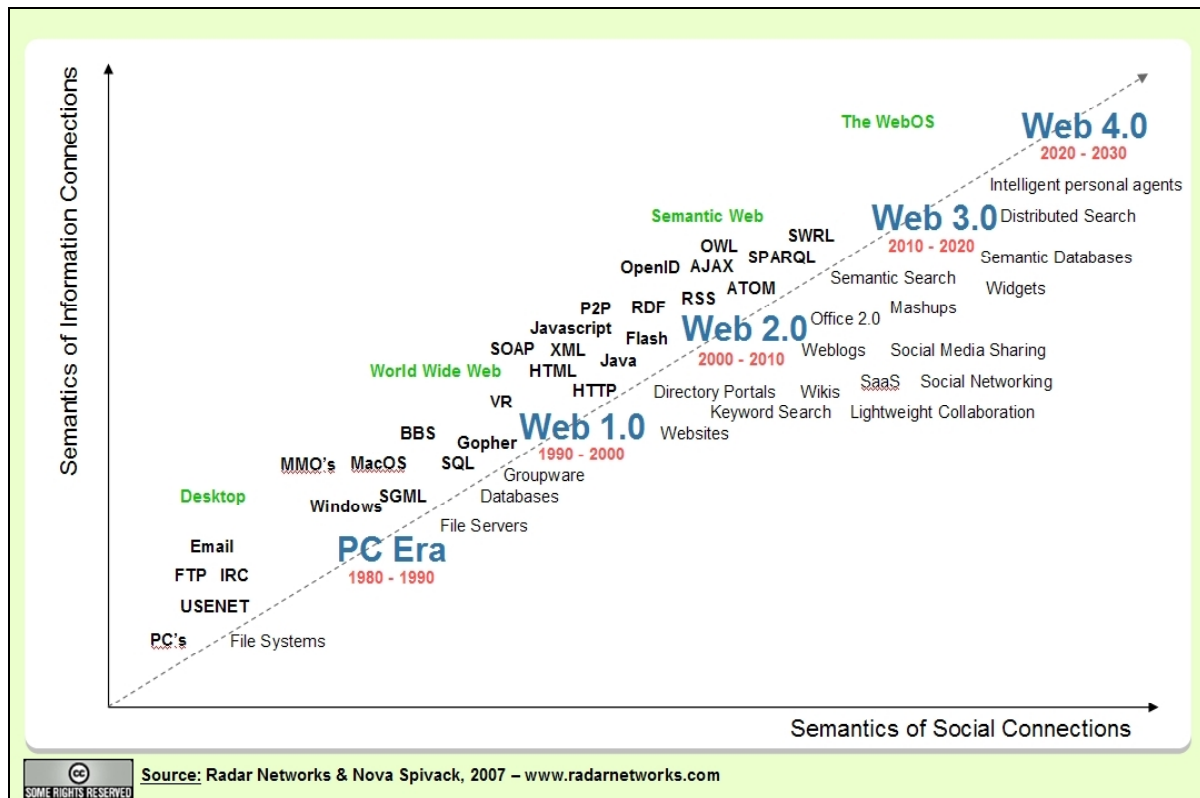

Figure 1.2: Constructive interference between information semantics and social semantics

1.2.2 Infrastructure Models

The software infrastructure underpinning online business interactions and service provision follows predominantly three models: Client-Server, Cloud or Utility Computing, Distributed or P2P, and GRID.

> In *The Big Switch*, Nicholas Carr (2008) provides a clear and insightful account of how the Edisons of the digital age as Google, Amazon and other global service providers are employing technological innovations and new business models to transform the Internet. The switch he describes is from a client-server computing model, based on a personal computer linked to a shared server, to a 'giant information utility' in which the Internet will provide information services, much as Google is providing search and related services today. This is certainly a move away from the current Internet that is dominated by intelligence in the form of personal computers linked to a shared server at the end of a relatively dumb network (Zittrain, 2008). Across Europe, this transformation is variously referred to as a shift from software to services – networked on-line services or Software as a Service (SaaS). More generally, the Internet is becoming a global and open Service Delivery Platform of converged IT, media, networks and devices.[2]

At the same time, distributed architectures and P2P networks continue to thrive in research and applications, showing that

> rather than socio-economic systems being determined by technological developments, sometimes technology can be determined by its users. … At the research level, P2P networks benefit from a constructive tension between two completely different disciplinary domains. While P2P networks research is increasingly drawn toward biology and physics in response to ever-increasing demands on the performance of such networks, it is also drawn toward social science as the development of P2P

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[2] Mike Boniface, IT Innovation (www.it-innovation.co.uk)

applications is increasingly influenced by a convergence between social science and design, known also as "social computing". (Dini and Krause, 2007)

The distributed architectures developed in the OPAALS project have led to the emergence of a new model, called Community Cloud Computing (C3).[3] C3 offers an alternative architecture, created by combining the Cloud with paradigms from GRID Computing and decentralised principles from Digital Ecosystems, including decentralised governance, privacy, identity, trust, and accountability, thus remaining true to the original vision of the Internet.

