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ensemble
Promoting Future Internet Enterprise Systems Research

"Envisioning, Supporting and Promoting Future Internet Enterprise Systems Research through Scientific Collaboration"

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# Research Roadmap Updates - 1st Version

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## Partners

| | | |
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|  | National Technical University of Athens (NTUA), Decision Support Systems Laboratory, DSSLab<br>Co-ordinator | Greece |
|  | Consiglio Nazionale delle Ricerche – Istituto Di Analisi Dei Sistemi Ed Informatica "A. Ruberti" (CNR) | Italy |
|  | Coventry University (CU) | United Kingdom |
|  | UNINOVA – Instituto de Desenvolvimento de Novas Tecnologias (UNINOVA) | Portugal |
|  | INTRASOFT International S.A. (INTRASOFT) | Luxembourg |

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# Executive Summary

This document represents the first full draft of the FInES Research Roadmap 2020+ that has been produced by the dedicated FInES Research Roadmap Task Force, articulated in the Editorial Board and the Scientific Advisory Group (SAG), with the support of the Experts Scientific Committee (ESC) of the ENSEMBLE Project.

The document is organised according the 4 Knowledge Spaces that have been identified and that drive the Roadmapping activities:

The first level of the FInES Folksonomy is organized according to four knowledge spaces conceived as a reorganization of the fabric of the FInES Research Roadmap 2010. Such spaces are the following.

1. **Socio-economic Space** (SOCE) – this space represents the larger context in which enterprises operate. It includes topics such as the social responsibility of enterprises, the impact on the environment and their carbon footprint, until the system of values that goes beyond the pure financial dimension.
2. **Enterprise Space** (ENTP) – this is the space where we address the key characteristics of future enterprises, the emerging business and production models, new governance and organization paradigms, new forms of cooperation: all geared towards a continuous innovation paradigm. This space includes the investigation on new styles for the relationships with customers, yielding new market forms and logics.
3. **Enterprise Systems, Platforms, and Applications Space** (ESYS) – this space is specifically concerned with FInES, i.e., with the ICT solutions and socio-technical systems aimed at supporting the emerging future enterprises that will largely operate over the Future Internet. The issues delineated in this space will be aligned with business needs and rationale identified for the future enterprises.
4. **Enabling Technology Space** (TECH) – this is the knowledge space that concerns the ICT solutions, in particular Future Internet solutions, knowledge representation, cooperation and interoperability, trust and security advanced services, etc., that will be necessary for the development of FInES. We know that ICT solutions will be evolving according to their own strategies and trajectories, so it is important to understand what ICT enabling solutions will be available 'by default' and what solutions will need to be 'solicited' for the purpose of FInES.

The above spaces are seen somehow nested one into the other, with a top-down containment process. Such containment entails a mutual dependency, but for the sake of clarity we addressed them in separate chapters.

In the framework of the **Enterprise Systems, Platforms, and Applications Space**, which is specifically concerned with FInES, a list of Research Challenges have been identified. They are listed here, and detailed in the Chapter 3.

- RC1. Unified Digital Enterprise
- RC2. Linked Open Knowledge
- RC3. Complex Systems Modelling
- RC4. Innovation-oriented enterprise production platforms

- RC5. Unified Digital Enterprise (UDE) Management System
- RC6. Cooperation and collaboration platforms
- RC7. Proactive FInES Mashup
- RC8. Autonomic Computing Components and Subsystems
- RC9. Flexible Execution platforms

Finally, during the elaboration of this first document, the individual chapters have gone through a systematic consultation process that involved the members of the SAG and ESC. The consultation, that took place online, by using an open tool (Google Forms), was organised in a way to allow the experts to: (i) express the degree of agreement on the positions and the topics reported in each chapter, by voting on a scale from 1 (disagreement) to 5 (full agreement); (ii) fill in a text box to indicate the motivation of the casted vote; (iii) fill in a text box with alternative positions of topics, if any; (iv) provide the bibliographic references (if any) to support the stance. The results of the consultation process are available in the annexes of this document.

# Table of Contents

# List of Figures



# List of Tables

# 0 Introduction

This document is the first full draft of the FInES Research Roadmap 2020+, a study on the future research lines promoted by the FInES Cluster and carried out as a collective endeavour by the projects and the experts who participate in the cluster activities. Furthermore, the research roadmap activities have been supported by the ENSEMBLE project. This document follows a previous FInES Research Roadmap that has been published in June 2010.

This document has been drafted by the Editorial Board originating from ENSEMBLE, in particular by Michele Missikoff (Chief Editor) with the help of the Editors: Yannis Charalabidis, Ricardo Goncalves, and Keith Popplewell. The document has been also submitted for comments to the 2 scientific committees established by the ENSEMBLE project and, in a later phase, to the projects operating within the FInES Cluster.

The Scientific Advisory Group (SAG) has been created with the specific objective to support the development of the FInES Research Roadmap 2020+ while the Expert Scientific Committee (ESC) has been created with a wider scope, to support the scientific activities that are carried out within the ENSEMBLE project, therefore the involvement of the latter in the FInES Research Roadmap is only partial, while the former has the central objective to support this research roadmapping activity, in all its phases. Below we report the two lists of experts participating in the two groups.

The FInES Research Roadmap Scientific Advisory Board currently consists of the following experts:

**Table 0-1: The Scientific Advisory Group Members**

| Last name | Name | Affiliation | Nationality |
|---|---|---|---|
| Bhullar | Gash | control2k | UK |
| Constantinides | Efthymios | University of Twente | The Netherlands |
| De Lama Sanchez | Nuria | ATOS ORIGIN | Spain |
| De Panfilis | Stefano | Engineering Ingegneria Informatica S.p.A. | Italy |
| Dogac | Asuman | METU - Software Research and Development Center | Turkey |
| Fischer | Klaus | German Research Center for Artificial Intelligence | Germany |
| Grilo | Antonio | Nova University and Neobiz Consulting | Portugal |
| Gusmeroli | Sergio | TXT e-Solutions | Italy |
| Mehandjiev | Nikolay | The University of Manchester | UK |
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| Last name | Name | Affiliation | Nationality |
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| Sutcliffe-Braithwite | John | BT Connect | UK |
| Zelm | Martin | CIMOSA | Germany |

The ENSEMBLE Experts Scientific Committee currently consists of the following experts:

**Table 0-2: The Experts Scientific Committee Members**

| Last name | Name | Affiliation | Nationality |
|---|---|---|---|
| Ahrweiler | Petra | University College Dublin | Ireland |
| Berre | Arne-Jørgen | SINTEF | Norway |
| Bishop | Stephen | UCL | UK |
| Cave | Jonathan | University of Warwick | UK |
| Chen | David | University Bordeaux 1 | France |
| Constable | Robert | National Institute for Creative Art, University of Auckland | New Zealand |
| Goranson | Ted | Sirius Beta | USA |
| Grilo | Antonio | Nova University and Neobiz Consulting | Portugal |
| Gusmeroli | Sergio | TXT e-Solutions | Italy |
| Ivezic | Nenad | NIST | USA |
| Koppenhagen | Norbert | University of Mannheim & SAP AG | Germany |
| Leyton | Michael | Rutgers University | USA |
| Manzalini | Antonio | Telecom Italia | Italy |
| Shen | Weiming | National Research Council of Canada | Canada |
| Taxén | Lars | Linköping University | Sweden |

The FInES Research Roadmap Task Force, articulated as explained above, operates under the supervision of the Chair of the FInES Cluster, Cristina Martinez, and the Co-chair, Man-Sze Li. Furthermore, an essential support has been provided by the FInES Cluster Assistant, Diana Vlad-Calcic.

## 0.1 Method of Work

The FInES research Roadmapping work has been organized in three main phases, to which three versions of the FInES Research Roadmap correspond, due at months 12 (August 2011, draft v. B1), 18 (February 2012, draft v. B2), and finally 24 (August 2012), when the final document will be released (full v. 1.0).

The starting idea has been to see the research roadmapping activity as a knowledge base creation and organization for achieving a knowledge repository aiming at representing the FInES Knowledge Universe. To this end, we adopted a convergent approach of bottom-up and top-down processes. The bottom-up process started with the collection of research topics from the SAG and ESC members, soliciting them to provide 10 keywords each with a free, inventive mental attitude. In parallel, the Editorial Board started to elaborate on a few comprehensive knowledge spaces; in particular four knowledge spaces have been identified, that represent the top categories for the FInES knowledge management: socio-economy, enterprises, enterprise systems, and ICT.