Figure 1.3:

Community **Cloud**
Computing
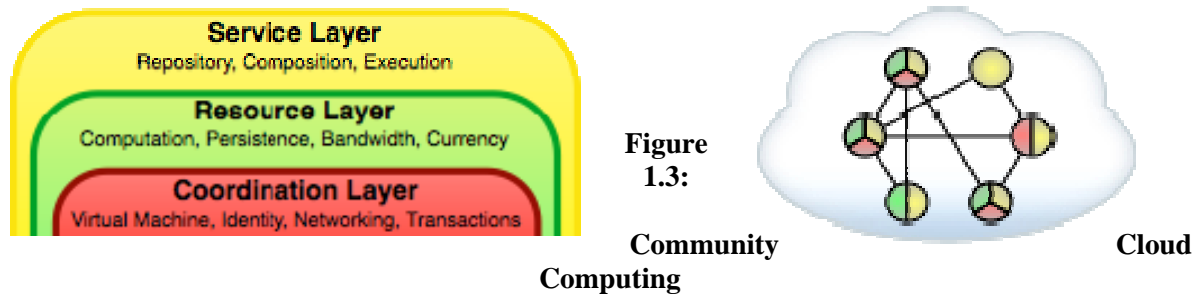
The characterisation of information and related control and ownership issues and the utility approach to the infrastructure model are key bases for the Interoperability Service Utility (ISU) of the Enterprise Interoperability Research Roadmap, Version 4, published in 2006,[4] where such issues are also discussed. As stated in that Roadmap,

> The ISU provides interoperability as a technical, commoditised functionality, delivered as services. Value-added functionalities, for which customers would be willing to pay a premium, would flow above the ISU. The provisioning of such functionalities and related customised/localised services is an issue for the market. The ISU is conceived to be a basic "infrastructure" that supports information exchange between diverse knowledge sources, software applications, and Web Services. … Implicit to the ISU is an important proposition: interoperability as a technical functionality is a public good – non-rivalrous and non-excludable. Just like the Internet and the Web, the ISU needs to be available for all to use, exploit and build upon. It must be open and be shared. It needs to be trusted. It needs to be independent of, rather than an extension to, particular enterprise software solutions provided by technology vendors. The precise degree of interoperability that an enterprise desires and obtains in practice, however, remains a business decision of the enterprise.

1.2.3 The Socio-Economics of the Disconnected Network

Disconnected networks, for instance such as those developed in the BIONETS project[5], can support a variety of business models, including the domains of brokerage, advertising (revenue model), infomediary (selling and buying data), merchant, manufacturer (direct), affiliate, community, subscription and utility. Disconnected networks can support a variety of business and economic models, which are based on different value systems. In addition to accessing more conventional services offered by the telecom operator when in range of an access point, they can rely on the value generated by the social interactions themselves in supporting exchanges of content, or through Benkler's 'economics of sharing', based on the sharing of unused capital (Benkler, 2004), or by setting up a 'community currency' specific to a particular social group.[6]

Regarding mobile services, Figure 1.4 shows a fairly general categorisation of different network models based on geographical relevance and length of time the data needs to be retained (Elaluf-Calderwood and Dini, 2009).