From a methodological perspective, the main innovation with respect to the previous FInES Research Roadmap is that this time we intend to go beyond the 'traditional' paper document approach (even if in digital form). We intend to build in parallel a Knowledge Base having a different structure and a wider possibility of access to the knowledge that has been gathered and organised during the Roadmapping activities. In particular, we adopted a social, collaborative working approach to be followed both in the construction of the FInES knowledge universe and its subsequent maintenance. In essence, the idea is to achieve (and make it sustainable) a fully open (although moderated) knowledge infrastructure, on the style of Wikipedia, that contains the essence of the FInES knowledge.

An important aspect is represented by the web-based tools that will be adopted, to guarantee that the outcome or the FInES Research Roadmapping activities will not be limited to a paper (or electronic) report, but will also take the form of a web-based knowledge infrastructure, organised according to the FInES Folksonomy. In this first phase, we started to experiment a free, web-based tool: Google Forms. It proved to be effective and easy to use by the SAG and ESC, while in the next phase we are further opening its adoption to the FInES projects for collecting their contribution to the Roadmap. Furthermore, in the next phase we will explore additional tools aimed at allowing the FInES Community to easily access and maintain the content of the Research Roadmap. The actual adoption of Web-based tools will depend on the concrete advantages emerging with the trial use. We have already started to use and experiment a few and, according to their actual effectiveness and acceptance, we will decide the actual adoption.

## 0.2 Organization of the document

The material presented in this document has been organised according to four FInES Knowledge spaces.

The first level of the FInES Folksonomy is organized according to four knowledge spaces conceived as a reorganization of the fabric of the FInES Research Roadmap 2010. Such spaces are the following.

1. **Socio-economic Space** (SOCE) – this space represents the larger context in which enterprises operate. It includes topics such as the social responsibility of enterprises, the

impact on the environment and their carbon footprint, until the system of values that goes beyond the pure financial dimension.

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The four knowledge spaces will be elaborated in more details in the following chapters that represent the core outcome of the first phase of the FInES Research Roadmap activity. The main document will be then followed by a number of annexes, reporting the material produced by the experts in the achieved consultations.

These spaces are of course tightly intertwined, in a sort of mandala where on one side we could tell that 2 (Enterprise space) is part of 1 (Socio-economic space), 3 (Enterprise Systems, Platforms, and Applications space) of 2 and 4 (Enabling Technology space) of 3, but also that 2 feeds and "in-forms" 1, and so on. What at first glance looks like a hierarchy, in deepening the analysis becomes an endless loop with two counter-circling streams of influences, constraints, enabling factors.

# 1 A Vision on the Socio-economic Space in 2020+

## Preface

This section proposes a vision of the Socio-Economic space, having the 2020 (and beyond) as time horizon. The Socio-economic space represents the larger context in which enterprises operate, interacting with the other players and the environment, aiming at the increasing of wealth while satisfying customers' needs. The analysis of the trends that characterize the various drivers of societal aspects, in order to forecast what our society will be like in ten years from now, is also very important. A systematic forecast is outside the scope of the FInES Cluster, so the characterization of the future evolution of this space will be largely based on relevant publicly available documentation[1]. In elaborating our vision of the future, we will focus on the impact that the socio-economic space will have on the way enterprises will operate and achieve their objectives. In this analysis, we intend to consider a societal context where there are values that go beyond the pure financial dimension, such as ethical values and social responsibility, transparency, impact on the environment and carbon footprint.

## 1.1 The need for a socio-economic discontinuity

For more than a decade, the Western economies are facing a troubled phase where economic crises follow one another. Today there is large agreement that the existing socio-economic models cannot continue to exist as they used to be in the last period: we reached a point of **discontinuity** (a point of 'bifurcation', according to Complexity Theory). There are a number of factors that anticipated such a change: from the serious economic crises of the last decade to the enormous sovereign debts accumulated by the countries, and to the limited expansion of the Western economies, opposed to the marked growth of the emerging economies (well represented by the so-called BRIC: Brazil, Russia, India, China). The latter operate on a global scale pushing up the costs of raw material and natural resources while competing against Western economies with low price goods and services. The mentioned signs have been anticipated and analysed by a number of experts, such as David C. Korten when talking about the advent of 'The Perfect Economic Storm' and the related consequences, from the failure of the financial systems, to the deterioration of the environment and the increase of social inequality. In essence, there are clear signs that Western countries, and Europe in particular, cannot proceed along the beaten paths, just practicing 'business as usual'. The Western development models require a change of paradigm to maintain (not to mention improving) the current standard of life.

[1] To provide additional material, the ENSEMBLE project has organised a brainstorming session in the Samos 2011 Summit. The rich outcome is currently under elaboration and will be included in the next version of the draft.

## 1.2 Different growths for wealth and well-being in reduced economic expansion

The key problem of Europe for the next decade will be to find a socio-economic model capable of guaranteeing a growing standard of life (or, at least, avoiding its decline) for people in presence of economies that will not be able to exhibit a continuous and significant expansion. In essence, the objective is to achieve a growing socio-economic well-being without an equivalent growth of the wealth produced by the industrial systems. To achieve such a double speed socio-economic model, it is necessary to proceed along different lines. Primarily addressing the economic development model, where the established mechanisms, based on consumerism, with a parallel expansion of consumption and production, needs to be revisited. With this respect, it is noticeable that there is a growing awareness in some sectors of the Society and a cultural trend that promotes a set of new socio-economic values. For instance, a number of essays and publications provide good clues towards the interpretation of the riches of a country by means of new indicators (see [2] from Annex A.1, the well-known Stiglitz-Sen-Fitoussi Report). Such indicators go beyond pure monetary values to measure the wealth of a country. Other directions propose an approach that considers the possibility of satisfying the needs of people in a different way with respect to the Society of Consumption (e.g., see [9] from Annex A.1, the 'Economics of Enough', by Diane Coyle). Furthermore, there are studies indicating how to approach a future characterised by a limited growth (see [11] from Annex A.1, Serge Latouche and his 'graceful downscaling') and how to cope at best with such a perspective. The idea is that, having lived a long period of (relative) abundance, we have large margins for savings by means of optimization, reuse, refurbishing, etc., in essence, using better and longer what we already have.

## 1.3 Towards a totally connected Society

The above sketched scenario needs new forms of social cohesion to be achieved. Internet is changing the way people know each other, get in touch, exchange information, opinion, knowledge; we are rapidly evolving towards a totally connected society, where cultural interoperability will be at the basis of new forms of social innovation. But also solidarity and new types of subsidiary economies (e.g., advanced forms of private-public partnerships and the Third Sector) need to be developed, aiming at exploring new ways of production and consumption for goods and services (i.e., producing to live better with less). Accordingly, the current notion of 'job market' will progressively evolve, leaving the scene to new forms of enterprise and productive occupation (e.g., the advent of 'workeprenuer' as a synthesis of self-employed worker, consultant, flexible employee), jointly with new solutions for social protection (e.g., evolving along the line of 'flexicurity '.)

On the socio-economic side, to guarantee a growing **well-being for people** in absence of an expanding economy, it is primarily necessary to achieve social cohesion at all levels. Here the role of Future Internet is central, to support also new forms of social and political participation. It will be able to carry the initiatives aimed at fighting against social fragmentation, if suitably enshrined in focused socio-political agendas. Among the primary interventions, we see new forms of active participation of citizens (e.g., deliberative democracy), advanced education systems, with effective life-long programmes, and the promotion of enhanced socio-economic opportunities for all citizens. Cohesion

is required at different levels, among countries, among social groups, down to the individual persons, reconciling different roles of the people that, in a highly connected society, will have open spaces for interactions and confrontation. The individual has a private and public life; he/she is a citizen, a worker, an entrepreneur, in different moments or different seasons of the life. Such roles are becoming more interwoven and will emerge as different, coexisting facets of the same individual. Another issue is solidarity: helping the less fortunate people and societies is not simply a humanitarian achievement. It represents also an opportunity to expand the base of wealth production, contributing to the global growth.

## 1.4 Innovation in a Knowledge-based Society

Since more than a decade (ref. the Lisbon Strategy) it is widely shared that Europe needs to evolve towards a knowledge-based economy[2]. But this objective resulted harder to be achieved than expected (due also the recurring economic crises). It appeared that developing and adopting knowledge technologies is not enough, the heart of the knowledge-based Society is the people. In the next 'Decade of Discontinuity', it is necessary to foresee a socio-economic model where technological development will take place having the people (citizens, workers, entrepreneurs, etc.) at the centre. Only people are able to deploy the creativity that, supported by the necessary knowledge, is able to promote innovation and growth.

It is necessary to put the people at the centre, creating a cultural base for innovation that will be adopted not only in the production realm, but also in the social life, leveraging the competencies and skills of every individual. Then, innovation will be deployed towards new life styles, new development models, and effective strategies for a sustainable growth. This requires also an innovative (wise) approach to the usage of natural resources, e.g., on energy consumption, to the usage and disposal of goods, and to the access to largely available services for the individuals, for the enterprises, and the public institutions. This will free the needed resources that can be dedicated to the improvement of the well-being of people and the society and, at the same time, without compromising the well-being of the future generations.