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[3] http://www.communityclouds.net/
[4] http://cordis.europa.eu/fp7/ict/enet/ei-research-roadmap_en.html
[5] www.bionets.eu
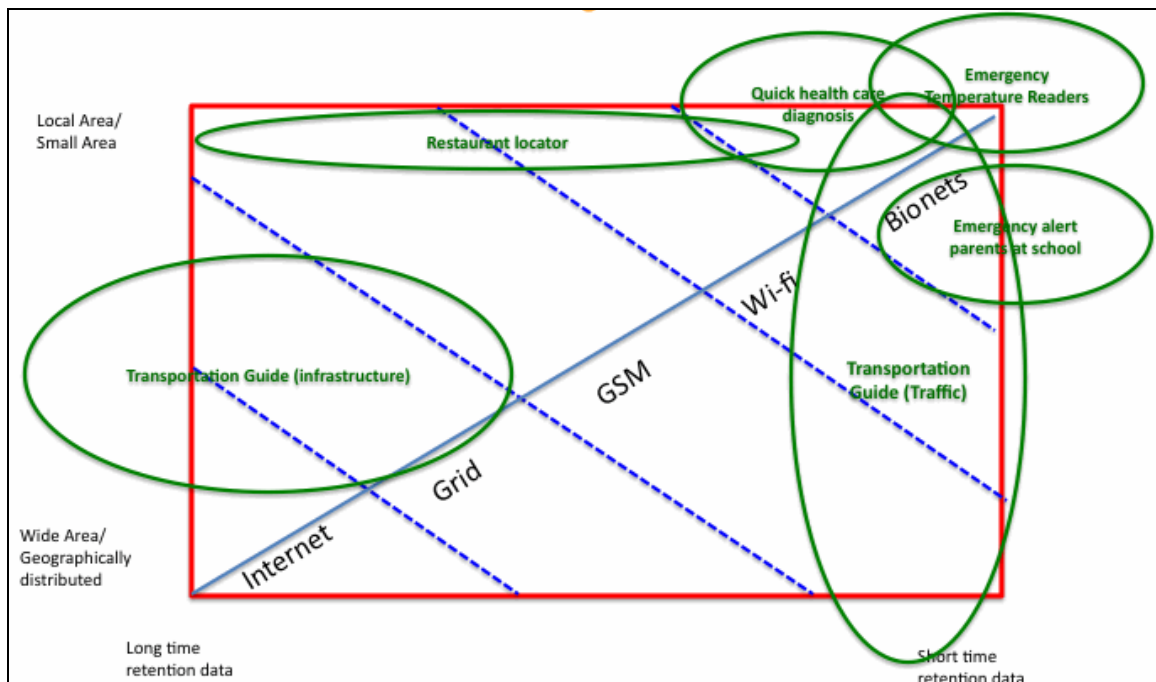[6] http://www.openmoney.org

Figure 1.4: Spatial relevance vs temporal relevance for mobile services
(Elaluf-Calderwood and Dini, 2009)

1.2.4 When the Users Join the Team: the Case of Second Life

The spread of the Internet has enabled users to become participants in the production of media content rather than being the recipients of the delivery of products and this is facilitating what has been termed a *participatory culture* (Jenkins, 1992). A growing number of firms have noticed this user-driven trend which has become associated with a shift in the organization processes of production, distribution and consumption (Benkler, 2006; Bruns, 2007; Hartley, 2008). More specifically, whereas firms initially saw user participation as a threat, firms are now aiming to utilize and leverage the unique qualities of the Internet infrastructure by inviting users directly into their commercial production and distribution practices (Li and Bernoff, 2008; Tapscott and Williams, 2006). With the availability of affordable and accessible tools for content production and distribution, user participation is emerging as a creative infrastructure that is associated with pervasive knowledge-intensive and information-rich user-created content activities. In other words, processes. Second Life users appear to be integrated within the overall strategy as part of the product life cycle rather than as end-users. (van der Graaf, 2009)

1.2.5 New Value Systems

The rumble around 'new value systems' became louder since the sub-prime mortgage financial crisis. New value systems, emerging from the on-going integration of the gift and exchange economies, have been driving Open Source development for two decades, but the frenzied run on the apparently inextinguishable credit line underpinning increasingly leveraged financial products built on high-risk loans finally tipped a structurally unstable system over the edge of stability, an event that in the socio-economic context we call "loss of trust". This has caused a great deal of rethinking about what drives our capitalist economies, which tends to collapse two separate discussions: the first is a discussion about financial markets vs. the real economy; the second is a discussion about capitalist vs. other kinds of values. A recent issue of *The Economist* addresses the first one rather nicely:

> The world confused financial assets with real ones. At the heart of the current crisis is a fundamental confusion about the nature of wealth. Think about it from the perspective of a Martian. Were an extraterrestrial to be shown a room full of gold ingots, a stack of twenty-dollar bills or a row of numbers on a computer screen, he might be puzzled as to their function. Our reverence to these objects might seem

as bizarre to him as the behaviour of the male bowerbird (which decorates its nest with shiny objects to attract a mate) seems to us. … Wealth consists of the goods and products we wish to consume or of things (factories, machinery, an educated workforce) that give us the ability to produce more such goods and services. Financial assets arise from the desire to postpone consumption so that money can be saved, either from precautionary reasons or to invest so that more goods and services can be consumed in the future. Looked at it this way, financial assets are not "wealth" but a claim on real wealth. If those claims multiply or rise in price, that does not mean aggregate wealth has increased. … This truth is obscured by the business cycle, which causes revenues and margins to fluctuate, and by investor sentiment, which causes shares to be derated and rerated (the dividend yield to rise and fall). … It is the link between speculation and asset price that explains this crisis. The ability to borrow money to buy assets fuelled the rise in asset prices. And the wealth effect of higher prices persuaded those in English-speaking countries to borrow more money to sustain consumption. (*The Economist*, Oct 2009)

Thus, assuming we were to find an effective way to keep speculation in check, we would still be facing deeper questions about what drives us as individuals and as a society. Should it be the accumulation of money as a token of "delayed consumption"? Or, more provocatively, can money serve as an effective quantifier of a broader range of values than of simple 'potential to consume' at a future date? This is where it gets difficult. We are tempted to think of the work of a teacher as something hardly 'consumable', but the teacher must get paid. The whole service sector seems to operate on a slightly different footing to retail, capital equipment, or consumer electronics. But there are whole areas of society that are even more independent of revenue exchange.