In this socio-economic frame the enterprises play a central role, since they represent the primary source of wealth production, being at the same time one of the key players of the social and cultural evolution. Just think about the marketing campaigns, when advertising is based on the promotion of certain life models. Also here we can see important signs of change that will presumably continue in the future. For instance, today we see many ads where a given product (a car, a pair of glasses, etc.) is publicised connecting it to a style of life respectful of the environment: an evident sign that the marketing strategies are changing their 'mantra'. The role of enterprises is, and will continue to be, central in the cultural development of a Society. Enterprises have the opportunity to act in different contexts: internally, e.g., addressing the organization model, production and logistics, and externally, with the marketing strategies and customer relationships, and in the socio-political arena, with their lobbying capabilities. Enterprises can be one of the central 'engines' for the coming decade of innovation and discontinuity.

[2] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm

## 1.5 Some specific topics

The following list of bullet points represents the topics that would be useful to better elaborate. The idea is that each element of the list can be expanded to a text that better explains what the indicated topic means for the future Socio-economic space. In this phase, the list is mainly intended to trigger a debate during the consultation phase. It needs to be noted that the list is mainly derived from the Keyword Harvesting performed with the FInES Scientific Advisory Group. After the consultation, we will obtain a more consolidated list on the basis of the ratings of relevance that will be given. The topics that will be selected as most relevant will be linked to the elaboration text, in the next period of FInES RR editing.

This organization has been mainly conceived for the FInES RR Web site, where the elaboration page will be reached by clicking on the specific keyword.

- T1.1 Innovation as a cultural attitude
- T1.2 Homo Connectus: Convergence of homo-sapiens with the digital world
- T1.3 Social computing
- T1.4 Social complexity dynamics in a Multi-faced Society
- T1.5 Humanistic capitalism
- T1.6 Natural capitalism
- T1.7 Consumerism
- T1.8 Finance versus economics
- T1.9 Smart society, smart cities, smart government
- T1.10 Social transparency
- T1.11 Social networks and Wisdom of Crowds
- T1.12 World sustainability
- T1.13 Life-work balancing
- T1.14 Societal values
- T1.15 Neo-positivism
- T1.16 Social solidarity vs. individualism
- T1.17 Aging
- T1.18 Globalization
- T1.19 Urbanization
- T1.20 Society of consumption

# 2 The Future Internet-based Enterprise

*Imagination starts with individuals but flowers in groups, and it needs the power of an organisation to bring it to its full potential (Charles Handy, The New Enterprise Culture, 2004)*

*'Freedom is the source of innovation, invention, trying new things, and bringing about change and new projects. It is crucial to the long-term success of an enterprise' (Bill Gore. Gore-Tex inventor)*

## Preface

The Enterprise space is where we address the key characteristics of future enterprises, the emerging business and production models, new governance and organization paradigms, and new forms of cooperation, all geared towards a continuous innovation paradigm and a harmonious positioning in the Socio-economic space. Future enterprises are expected to base their success on knowledge assets, skills and competencies, creativity and innovation, awareness of opportunities and risks, with a wise risk taking attitude, and, last but not least, the adoption of ICT solutions constantly aligned with business needs. This space also investigates specific issues, such as trust and transparency, the role of innovation, new approaches to human resources, and new styles for relationships with customers, yielding new market forms and logics.

The next decade is expected to see a deep change in the way enterprises operate, mainly due to the advent of the Future Internet and the maturity achieved by enterprises in adopting new socio-technical solutions based on the former. This chapter addresses two main themes:

- The first theme concerns a number of Grand Objectives of Future Internet-based Enterprises that we believe will be central in a virtuous development of the socio-economic system of European enterprises. The proposed objectives represent an elaboration of the Quality of Being proposed in the previous FInES RR: they are sufficiently general to be applied to the majority of enterprises, independently of their size, nationality, or industrial sector. To achieve its objectives, an enterprise needs to act in a systematic and coherent way.
- The second theme proposes an operational approach, essentially a method (very sketchily depicted) that represents also a bridge towards the next chapter, where the Future Internet Enterprise Systems will be addressed, together with the related research challenges.

## 2.1 The Grand Objectives of the Future Internet-based Enterprises

As anticipated, this section represents a logical continuation of what has been reported in the existing FInES Research Roadmap 2010, reporting a synthesis of the 6 paradigmatic enterprise profiles, with the addition of two new profiles: Humanistic Enterprise and Agile Enterprise.

**GO1. Humanistic Enterprise** – Enterprises had for centuries the main goal of creating wealth maximising profits. Since the Taylor's industrial revolution, the human components have been subordinated to this primary goal. With the advent of the Knowledge economy, the assets are becoming immaterial, represented by the people's intelligence, therefore inducing a progressive shift in the ownership of the production means: from the employers to the employees. A Humanistic Enterprise (HE) [1] (from Annex A.2) accepts to put the persons at the centre, being them

employees, free lance consultants, partners, or customers. And in terms of performance, the HE will aim at co-producing wealth and well-being, considering among its stakeholders the human resources, the customers, and the socio-economic context in which it operates.

**GO2. Inventive Enterprise**. Invention precedes innovation, and an Inventive Enterprise is capable of dealing with the entire lifecycle of innovation: from invention to production, impacting on all the departments: from production to marketing, from logistics to HR. It is important here to conjugate the inventive capability with the ability to transform inventions into innovations and then quickly change the production mechanisms to implement the new solutions, without stopping the ongoing business. To this end, another central QoB is the *agility*.

**GO3. Agile Enterprise**. The world is continuously changing for enterprises (and Society at large). Changes have a double sign: a positive sign when considering the opportunities of expanding the production and the market, when innovative solutions can be adopted to the benefit of the enterprise and the stakeholders; but also a negative sign when triggered by competitors enterprises are becoming aggressive, customers are showing disaffection, or the global economy is being shocked by the n-th crisis. The Agile Enterprise is capable of reacting to endogenous and exogenous contingencies with flexibility and adaptability in its organization, strategies, production plans [2] (from Annex A.2). But it is also proactive, being capable of anticipating change needs, quickly transforming its organization to seizing innovation opportunities.

**GO4. Cognisant Enterprise**. The amount of knowledge that today is available at our fingertips goes beyond our imagination. But the knowledge we can directly produce or discover in the Internet, and store in a knowledge base, has no effect on the business if it is not made operational, i.e., it is not embedded in the behaviour of the enterprise agents (either living or artificial.) A Cognisant Enterprise reaches beyond knowledge management, aiming at acquiring not only specific knowledge, but also the way to use it, the context and the expected effects of its adoption, risks and alternatives, etc. [3] (from Annex A.2)

**GO5. Community-oriented Enterprise**. The extensive adoption of Social Media in the enterprise gives the possibility to leverage on the social intelligence of different communities, both internal (e.g., among employees) and external (e.g., among customers, suppliers), to improve its operations and performances. The smooth flow of information will improve also transparency and accountability. Conversely, problems of privacy and security should not be underestimated.

**GO6. Cloud Enterprise**. This characteristic refers to the blurring of the enterprise boundaries, where it is not easy to distinguish the 'inside' and the 'outside', the employees and the partners, the competitors and the collaborators. New forms of labour and collaboration (e.g., the 'workeprenuer') will flourish. The 'cloud approach' is expanding in the socio-technical systems and, if correctly governed, it will bring important benefits. The 'cloudiness' is emerging also with the de-materialization of products that tend to be embedded into services, progressively losing their 'material value'.

**GO7. Glocal Enterprise**. Globalization is here, and it will continue to expand along different dimensions (commercial, cultural, religious, etc.). Enterprises need to tackle the globalization, for surviving and expanding, but at the same time they must be able to operate on the specific territories where their productions and markets are, knowing how to cope with the local rules and customs (see also the related issue of absorptive capacity [4]-Annex A.2). Glocality should also be considered in

terms of position along the time arrow, meaning the present time (local, synchronic view) and the future time (global, diachronic view) that need to be considered with a unitary approach.

**GO8. Green Enterprise**. This is a well known (even abused, in a way) dimension that, however, should not be neglected. It concerns the impact on environment, from the consumption of raw material to the production of waste, to the ecological footprint. It is important to reassert the importance of this dimension since there is a risk of worn out that brings indifference. The 'green' behaviour should become a mentality and a working style. This is a very crucial issue for the well-being of ourselves and our offspring.