1.2.6 Research Outputs from Digital Ecosystems

The emergence first of Open Source and, more recently, of the huge volume of free content exchanged on the web through various means such as social networking sites, Wikipedia, and the like lend particular significance to the concepts discussed so far. We might broadly categorise free content as 'knowledge' or 'cultural expression'. It would appear that the drive to share both these kinds of content has become so strong, and is increasing so quickly, that its increasingly central role in our society can't be ignored any longer. If we define 'value' to be simply what society values, then when hundreds of millions of users all over the world are changing their behaviour to engage in a particular kind of activity we can only surmise that they 'value' such activity. This is how new values emerge. Hence, in developing new sustainable models for business, innovation, and development for the new Future Internet environment, we either redraw the boundaries of where sustainable revenue models can still operate, or we redefine what 'sustainable' means.

In this context we can benefit from a number of years of European research such as Digital Ecosystems, through which we have arrived at the following tentative conclusions:

1. Distributed P2P architectures are more challenging technically and scientifically but are important to strengthen horizontal market dynamics and democratic processes

2. Keeping the infrastructure Open Source is more challenging economically but leads to a sense of distributed responsibility and ownership that is important for bootstrapping an open and transparent governance framework. Such an open source and P2P infrastructure supports the generation, publication, and consumption of services that should be able to follow any one of the available licencing models. The choice of licencing model should be entirely up to the companies offering the services.

3. Locality, whether in the virtual or geographical sense, is important because responsibility and democratic, multi-stakeholder processes are linked to identity and citizenship, and these concepts are reinforced in small-world social networks better than in large populations of anonymous users.

4. Further to point 3, ICT adoption, development, and innovation policies need to be customised and localised for particular regions or value networks by the 'local' stakeholders, with active participation from industry, academia, and local government.

5. Open knowledge networks such as digital ecosystems are extremely important for triggering communication processes in a region or sector and among a group of stakeholders that can support collaborative practices in research, business, and in policy-making.

1.3.   Environments for Technology and the Enterprise in 2025

Out of the trends discussed in the previous section will arise new environments in which new forms of the enterprise and new technologies will grow and evolve. Some of these environments were discussed in the FInES Position Paper as the result of contributions by the FInES Cluster projects and their partners. We reproduce the main points here, along with the graphical rendition shown by Figure 1.5.
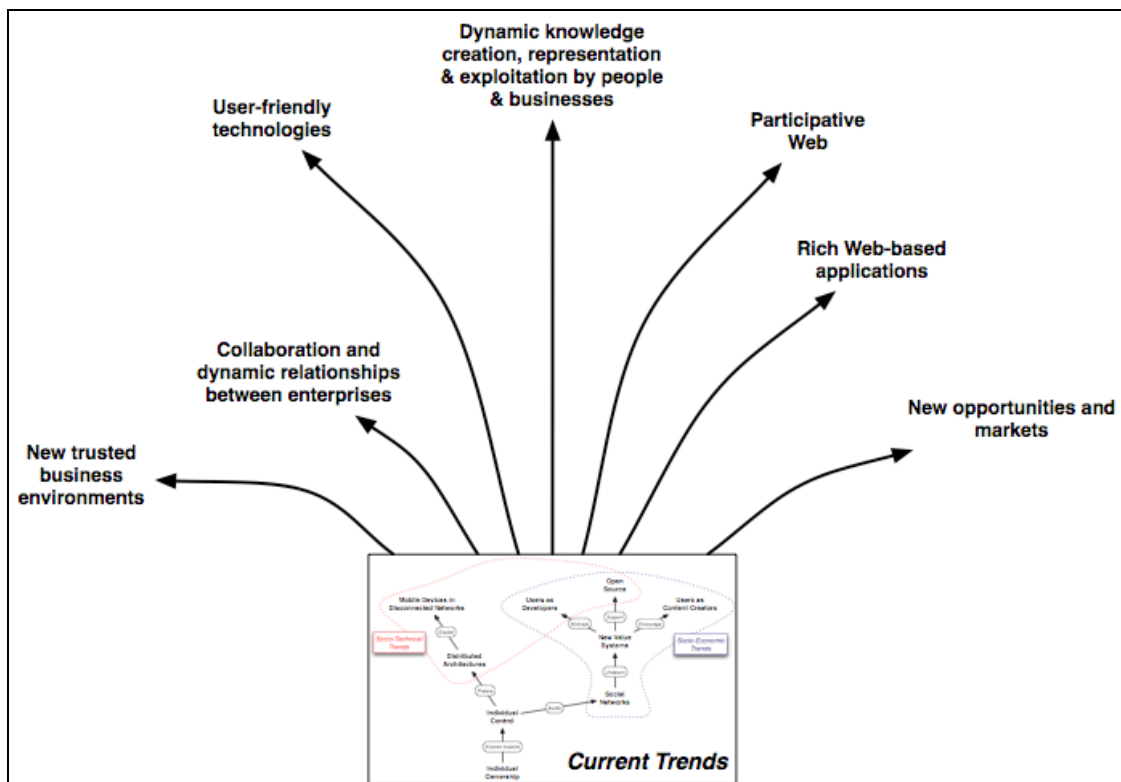