## 2.2 The Operational Dimension

The above enterprise profiles, the Grand Objectives of Future Internet-based Enterprises, are not easy to be achieved. They require for an enterprise agility and the capacity of continuous improvement and innovation that, in turn, entail new operational approaches with a shift of priorities from enterprise resource management and planning to systematic and seamless change management. To this end, one possible option is represented by the adoption of a cyclic fractal approach to change management. It is cyclic, since it will be constantly repeated in different areas of the enterprise, and fractal [5] (from Annex A.2), since it will be applied at different levels of granularity. The phases of the proposed operational approach are: Invent, Plan, Build, Operate, Monitor and Manage.

**Invent**. This is the first phase of the cycle that consists in the preliminary identification of new solutions to be adopted, in all possible areas of the enterprise (from production to HR, from management to marketing).

**Plan**. Planning is required in order to devise a trajectory capable of transforming a new idea into a concrete solution to be adopted. Here, techniques such as resource analysis, SWOT and risk assessment play a central role. Simulation and what-if analysis can also improve the understanding on the expected cost and performance of the new solution.

**Build**. This is the phase where the new solutions are actually implemented. Again, this may apply to different enterprise areas and domains, e.g., building new business solutions (including new organizational models, new processes, and new capabilities), or new products, or new competencies for the employees.

**Operate**. In this phase, the new solutions and capabilities are actually made operational, becoming an integral part of the enterprise activities and production. The start of this phase is critical since in an Inventive Enterprise, improvement and innovation need to be adopted without affecting the ongoing business (or limiting the impact in case of radical changes).

**Monitor and Manage**. This phase is actually overlapping the previous one, having a specific focus on how the innovation is performing. But in general, the M&M activities need to be constantly operational since, as anticipated, there is no suspension of the business activities.

## 2.3 Supporting the advent of the Future Internet-based Enterprises

An enterprise is a complex artefact, however, its unique anatomy, composed of very different active (human and artificial) and passive (tangible and intangible) elements, has hindered the extensive use of Engineering disciplines. Enterprise Engineering is seen as 'the application of knowledge, principles, and disciplines related to the analysis, design, implementation and operation of all elements associated with an enterprise' [6]. Systematic methods, based on advanced modelling techniques, are required to correctly address the activities carried out in the different phases of the operational dimension. But traditional engineering is not adequate, since it is a discipline stemming from the Industrial Revolution and the Positivism that aims to keep the reality (in particular, the artificial reality) under control. Conversely, we need a sort of Partial Engineering, with a Complexity Theory approach, where there will be a certain degree of autonomy for important sections of the enterprise. For instance, Business Process Modeling and Management will be complemented by the possibility of reacting to unexpected events (ref. Complex Event Processing). When we adopt, jointly with the systematic engineering approach, also a social computing approach, then we get in the space of the so called Enterprise 2.0.

## 2.4 Some specific Topics

As done in the previous chapter, here follows a tentative list of topics that, in the second phase of elaboration, may deserve special attention and specific elaboration.

- T2.1 Enterprise Engineering
- T2.2 Enterprise Modelling
- T2.3 Enterprise 2.0
- T2.4 Social Computing
- T2.5 Risk Assessment and Management
- T2.6 Humanistic Enterprise
- T2.7 Humanistic Management
- T2.8 Trust and Security
- T2.9 Transparency and Accountability
- T2.10 Business – IT Alignment
- T2.11 Business Process Management vs. Complex Event Processing
- T2.12 Change Management
- T2.13 Knowledge Management
- T2.14 Social Intelligence
- T2.15 Simulation
- T2.16 Performance indicators

# 3 The Future Internet-based Enterprise Systems

*'For the first time in history, technologies allow us to gain the economic benefits of large organisations, like economies of scale and knowledge, without giving up the human benefits of small ones, like freedom, creativity, motivation and flexibility.'* (Thomas Malone, The Future of Work)

## Preface

This chapter is specifically concerned with FInES (Future Internet-based Enterprise Systems), i.e., with the socio-technical methodologies, platforms, applications, systems, and, in general, ICT solutions aimed at supporting emerging future enterprises. Here we intend to delineate the key characteristics of a FInES and the related research challenges to be faced in the next decade. The key objective of a FInES is to facilitate the continuous improvement and innovation, as identified in the previous chapter, that represent a key characteristic of a winning enterprise, while carrying on at best value production business operations. To this end, the key trait of a FInES will be its flexibility and continuous alignment with the business needs.

The addressed issues are organized along three basic dimensions: the Knowledge Dimension, since before doing it is necessary to know, the Functional Dimension, to see what will be the main functions of a FInES, and the Engineering Dimension, to investigate new development techniques, with a specific focus on software applications.

## 3.1 The Knowledge Dimension

This dimension has a methodological nature. Here, the main challenge is to delineate methods and paradigms aimed at modelling the business reality. The corresponding software solutions will be addressed in the next section.

The degree of penetration of the ICT in the production reality will continue to a point where all we need to know about the enterprise will be in digital form, equally accessible and processable by computers and (mediated by the latter) by humans. Today we are very close to this, if you consider the massive amount of documents and data that are electronically produced, acquired, and circulated within an enterprise. To reach this objective we need to promote high quality research in several directions. Among the key ones, we have the following Research Challenges (RC):

**RC1. Unified Digital Enterprise.** It consists in a full digital image of the enterprise, representing various aspects, such as conceptual and factual (data) levels, behavioural and structural aspects, at various levels of detail. Today, the Knowledge Management appears to be a broken promise. The primary reason lies in the excessive emphasis given to technology: representation methods, storage structures, search and retrieval, inference algorithms, etc. have substantially progressed and are getting more efficient every year. But the real value of knowledge lies in the degree of penetration in all the business activities, on how it is capable to improve decision making, strategy building, and the everyday operations of the enterprise, i.e., permeating and changing the behaviour of the 'learning enterprise.' This Research Challenge is multi-faceted, one articulation concerns the knowledge pragmatics [1] (from Annex A.3), i.e., how to guarantee the actual usage of the available knowledge.

Another important articulation concerns the paradigms to achieve a holistic view of an enterprise. Along this line an important notion is that of a reference architecture. An Enterprise Architectural Framework (EAF) [2] (from Annex A.3), tightly connected with the Enterprise Engineering discipline, is a meta-model to be used as a reference in identifying the different parts and components of an enterprise, and therefore to suitably organise the enterprise knowledge, providing a general comprehensive view. Today there are many interesting proposals that need to further evolve (e.g., adding semantics): Zachman, PERA, CIMOSA, TOGAF, DoDAF, and methodologies, such as Model-Driven Architecture (MDA.)

**RC2. Linked Open Knowledge**. A Unified Digital Enterprise (UDE) is a complex structure that emerges from the collection of several knowledge resources logically and geographically distributed, inside and outside of the enterprise. E.g., in factual (data) knowledge, different bits and pieces of information can be referred to by the same business entity they belong to. Semantic annotation and filtering [3] (from Annex A.3), allowing for the rebuilding of a full digital representation of business entities, is one of the challenges. We expect that the evolution of Linked Open Data will be an important issue. In particular, it will be important to achieve a tight integration between 'internal' and 'external' knowledge, in a dynamic scenario where what is external today can be internal tomorrow, and vice versa (ref. Cloud Enterprise.) This research challenge is based on the use of ontological resources and, to provide increased reliability and consensus, on crowdsourcing approaches (like a Folksonomy).

**RC3. Complex Systems Modelling**. An enterprise is a complex artefact [4] (from Annex A.3), therefore many sections will be fully specified by using some deterministic modelling techniques, but there will be sections for which only partial specifications will be possible (e.g., via agents, rules, etc.) and their actual behaviour, not defined 'a priori', will emerge according to the autonomous initiatives of proactive components. Here, Complexity Theory is expected to yield important contributions.

## 3.2 The Functional Dimension of a FInES

Traditionally, enterprise software applications (ESA) are primarily conceived to support the day-by-day value production of an enterprise, with an optimal management and planning of the resources (ref. ERP). There are other vital functions and activities that are partially integrated, from the strategic marketing to the R&D, to financial scouting, and to organizational innovation. According to the notion of a UDE (Unified Digital Enterprise), the idea is to proceed towards a totally integrated approach also from an functional point of view, where different aspects and activities are seen in a unique frame: rebuilding an holistic (even if partial[3]) view of the enterprise behaviour, constantly aligned with the reality. This is not an easy objective, especially in presence of high dynamicity and frequent discontinuities: a scenario that requires constant monitoring of inside and outside events and a capacity of quick aligning to changes, but also the capacity of generating discontinuities (to achieve a competitive advantage).

[3] This is only an apparent contradiction. In fact today the prevailing scenario is partial and fragmented, the objective is to reconnect the fragments, while incompleteness is not amendable. (For an inspiring reference, see: *On Exactitude of Science*, in An Universal History of Infamy, J.L. Borges)

**RC4. Innovation-oriented enterprise production platforms**. We foresee the architecture of a FInES organised according to 5 functional areas, corresponding to the 5 main dimensions identified in the previous section (Section 2.2). They aim at supporting the everyday business and, in parallel, the continuous improvement and innovation. The 5 functional areas can be implemented in different articulations dealing, e.g., with different business departments (from production to marketing, from logistics to HR). They are sketchily reported below (additional information of the 5 business areas is available in the previous chapter and, more extensively, in the previous FInES Research Roadmap 2010):

- **Invent**. A set of services to support the generation and assessment of new ideas and innovation opportunities, with an open approach (e.g., rif. Creative Commons [5] from Annex A.3), integrating the contributions of multiple actors and stakeholders.
- **Plan**. A set of services supporting the modelling of new solutions (e.g., process, product, marketing, etc.), decisions making, and the implementation detailing until the production of blueprints.
- **Build**. The actual implementation in accordance with the plans achieved in the previous phase, extensively using a component-based approach. The emerging self-configuring [6] (from Annex A.3) objects and systems (ref. FInER [7] from Annex A.3) will play an important role.
- **Operate**. The core functional area for what concerns value production, ever evolving according to the innovations and optimizations conceived and implemented in the previous phases.
- **Manage & Monitor**. The continuous observation of the reality to understand what's going on, to guess and check trends and deviations, to anticipate new opportunities and threats, to assess the effectiveness of process models and, more in general, of the adopted innovations. The use of indicators will be embedded in systemic views (e.g., Semantic and Holistic Balanced Scorecards [8] from Annex A.3).

**RC5. Unified Digital Enterprise (UDE) Management System**. This is the distributed platform providing all the services required to create and maintain the Unified Digital Enterprise (UDE) Knowledge, allowing at the same time easy and wide access. The knowledge resources will be only partially built as a specific modelling endeavour requiring the active intervention of human experts. The UDE knowledge will be stored in a Cloud repository largely automatically built (and continuously evolving) by using advanced techniques. Among those, we may cite Knowledge Mining and business *osint*[4] solutions, starting from different resources and software applications data, tracking the actual behaviour of business operations (that leave consistent 'digital traces'). But humans will maintain an important role, therefore the research will need to focus on the problem of rendering this large, variegated amount of knowledge to the human user, allowing him/her to interact, explore, validate, integrate. Another important service will be the proactive routing of knowledge to the interested users. But an enterprise is not an isolated entity, therefore a significant part of this knowledge infrastructure will concern the environment in which the enterprise operates.

[4] Osint: Open Sources Intelligence. It is a discipline aimed at extracting knowledge from a variety of open information sources, both on the Web and within an organization.

**RC6. Cooperation and collaboration platforms.** This functional area includes a rich number of services aimed at supporting a productive exchange of information, knowledge and services, among humans (cooperation, social computing), among computers (interoperability) and between the two (the evolution of human-computer interaction: HCI). The flow of information and services will also contribute to the constant update of the UDE knowledge (with a Social Computing philosophy). For the human-computer interaction, we will have a progressive disappearing of the computing devices, including terminals, PCs, laptops, etc., since large part of the interactions will take place while using familiar objects and business entities that will offer a multi-channel interface (images, voice, floating text, etc.). Even immaterial entities (e.g., a marketing strategy or an innovation idea) will be represented by mnemonic icons, that can be accessed and manipulated in a virtual 3D space.

## 3.3 The Engineering Dimension of FInES

Traditional Software Engineering techniques [9] (from Annex A.3) have difficulties in chasing the fast pace of the ever changing reality [10]. This will be even harder in a FInES scenario, seen its increased complexity and richness with respect to the existing enterprise systems. The structure and behaviour of a FInES will reflect the UDE knowledge that will be constantly aligned with the reality. Then, the challenge is how to implement the enterprise software applications keeping them aligned with the UDE knowledge. Below some key research challenges are described.

**RC7. Proactive FInES Mashup.** The UDE (Unified Digital Enterprise) integrated model will include the knowledge that specifies functions and operations, services and processes, data and information. Such knowledge will be used to search for the suitable organizational units and software components to be acquired and integrated in building a FInES. In building and keeping constantly aligned the technological and business components, there will be a combined top-down (goal- and human-driven) and bottom-up (event- and object-driven) process, supported by suitable tools and platforms. Here the role of smart networked objects is fundamental, since many software functions and operations will be embedded into the objects. They will have the intelligence to get in touch with other objects, creating greater aggregates able to exhibit emerging characteristics, e.g., functions and operations not available in any of the components.

**RC8. Autonomic Computing Components and Subsystems.** The FInES composition will rely on several pre-existing computing elements, including service clouds, available from the wide ocean of OSS repositories and providers reachable on the Internet, and also as specific assets available from the participating ecosystems or from the private assets of the enterprise (see also the notion of Future Internet Enterprise Resource: FInER from the FInES Research Roadmap 2010). The Future Internet will be able to provide a large choice of commoditized routine services, while the added value for the enterprise will depend on the capacity of achieving strategic business processes, decision making, and, in particular, complex event processing. The emerging picture reserves a central role to the humans, as individuals but also as collective subjects, since new forms of collective intelligence (ref. Crowd Intelligence) will represent an important ingredient of FInES. Another marked innovation will be represented by capabilities and roles of constellations of smart interconnected objects, both material and immaterial; they will perform the large majority of tasks, leaving to humans more strategic and 'brain intensive' activities.

**RC9. Flexible Execution platforms**. FInES will be characterised by a great variety of different ICT solutions and approaches, there will not be a unique 'killer paradigm' but rather a coexistence of federated platforms and solutions [11] (from Annex A.3). From multi-agents platforms to rule-based and best practice systems, from complex event processing to business process engines, to traditional software packages, different ICT solutions will coexist, performing the tasks and functions of the kinds more suited for them. Among the key services we may cite the Complex Event Processing, with the capability of dynamic reconfiguration of business process logic, multi-agent platforms, with the marked autonomic capabilities, and Semantic Interoperability, with the possibility of seamless interaction among heterogeneous objects, services, and platforms.

Please note that a reliable and sufficiently accurate enterprise model, including the conceptual, factual, and behavioural levels, represents also a precise specification of its software applications. Therefore, the hoary problem of **Business-IT Alignment** is intrinsically solved. UDE platforms will possess the mechanisms to keep under control the alignment of the enterprise model with the perceived reality and, transitively, with the software applications.

## 3.4 Some specific topics

T3.1 Augmented Reality
T3.2 Autonomic Objects and Networks
T3.3 Business OSINT
T3.4 Business-IT Misalignment
T3.5 Change Management
T3.6 Complex Event Processing
T3.7 Complexity Theory
T3.8 Creative Commons
T3.9 Crowdsourcing
T3.10 Enterprise Architectural Framework
T3.11 From Linked Open Data to Linked Open Knowledge
T3.12 Innovation & Continuous re-design
T3.13 Knowledge Mining
T3.14 Knowledge Pragmatics
T3.15 Knowledge Rendering
T3.16 Semantic Annotation and Filtering
T3.17 Semantic Interoperability
T3.18 Simulation and 'What-If' Systems
T3.19 Smart Objects Exploitation
T3.20 Social Computing
T3.21 System Mashup
T3.22 Virtual Reality

# 4 Future Technologies for FInES

"*One machine can do the work of fifty ordinary men. No machine can do the work of one extraordinary man*" (Elbert Hubbard, 1923)

## 4.1 Preface

Digital Technology, from its inception, has been characterised by an impressive innovation rate. That has been particularly relevant in the last 20+ years, after the advent of the Internet, with a significant impact on the socio-economic sphere. R&D in ICT will continue with a sustained innovation rate, but with increasing difficulties for what concerns the practical applications and the socio-economic impact that will hardly maintain the same pace. One of the main problems is due to the fact that the ICT engineering methods of today will hardly scale up to tackle the enormous future challenges, in particular the size and complexity of the Future Internet and, specifically, of the FInES applications. Innovation and developments of the Future Internet applications will heavily challenge computer science and engineering methods and tools we use today. The massive amount of data [1] (the well-known data deluge issue [2]-Annex A.4), the management and coordination of trillions of intelligent objects, convergent and pervasive networks connecting everyone and everything: all this needs new methods and tools to developing, maintaining, and managing future large, complex, interconnected socio-technical systems [3] (Annex A.4).

An encompassing study of technology trends is outside of the scope of this document. Here we intend to focus on a subset of ICT research areas connected to the FInES. Furthermore, we will abstract from the basic computational and networking technologies, assuming that in the next decade they will substantially develop and produce fundamental solutions. The objective of this chapter is to provide a FInES-oriented point of view on a possible (and/or desirable) evolution of ICT development. The presentation is focused on a few research areas rather than specific ICT solutions. (Alike the previous chapters, specific technologies will be listed in the final section: Some relevant topics.) Then, the technological areas included in this chapter concern: networking, knowledge, applications, computing and storage, user interactions.