Figure 1.5: The environments of the Future Internet

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.

1.4. Conclusion

Research in the area of enterprise systems for the Internet of the future involves a number of disciplines that cut across the social and computer sciences. In this chapter we have tried to give a high-level view of how the insights gained by past research, the current trends in technology development and use, and the emerging patterns of user behaviour are pointing to the need for a novel integration of a number of disciplinary viewpoints that begins with the recognition and acknowledgement of our very different epistemological positions and ends with the hope for an open society ready to keep pace with the growth of new socio-economic values and institutions emerging in the Future, global, Internet.

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2. Grand Objectives

2.1. Introduction

This chapter focuses enterprises with the intent of drawing the a few characteristics they will assume in the future, having progressively acquired them along an evolution over time until 2025. Grand Objectives (GO) do not intend to indicate precise organizational structures or production models capable of maximising profit while minimising costs. This detailed objectives will be elaborated in the next chapter, where precise objectives and the research challenges to achieve them will be described. Here we intend to focus on a number of qualities and capabilities (e.g., accountability and transparency, innovation aptitude, knowledge-oriented keenness) that successful enterprises will exhibit in the future. Such qualities do not represent precise targets to be reached; rather, they represent directions along which an enterprise can proceed, progressively improving (e.g., on its transparency) year after year. With this respect, a GO can be seen primarily as an "intention", as a commitment to proceed in the indicated directions. In this respect, even if a GO has a long time perspective, when an enterprise starts the way (e.g., improving its transparency) the preliminary results will be perceivable in the short term.

The way is not smooth, in this chapter we will indicated a number of GO knowing that to reach them, starting from the current conditions, it is necessary to proceed along effective innovation strategies and, parallelly, to remove several roadblocks. Having defined the objective in this chapter, the strategies to reach them will be addressed in the two following Chapters 3, for what concerns the socio-technical innovation, and Chapter 4, for what concerns the ICT specific issues.

2.2. The Grand Objectives as enterprise qualities

As indicated, the GO are intended to be directions to pursue rather than precise targets. For this reason, the GO can be seen as a set of complex processes that will take place inside and outside (in the Society at large) of the enterprise, progressively introducing deep changes in its nature and behaviour. To characterise such changes, we wish to introduce a wider notion of quality than is used today. For example, the philosophy and practice of Total Quality Management (TQM) has been extensively diffused and accepted. However, TQM is far from being "total", since it essentially addresses concrete aspects, such as processes and products, overlooking many other aspects, such as the impact with the environment and the ethical issues[7]. Here we intend to introduce a notion of quality at a more comprehensive level, that surely includes the current notion of TQM, but that also touches on other more intangible aspects of the enterprise, seen in its entirety. We can introduce then the space of the enterprise *Quality of Being* (*QoB*). This will be the approach adopted in this chapter.

Concretely, we will address different dimensions referring to specific features that characterize the *Quality of Being (WoB)* of an enterprise. We believe that the *QoBs* deeply influence the way an enterprise operates, the management style, the relationships with employees and staff, with clients and partners, the marketing strategies and practices; but also the carbon footprint, the level of social responsibility, and finally, the contribution to the overall development of the society at large. In essence, the FInES Grand Objectives will be a set of qualities to be pursued by enterprises over the next decade, without saying how such qualities can be acquires by an enterprise, what such an enterprise should do, what organization model should assume, and, more specifically, what will be the technological solutions to be adopted. Such themes will be mainly addressed in the next Chapters of this Roadmap.