## 4.2 Future Networking technologies

Networking (Future Internet) will be one of the key areas that will exhibit the most impressive progression, sweeping away any barrier of range (LAN, WAN, sensors networks, ZigBee, ...), technology (TCP/IP, Enthernet, WiFi, WiLD, ...), carrier infrastructure and mobility (cable, radio signals, ...), etc. Future Internet is expected to fully and seamlessly connect nodes of a different nature, belonging to 4 categories, allowing them to effectively exchange data and cooperate.

1. Real entities 2. Virtual entities 3. Natural entities (firstly people) 4. Artificial entities

The Future Internet will provide secure data and service exchange among such diverse entities, offering an increasingly large set of supporting services. Functional enrichment of Future Internet will be fostered by the commoditization of growing number of services and facilities that will stretch the current notion of networking, supporting, e.g., advanced forms of collaboration, interoperability (ref.

ISU – Interoperability Service Utility), trust and security, social computing [4] (Annex A.4), etc. Particular attention will be also dedicated to the correct handling of digital (multiple) identities.

## 4.3 Future Knowledge technologies

This is another key technological area that will allow for a wide spread of high performance content networks able to extensively store, link, integrate, and distribute data and knowledge, coming from any possible entity and source. Knowledge will freely (up to IPR) traverse the Future Internet to reach (upon request or spontaneously, in a proactive way) any possible entity needing it[5].

**4.2a – Diffused Knowledge Base Technology**. We will be soon facing the Yottabyte syndrome (ref. the Data Deluge problem [2]), since the total database capacity of the Planet is not increasing at a sufficient rate to be able to hold all the produced data (thanks primarily to the Internet of Things and multimedia). Then, beside Cloud Computing we need to develop Ground Computing, i.e., diffused storage and computing power offered by real smart interconnected objects. Diffused knowledge acquisition may lead to contradictory situations where areas with an abundance of (spontaneously produced) information will coexist with areas where information is incomplete; furthermore, also the precision of the acquired information (challenged by the quality of sensors and human errors) and the factual contradictions, possibly generated by multiple sources, need to be tackled.

**4.2b – From raw data to knowledge assets.** Data will, in principle, remain where generated. Real world entities aggregation will drive data aggregation, progressively transforming data into human-oriented knowledge assets (to this end, new forms of data analytics, knowledge mining, natural language processing, etc., will be among the key enabling technologies). In essence, the role of humans in the creation of knowledge assets will progressively turn marginal; similarly for knowledge consumption that will mainly concern smart objects and systems. A paramount important area will concern the possibility of largely covering and capillary monitoring the reality, with a multiplicity of (virtual and physical) probes and sensors capable of faithfully rendering the state of play.

**4.2c – Innovation-oriented knowledge assets**. Innovation is primarily a human intelligence endeavour, but it requires a lot of high quality, focused knowledge resources, partially about the present state of play, but mainly about the (foreseeable, expected, desired) future evolutions. Knowledge about the future will be systematically acquired both from human-oriented sources (experts, dedicated agencies, think tanks, etc.) and dedicated software systems (simulators, 'what-if' engines, etc.), aiming at supporting the FInES systems devoted to business innovation. The role of social collaborative intelligence will also be central, with specific technologies aimed at supporting social knowledge production and knowledge mining from social interactions.

[5] ref. Semantic routing: Don't search, the right information will find you! When you need it, where you need it.

## 4.4 Future application technologies and complex systems engineering

This is the key enabling technology for FInES in the next decade. "As [enterprise] systems become increasingly large and must seamlessly interoperate with other systems in ways that were never envisioned, system engineers are bumping into the limits of the tenets, principles, and practices traditionally used in systems engineering." [6] (Annex A.4)

When trillions of intelligent entities (natural or artificial, real or virtual) will be able to connect and interoperate, the problem of developing, deploying, and maintaining software applications will be another challenge hard to be addressed with today's methods and tools. Application software engineering and enabling technologies need new developing paradigms. Specifically, it is important to centrally base the development of future enterprise systems on the Future Knowledge Management assets, keeping the two areas constantly aligned (and the latter aligned with the reality).

**4.3a – Proactive and autonomic computing** [7] (Annex A.4). Smart entities (objects, humans, avatars, etc.) will connect and cooperate to achieve given business objectives, in presence of pre-defined rules and constraints (represented in some Future Knowledge net), but in absence of prescriptive procedures. Smart entities will spontaneously interconnect to form larger entities exhibiting emergent behaviours (e.g., shop floor machines will gather to spontaneously, albeit supervised, create a production line).

**4.3b – From deterministic to fuzzy computing**. The emerging complex systems engineering requires to progressively abandon the deterministic approach in many business applications. Largely adopting probabilistic methods and tools (e.g., based on Bayesian and hidden Markov models) will yield the possibility to develop digital artefacts without fully predefined characteristics and behaviours.

**4.3c – Beyond system consistency**. Reality is largely inconsistent: often exhibiting a local consistency that, when scaling up, quickly reveals its global fragility[6]. With the advent of large scale open systems, we need to consider inconsistency not as an exception, but as the rule. We need to develop solutions to allow us to survive with inconsistent systems, starting with the systematic adoption of negotiation facilities, exception handling, etc. One example of this, concerning imprecision in the context of manufacturing enterprise, is very well-known: you can never be really certain of exact inventory. Inventory is recorded by accumulating a very large number of receipts, and a very large number of issues, then subtracting one from the other. After quite a short time (depending on turnover) a 0.1% error in recording of each of these can come to a large stock error.

**4.3d – Governance application technologies**. While traditional deterministic routine operations (e.g., invoicing) will be performed by intelligent autonomous agents and smart objects, humans will concentrate on higher tasks, needing more support for understanding, supervising, forecasting, and decision making. In this context, we will see on the one hand the central role of the mentioned local capability of data filtering and aggregation, one the other hand there will be the need to develop intelligent software, capable of advanced reasoning and derivation (e.g., deduction, induction, abduction) services, such as:

- Simulation and 'what-if' , including Complex System simulation

[6] This problem is in general unsolvable. Ref. Popper falsificationism.

- Recommendation systems
- Rule systems and inference engines
- Mathematical modelling
- Statistical and probabilistic reasoning (e.g., Bayesian engines)
- Fuzzy logic analysis to encompass human understanding of systems under analysis

**4.3e – Top-down problems definition and bottom-up systems aggregation**. Complex application engineering will exhibit a divergent movement: downward, where engineers will concentrate on the development of intelligent components, de-contextualised from specific applications, and upwards, where business specialists will concentrate in defining rules, constraints, best practices for their business sector and the specific enterprise. The intermediate level of enterprise application systems will be only partially practiced by humans: business systems, and related processes, will be progressively subtracted to deterministic development; they will be created with a bottom-up aggregation of components (spontaneous, supervised, and, in some cases, explicitly crafted). In case of direct human intervention, the approach will be largely supported and mainly based on 'business mashup' methods and tools [8] (Annex A.4). In essence, enterprise systems will be less the outcome of an explicit, top-down engineering endeavour and will be increasingly created and evolved starting from components that 'spontaneously' (but largely supervised) will rally together for given objectives (in case, participating to multiple aggregations / objectives).

## 4.5 Future computation and storage technologies

As anticipated, computation and storage will progressively shift away from the traditional computer centres, moving towards two different (but connected) spaces: on the clouds and on the earth. The former represents a well established and expanding technology (see market figures[7]), and it is plausible that the existing problems, from cloud interoperability to trust and security, to reliability [9] (Annex A.4), will be satisfactorily solved in the next years. The latter (that we referred to as Ground Computing) will emerge from the interconnection of the trillions of smart proactive objects that will be able to locally store and manage significant amounts of data, and cooperate to provide information and services at different levels of aggregation. The computation will possibly adopt a 'glocal' paradigm, going from a local dimension, with detailed and analytical computation on locally confined data, to a global dimension, with general and synthesis computation, yielding and consuming knowledge assets.

The future computing and storage capacities, largely based on smart proactive interconnected objects, capable of collaborating to 'spontaneously' create larger, more complex computational entities (ref. FInER [10]-Annex A.4, will emerge from the evolution of existing technologies, such as: Multi-Agent Systems and Swarm Computing [11]-Annex A.4). Along this line, various research challenges will need to be addressed, such as:

- How to create smart proactive objects;
- How to connect them at best, in an effective and flexible way, allowing for their dynamic (re)configurations;

[7] http://blogs.computerworld.com/16863/cloud_computing_by_the_numbers_what_do_all_the_statistics_mean

- How to provide an increasing degree of autonomous freedom of getting together, networking and self-organising to form more complex entities, without a centralised authority. (This is true for both objects and people.)

In this approach, the current vision of services and service-oriented architecture will be absorbed and superseded by the central notion of smart objects and entities that actually provide the services (i.e., placing in the centre the service 'owner' rather than the service, i.e., the service provider, with an increased semantic approach[8].)

## 4.6 Future Natural Interaction

In the foreseeable future we will have two main interacting players: people and objects, with computers that will progressively disappear, behind a car dashboard, a household appliance, a complex document representing a marketing strategy, a picture (a photo, a cartoon image, an icon) representing, e.g., people, enterprises, etc. We will practice less with interfaces to computer terminals, laptops, PCs, etc. We will rather have natural interactions [12] (and evolution of today Natural User Interface, for which Kinect is a good example) with the objects and the people we meet during the everyday activities. Natural interactions will involve all the entities of the 4 categories indicated in the 4.1 (object-object, human-human, object-human). Particularly relevant will be the remote, both synchronous and asynchronous, human interactions, characterized by an ever growing sophistication (avatars, acting in personalized and metaphorical ambient, and the like), yielding to new forms of participation in all the phases of the production cycle (Invent, Plan, Build, Operate, Monitor).

Natural interaction will involve also the knowledge technologies and the possibility of directly access to objects' knowledge. For instance, augmented reality will allow us to know details of a beans' can in the food store[9] by simply pointing a mobile device to it. Then, gesture and voice may represent other natural ways of interacting with smart objects around us.

**The wane of interactive interfaces**. With the upsurge of smart objects computing, interactive computer interfaces will lose centrality. The human-supervised computing will take place in a scenario where each of us, everyday, will interact with hundreds of (embedded) computers [3] mainly with a supervisory purpose. In essence, we will be interacting with the objects (systems, contexts, people, etc.) that we need to keep under scrutiny getting information and providing our feedback in fashions that are different from the keyboard-screen paradigms of today. Furthermore, proactive agents, Intelligent Personal Digital Assistant, Knowbots, etc., will proliferate to support us in surviving the Knowledge Deluge syndrome. On the other side, humans will interact providing their mood through virtual "emotional sensors" that will suitably aggregate and convey the corresponding knowledge to the right addressees.

[8] Having retrieving the service using its semantics and metadata, then discovered the service 'owner' is scrutinised for the sake of trust and security, reliability, costs, etc, but also for administrative issues, like contracting, billing, etc.
[9] See also: 6th Sense , from MIT (http://www.ted.com/talks/pattie_maes_demos_the_sixth_sense.html

## 4.7 Some related topics

Also in this chapter we list a few topics that may need more attention and elaboration to be provided in the next phase.

T4.1 Advanced Negotiation Techniques
T4.2 Advanced Enterprise Service Bus
T4.3 Augmented Reality
T4.4 Cloud Computing
T4.5 Component-based Software Engineering
T4.6 Data, Information, Knowledge Quality
T4.7 Haptic Interface [13] (Annex A.4)
T4.8 Inconsistent and Imprecision-tolerant Systems
T4.9 Intelligent Personal Digital Assistant
T4.10 Linked Open Knowledge, Knowbot
T4.11 Knowledge Mining, Text Mining, Natural Language Processing
T4.12 Model-driven Development (MDD) and Model-driven Architectures (MDA)
T4.13 Multi-Agent Systems
T4.14 Proactive and Autonomic Computing and Networks [14], Complex Event Processing
T4.15 Probabilistic Computational Models (e.g., Bayesian, hidden Markov models)
T4.16 Semantic Annotation & Filtering
T4.17 Semantic Data Analytics, Semantic Routing (data know whom to reach, when, in what form)
T4.18 Service-Oriented Architectures and Platforms
T4.19 Simulation and 'what-if' engines, Decision Theory
T4.20 Trust and security, digital (multiple) identities
T4.21 Symbiotic human/machine knowledge discovery
T4.22 Fuzzy analysis based on human expert assessment and computational propagation

# 5 Conclusions

At the present stage of the FInES Research Roadmap activities, the main components of the Roadmap have been laid out. These are:

1. The reference socio-economic scenario, in a perspective vision.
2. The objectives, issues, topics that are likely to be addressed in the projects that operate within the Cluster and beyond (where we are starting from).
3. The methods and tools we plan to use for building and maintaining the Roadmap, aiming at providing its sustainability beyond the time limits of the ENSEMBLE project.

In particular points 1 and 2 have been described keeping in mind that their contents would dynamically evolve during the course of the Roadmapping activities (and we are aware that things will change even during our activities, until the delivery of the final version of the report, due August 2012). For this reason, our work is organised so that a next revision and enrichment is planned for the next phase, with a second draft report planned on February 2012.

As for point 3, for which a number of tools have been analyzed, and briefly described in D3.2, the main issue afforded has been that of setting the stage for a Knowledge Repository, aimed to store the evolving content of the FInES Knowledge Universe, by the end of the Project, into the FInES Roadmap, ready to be further enriched and kept up to-date by the FInES Cluster projects, with a social, participative approach.

The content of the present deliverable represents the first seed of this Knowledge Base, and for its organization we have experimented the same methodology described in the Introduction, that is the participation of an extended body of expertise in the definition and organization of the knowledge items harvested and presented. Thanks to the participating partners, the 4 Knowledge Spaces and the related issues, challenges, objectives have been refined into the version here presented.

More important than this first cooperation effort will be the planned establishment of the social and collaborative working environment mentioned in the Introduction.

In these first phases of the work, the bottom-up approach has been used for the harvesting of the objectives, issues, topics currently addressed, and for the scenarios, built by extrapolating current trends in purposeful "extreme" degrees[10]. The top-down approach has been exercised in the definition of the 4 Knowledge Spaces.

In the next phases, all components of the FInES Knowledge Universe will have to be managed integrating these approaches, that is by proposing specific views or solutions from the part of the Editorial Board, or any expert in the Cluster, and letting the FInES (and even beyond) community of experts discuss them, propose additional viewpoints, and the like.

This is what we mean by the terms of Folksaurus (a Thesaurus built cooperatively) and FInESpedia. A topic maps management tool such as Ontopia and the FInES Cluster wiki will be integrated and experimented in order to provide these capabilities.

[10] To provide additional material, the ENSEMBLE project has organised a brainstorming session in the Samos 2011 Summit. The rich outcome is currently under elaboration and will be included in the next version of the draft.

As an example of the steps to be done next, the topics, objectives, issues and challenges mentioned in the present deliverable will have to be "merged" with those gathered in the previous steps, and then all these semantic nodes need to be related to each other in a network of dependencies. In this way the Roadmap will be represented by "streams" of research activities pointing to conceptual nodes which in turn represent desirable technical or social achievements. Furthermore, the concepts reported in the Folksaurus can be used to tag the deliverables of the Cluster projects. In this way, the conceptual map and the semantic tagging will ease the dynamic control that duplicated efforts are minimized, and priorities are respected. As the network dynamically evolves (and this evolution will have to be assured by the Community), the outstanding research streams will accordingly evolve.

Finally, we expect that in the next Roadmapping phase (from September 2011 until February 2012), we will have a wealth of interesting material to be integrated, starting from the outcome of the Scenarios session of the Samos Summit[11].

[11] Envisioning Future Internet Enterprise Systems: Visionary Enterprise Scenarios and New Research Areas. Available at: http://www.fines-cluster.eu/fines/jm/Publications/Download-document/203-Envisioning-Future-Enterprise-Scenarios.html

# Annex A: Bibliography

Bibliographic references have been organized according to the 4 main chapters that compose the core of the document.