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[7] But the picture is evolving, as proved by the more extensive view of the European Framework for Quality Management (EFQM)

Below, a brief description of different *QoBs* of future enterprises is presented. A more intuitive way of presenting the material would be to stick to traditional enterprise departments, such as: Sales and Distribution, Procurement and Production, Human Resources, Finance and Control. However, the *QoBs* we are referring to often intersect with more than one of the mentioned dimensions (for instance, transparency may apply to all of the mentioned enterprise sectors). Therefore, we decided to use the Quality space as the presentation organization, leaving to a later, more specific elaboration, the declination of each quality in the context of the actual enterprise departments and activties. Finally, to make the presentation more concrete, instead of presenting the qualities in abstract terms, we will use the some conventional enterprise labels, e.g., the *green colour* when describing the relationship of an enterprise with the environment.

2.3. The Grand Objectives of FInES

This is the central section where a number of enterprise qualities will be illustrated. Please note that they are not independent one another and we expect that a future enterprise will exhibit a certain blend of the different paradigmatic enterprise qualities reported below.

Cloud Enterprise *(with respect to employees, partners, customers)*

This dimension refers to an enterprise whose boundaries cannot be definitively defined, i.e. what is *in* and what is *out*, the "external" and the "internal" sections of the value chain. This is not a new for an enterprise, as modern enterprises have started to move along this path for a long time, but we strongly believe this path will continue to be followed in the future. More specifically, this QoB implies the capability of relying on a flexible, unrestricted set of production units (operating in places and according to processes largely outside the control of the main organization, sometimes even unknown). Intermediate (raw) products are typically fabricated (elsewhere) with a low level of coordination, with clearly defined agreements on time and quality of the produced goods or services. However, in the SLA (Supply Level Agreement) the prime partner will be qualified to introduce production conditions such as: low energy consumption, low carbon footprint (aiming at short supply chains and primarily moving bits, i.e., ideas, instead of atoms[8]), respect of human rights.

Examples of Cloud Enterprises: the majority of Open Source Software production is based on this paradigm. Moreover we may cite: *App Store, Amazon Mechanical Turk, Netflix Prize* and *BellKor Pragmatics Chaos*, and, on a different plane (less commercial), *Wikipedia*.

As a counterpart, on the market side, we can mention new ways for clients to be organized and getting better negotiation power. See for instance *CarrotMob*.

Sensible Enterprise *(reaching beyond knowledge)*

Currently, an enterprise are expanding their advanced ICT solutions for the gathering, storing, organising, and easily accessing the enterprise knowledge. Advanced Knowledge Management Systems (KMS) will soon be capable of allowing people to make extensinve and flexible use of the enterprise knowledge, of identifying and delivering the right knowledge to the right person at the right time. Today a KMS is capable of managing documental knowledge, typically sectorial and application-based ("applicative"). We believe that the development of a knowledge-based economy requires a significant enhancement in knowledge management, primarily by extending the current notion of enterprise knowledge. An important step forward will be when the enterprise will be able to go beyond concrete applicative knowledge, adding higher forms of knowledge (meta-knowledge and semantics), such as the rationale, motivations, and knowledge about the operational context. Essentially, a *Sensible Enterprise* will be able to use specific (technical, applicative) knowledge in conjunction with all the other knowledge resources capable to guarantee an effective behaviour. Such

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[8] Expression borrowed from "Being Digital", Nicolas Negroponte.

enhanced knowledge will model also the context, the objectives, the expected outcomes, the concrete use that people would make of the retrieved knowledge. Another aspect is the proactive attitude in knowledge delivery, with a capacity of a Sensible KMS, of "sensing" specific situations and forwarding useful knowledge to the actors involved.

This new way of managing and using enterprise knowledge is at the bases of the idea of a *Learning Enterprise*. The latter will be using methods and tools aimed at observing and keeping traces of the activities, recording the effects of actions, i.e., practical experiences leading to successes or failures, that will be systematically elaborated and stored, for future reuse. Traces of enterprise operations, and therefore material for enterprise learning, will be also extracted from things (in the context of the Internet of Things), equipped with devices (e.g., RFID) capable of notifying their states and evolutions. But a Learning Enterprise will not be simply characterised by the use of knowledge in its business and value production. The knowledge will be used by a Sensible Enterprise also to rethink its own organization, restructuring its processes, production, logistics, marketing, finances, and HR management, according to the new acquired knowledge.

Another point, related to the previous QoB, is the idea of Cloud Knowledge: it means that the knowledge of a Sensible Enterprise will not be limited to the resources stored locally, but its scope will span over the full Internet, having the possibility of accessing the knowledge resources at a global level. In a systematic way, internal and external knowledge will be related and complemented.

FEDS *(Far from Equilibrium Dynamically Stable)* **Enterprise**

This dimension refers to the essential traits of an operational philosophy typical of a highly innovative enterprise, capable of continuously evolve for improving, while keeping its operations running and delivering value. A FEDS Enterprise can therefore evolve in a continuous way without stopping its operations, i.e., being active, growing, and improving, like complex living entity continuously do. Such organisms are characterised by a partially organized structure, where several components escape a tight central control, being endowed with large autonomy[9]. In an enterprise, this means a strong delegation from the top to the lower operational levels, allowing the production units to have large margins of autonomy of means and strategies, while intermittently coordinating for common business goals. This QoB is highly synergic with the two previous ones: the Cloud Enterprise, characterised by loose production connections, and the Sensible Enterprise, since a great quantity of knowledge, of different sorts (including contextual knowledge), needs to be continuously exchanged among its parts, and with the outside world (across fuzzy boundaries).

Besides the positive aspects already mentioned, including flexibility, scalability, continuous innovation, there are a number of problematic aspects that need to be recognised. The latter are already present in today's advanced enterprises and cannot be removed, due to the inherent nature of the organizations we are depicting: high complexity and non-linear behaviour. We need to understand, and accept, the anti-Cartesian philosophy of "incomplete control", i.e., situations in which the evolution of the affairs escape not only our control, but also to a certain extent our forecasting capabilities (the recent economic downturn is a paradigmatic example of this). The traditional Cartesian thinking, with the idea that the technology will allow us to extend our control over the reality, has been counter-productive in many situations. In fact, in the quest for reaching full control of FEDS organizations, we refused to accept the limits of our current theories, overlooking different approaches capable of providing incomplete models: such approaches are realistic, in their capacity to provide useful output when possible and to honestly indicate where there are the "black holes", i.e., where the models will fail to give and answer. In essence, no answer is better than wrong answers. Finally, the mentioned "partial" methods can be coupled to feedbacks and controls on the mechanisms[10] that, even in case of unpredictable (and unpredicted) situations, will be able to minimise the negative impact of unforeseeable events.

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[9] See for instance, Autopoietic Systems, as proposed by Maturana and Varela.
[10] This is sometimes referred to as a Cybernetic Model of an enterprise. See Stafford Beer.

Green Enterprise

This QoB is tightly connected to the recognition that profit should not be obtained by offloading part of the costs onto society at large, or onto future generations[11]. The concern about the environment should not be simply considered as compliance with the existing laws, it should be integrated into the "DNA" of the enterprise, into the processes, the products, the after-sales relationships, the advertising and marketing styles.

In selecting the enabling technologies, in deciding how to proceed along innovative programmes, in all the enterprise activities there are wide possibilities of adopting a "green attitude." Traditionally, a green attitude has been perceived as additional costs for the enterprise. But the opposite is becoming more widely accepted. The first movers in this direction (see for instance Toyota hybrid car models) are enjoying a competitive advantage. This will surely continue in the future, and the Green Economy is generally considered, particularly during economic downturn, one of the sectors with the most promising prospect for growth.

White Enterprise

Many says that the current economic downturn is largely due to the absence of adequate levels of transparency and traceability of the financial products (e.g., MBS: mortgage-backed securities in subprime crises), but probably this episode highlights a more general problem of accountability and social responsibility. The latter, in particular, has a wider impact, when referred to as CSR: corporate social responsibility. In fact, the latter has a wide import, as explained in the following description[12] "*CSR policy would function as a built-in, self-regulating mechanism whereby business would monitor and ensure its adherence to law, ethical standards, and international norms. Business would embrace responsibility for the impact of their activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere*." This definition is quite extensive and again it represents a direction we wish to proceed with. Here, once more, it is difficult to set a precise target to be reached, but at the same time any progression in this direction will produce commendable effects.

Blue Enterprise

This QoB is tightly connected to the inclination to innovate that an enterprise exhibits. The terminology is directly derived from the EC publication "Value Proposition for Enterprise Interoperability[13]", that references the strategic positioning of an enterprise according to two different competition scenarios, referred to as "blue ocean strategy" and "red ocean strategy". The two scenarios are connected to the capability of an enterprise to innovate. In fact, the report recites:

> *Companies competing on **blue ocean** strategies simultaneously pursue differentiation and low cost. Their aim is not to out-perform the competition in the existing industry, but to create new market space or a "blue ocean", thereby making the competition irrelevant. They achieve this through value innovation, i.e. introducing radical innovations in the products, services, processes, etc., that are genuinely valued by customers.*

Glocal Enterprise

With the advent of the Globalization, enterprises have been pushed to operate at an international level, in terms of sourcing, production and markets, of finance and technologies. This process has promoted a number of improvements for the economy of the Planet, allowing for new business scenarios with new players entering the scene. But at the same time, especially where the enterprises do not show the

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[11] In economic terms, this means that externalities should be costed and factored into the cost of a firm in producing goods or services.
[12] http://en.wikipedia.org/wiki/Corporate_social_responsibility

[13] http://cordis.europa.eu/ist/ict-ent-net/isg.htm

"White" quality (see above), Globalization is producing hardship and difficulties for part of the populations in both advanced and developing countries. Globalization is today with us, and it will remain. Today, and in the future, rather than fighting against it, a number of corrections to limit its downside must be introduced. One of the most significant is the possibility of conjugating two apparently contradicting dimensions, i.e., local and global, merging them into a virtuous bland referred to as "*glocal*".

A *glocal enterprise* will be able of understanding and thinking at a global level, while being aware of the local levels in which it operates, acting in harmony with its territory. To achieve this, it is necessary to show a special kind of flexibility, necessary for instance to adapt products and production processes to the needs of a given territory. This includes, for instance, adopting different marketing strategies depending on the regional characteristics, the locally available technology, the financial conditions, the availability and costs of natural resources.

If we move from the spatial to the temporal perspective, this quality is reinterpreted along the line of time, referring to the capacity of the enterprise to be active and aligned with present time today and at the same time looking far ahead to be ready for future challenges. A *Foresightful Enterprise* should be looking ahead not only in terms of innovation, but also (see the Sensible and Green Enterprise) being capable of "trading" a reduced immediate advantage for a better future improvement or a reduced future detriment, to itself and to the society as a whole.

In this chapter we presented a set of Grand Objectives for future enterprises, by using a method that identifies such GOs with a few enterprise Qualities of Being. To recap, the proposed GOs are labelled as:

- *Cloud Enterprise*

- *Sensible Enterprise*

- *FEDS Enterprise*

- *Green Enterprise*

- *White Enterprise*

- *Blue Enterprise*

- *Glocal Enterprise*

We expect that the future enterprises will use the Future Internet and, in general, the innovative ICT solutions to achieve a virtuous blend of the above. However, we believe that such future enterprises will not spontaneously happen, as a result of the technological innovation taking place within a universal mechanism of growth and progress. On the contrary, the achievement of the above qualities needs careful and dedicated studies, capable of tracing a roadmap for the evolution of socio-economic system, and tenacious endeavours to proceed along these roads. Therfore, the existence of such a roadmap will not be sufficient to achieve the sought objectives, there is an additional need of two main drivers: (1) a constant and determinate governance, and (2) the systematic identification of hindering factors (among which, the defence of "status quo") and their removal.

3. Notes on the Remaining Chapters

Draft text of the remaining chapters will be provided in the next version of this document, with the following structure:

- *Chapter 3 Research Challenges in reaching the Grand Objectives*

  Chapter 3 will address the Research Challenges that need to be tackled in the next decade, to proceed towards the GO described in Chapter 2. There is a growing awareness that future research will be increasingly interdisciplinary and, even if here the context is primarily ICT, its application to enterprises requires the convergence and cooperation of multiple disciplines (from Economy to Social Sciences, from Organizational Theory to Complexity and Semantics). Therefore, the research will address issues such as: how future enterprises will operate, will be organised, or what will be their marketing strategies. Besides these enterprise oriented issues, there will be questions concerning the ICT solutions that will be needed to support such innovative enterprises.

- *Chapter 4 Enabling Technologies and Methodologies*

  In Chapter 4 there will be a specific focus on the ICT solutions for future enterprises. Having clarified the Research Challenges in the wider context, we are then able to address more specifically innovative ICT solutions, including methodologies, that will be needed to support the achievement of the research challenges. In this chapter, the elaboration will be more specific, including concrete technologies and how such technologies will be realised and will be adopted in the future enterprises. An important section of this chapter will be represented by the scientific bases that is needed to guarantee scientifically sound solutions and to avoid technology-driven innovation.

- *Chapter 5 Assessment of Key Achievements of Past Projects and Beyond (SotA)*

  In Chapter 5 there will be an analysis of the State-of-the-Art (SotA) and the available ICT solutions, organising them according to the following three categories: (A) ICT solutions already available that can be effectively adopted for the FInES objectives; (B) ICT solutions that appear under development and that will be available in the next period, to be adopted in time for the achievement of the FInES; (C) ICT solutions that do not appear today in the agendas of technology research roadmaps, for which it will be important to provide a consistent research programme. The analysis and assessment of the SotA will pay particular attention to the past and current European ICT project, with the intent to maximise the reuse of the achieved results.

- *Chapter 6 Conclusion and Recommendations*

  The report will be closed by this chapter, reporting some conclusion and a number of final recommendations.

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