## Annex A.1 Bibliography for Section 1

1. Korten C. D. (2009) Agenda for a New Economy: From Phantom Wealth to Real Wealth – A Declaration of Independence from Wall Street, Berrett-Koehler Publishers.
2. Report of the Commission on the Measurement of Economic Performance et Social Progress. Retrieved from http://www.stiglitz-sen-fitoussi.fr/en/index.htm.
3. Alternative Energy: Global Perspectives and Future Scenarios: The "Electrogreen" Is A Social Responsibility. Sapienza Università di Roma - Dipartimento di Ingegneria Elettrica - Facoltà di Ingegneria. Retrieved from http://labduee.ing.uniroma1.it/others/alternative-energy-global-perspectives-and-future-scenarios.-the-201celectrogreen201d-is-a-social-responsibility.
4. The Future of Manufacturing in Europe 2015-2020 - The Challenge for Sustainability - European Commission - Joint Research Centre - Institute for Prospective Technological Studies, retrieved at foresight.jrc.ec.europa.eu/documents/eur20705en.pdf on 20/7/2011.
5. Envisioning Digital Europe 2030: Scenarios for ICT in Future Governance and Policy Modelling - European Commission - Joint Research Centre - Institute for Prospective Technological Studies
6. OPEN: EU – Overview of Scenarios - One Planet Economy Network, retrieved at http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3879 on 20/7/2011.
7. A forward-looking analysis to identify new innovation paths for the Future Internet - PARADISO reference document (chapter "HOW WILL OUR SOCIETIES EVOLVE IN THE DECADES TO COME?"), retrieved at http://paradiso-fp7.eu/files/2011/05/PARADISO_reference_document_May2011.pdf on 20/7/2011.
8. The dynamic relationship between knowledge, identities, communities and culture. Ken Jones, School of Criminology, Education, Sociology & Social Work, Keele University, retrieved at http://www.scribd.com/doc/32405298/Future-Learning-The-dynamic-relationship-between-Knowledge-Identities-Communities-and-Culture on 20/7/2011.
9. Coyle D. (2011). The Economics of Enough. Princeton University Press.
10. Tickoo V. (2003). The impact of culture and socio-economic differences on communication technology diffusion in different countries. PhD Thesis, State University of New York, Buffalo, Retrieved from: http://www.galileoco.com/literature/tickoo03.pdf
11. Latouche S. (2007). Petit traité de la décroissance sereine (Brief treaties of serene downshift). Mille et Une Nuits, Paris.
12. EC (European Commission) (2007). New EU report shows active labour policy can increase employment rate despite low growth. Retrieved from: http://ec.europa.eu/employment_social/emplweb/news/news_en.cfm?id=81
13. March J.G., Simon H.A. (1958), Organizations, John Wiley & Sons, New York
14. Thompson J.D. (1967), Organizations in action, McGraw-Hill, New York
15. Lawrence P.R., Lorsch J.W. (1967), Organization and environment: Managing differentiation and integration, Harvard University Press, Cambridge
16. Natural capitalism. www.natcap.org
17. Social Solidarity. www.encyclopedia.com/doc/1O88-socialsolidarity.html
18. Stringer N. (2006). Improved work-life balance - the role of ICT http://www.orangecoalition.com/whitepapers/download.php/6

# Annex A.2 Bibliography for Section 2

1. Nakano, C.: Principles of humanistic enterprise in Japan : A new economic system of the future. Futures. 21, 640-646 (1989).
2. Weick, K.E., Sutcliffe, K.M., Obstfeld, D.: Organizing and the Process of Sensemaking. Organization Science. 16, 409–421 (2005).
3. Weick, K.E., Sutcliffe, K.M.: Mindfulness and the quality of organizational attention. Organization Science. 17, 514 (2006).
4. Levinthal, D.A., Cohen, W.M.: Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly. 35, 128 (1990).
5. Fingar, P.: Fractal Enterprise Architecture and Agent-Oriented BPM: Can UML or BPMN Model a Cloud?, http://www.bptrends.com/publicationfiles/FOUR%2009-14-10-ExtCompetition-Fractal%20Enterprise-Fingar_V5_-final.pdf, (2010).
6. Dietz, J.L.G.: Advances in Enterprise Engineering I: 4th International Workshop CIAO! and 4th International Workshop EOMAS, Held at CAiSE 2008, Montpellier, France, June 16-17, 2008, Proceedings. Springer (2008).
7. Afuah A. and Tucci C.L. (2002). Internet Business Models and Strategies. Second Edition. Boston, McGraw Hill.
8. Chesbrough H., Vanhaverbeke W., West J. (2006). Open Innovation: Researching a New Paradigm. Oxford University Press.
9. Normann R. and Ramirez R. (1994). Designing interactive strategy: From value chain to value constellation. Chichester, England: Wiley.
10. Ramirez R. (1999) Value co-production: Intellectual origins and implications for practice and research. Strategic Management Journal, 20(1): 49-65.
11. Schweizer L. (2005). Concept and Evolution of Business Models. Journal of General Management, 31(2): 37-56.
12. Stabel C.B. and Fjeldstad Ø.D. (1998). Configuring Value for Competitive Advantage: on Chains, Shops and Networks. Strategic Management Journal, 19(55): 413-437.
13. Melville N., Kraemer K.L., Gurbaxani V. (2004). Review - Information Technology and Organizational Performance: an Integrative Model of IT Business Value. MIS Quarterly, 28(2): 283-322.
14. Tapscott D. and Williams A. (2006). Wikinomics: How Mass Collaboration Changes Everything. Penguin Book, N.Y.
15. Paul Miller, Paul Skidmore (2006). Disorganization - Why future organisations must 'loosen up' http://www.orangecoalition.com/whitepapers/download.php/1
16. Orange Future Enterprise Coalition (2007). Byond boundaries - The emerging work culture of independence and responsibility. http://www.orangecoalition.com/whitepapers/download.php/8

# Annex A.3 Bibliography for Section 3

1. Grabowski, K.C.: Reconsidering the Measurement of Pragmatic Knowledge Using a Reciprocal Written Task Format. Working Papers in TESOL & Applied Linguistics. 7, (2007).
2. Saenz, O.A.: Framework for Enterprise Systems Engineering, http://digitalcommons.fiu.edu/etd/32, (2005).
3. Hofmann, T.: Latent semantic models for collaborative filtering. ACM Trans. Inf. Syst. 22, 89–115 (2004).
4. Waldrop, M.M.: COMPLEXITY: THE EMERGING SCIENCE AT THE EDGE OF ORDER AND CHAOS. Simon & Schuster (1992).
5. Eric von Hippel, Eric von Hippel: Democratizing Innovation, http://econpapers.repec.org/bookchap/mtptitles/0262720477.htm.
6. Hall, M.W., Gil, Y., Lucas, R.F.: Self-Configuring Applications for Heterogeneous Systems: Program Composition and Optimization Using Cognitive Techniques. Proc. IEEE. 96, 849-862 (2008).
7. Angelucci, D., Missikoff, M., Taglino, F.: Future Internet Enterprise Systems: a Flexible Architectural Approach for Innovation. The Future Internet Future Internet Assembly 2011: Achievements and Technological Promises. LNCS 6656, (2011).
8. Sharma, S.: Towards Holistic Performance Scorecard : A New Strategic Imperative. Vilakshan The XIMB Journal of Management. 5, 33-44 (2008).
9. Pfleeger, S.L.: Software engineering: Theory and practice. Prentice Hall (Upper Saddle River, NJ) (1998).
10. Ewusi-Mensah, K.: Software Development Failures. MIT Press (2003).
11. Zhu, D., Zhang, Y., Chen, J., Cheng, B.: Enhancing ESB Based Execution Platform to Support Flexible Communication Web Services over Heterogeneous Networks. 2010 IEEE International Conference on Communications (ICC). pagg. 1-6. IEEE (2010).
12. Schweizer L. (2005). Concept and Evolution of Business Models. Journal of General Management, 31(2): 37-56.
13. Future Internet Enterprise Systems (FInES) Research Roadmap, European Commission, FInES Cluster. Retrieved from http://cordis.europa.eu/fp7/ict/enet/documents/fines-researchroadmap-final-report.pdf
14. A Digital Agenda for Europe, European Commission, Com(2010) 0245 final/2. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:FIN:EN:PDF
15. Position Paper on Orientation for FP8: A European Innovation Partnership for European Enterprises, FInES Cluster. Retrieved from: http://www.fines-cluster.eu/fines/jm/Download-document/59-FinES-position-paper-FP8-orientations.html
16. From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation funding, COM(2011) 48. Retrieved from: http://ec.europa.eu/research/csfri/pdf/com_2011_0048_csf_green_paper_en.pdf
17. Europe 2020 Flagship Initiative Innovation Union, COM(2010) 546. Retrieved from: http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf
18. Internet Architecture for Innovation (2010). Future Internet Architecture Group. http://ec.europa.eu/information_society/activities/foi/library/docs/p3-aiai-2010.pdf
19. Nixon L. at Al., (2009). The Future of the Internet of Services for Industry: the ServiceWeb 3.0 Roadmap. In: Future Internet Assembly (FIA 2009), 23-24 Nov. 2009, Stockholm, Sweden.

# Annex A.4 Bibliography for Section 4

1. Future File Systems: Intelligent, Object-based Storage. (2008).
2. Technology: The data deluge | The Economist, http://www.economist.com/node/15579717.
3. Tennenhouse, D.: Proactive computing. Commun. ACM. 43, 43-50 (2000).
4. Helbing, D.: The FuturICT Knowledge Accelerator: Unleashing the Power of Information for a Sustainable Future. SSRN eLibrary. CCSS-10, (2010).
5. Helbing, D., others: The FuturIcT knowledge accelerator: Unleashing the power of information for a sustainable future. Project Proposal. (2010).
6. MITRE: Perspectives on Complex-System Engineering, (2005).
7. Want, R., Pering, T., Tennenhouse, D.: Comparing autonomic and proactive computing. IBM Systems Journal. 42, 129–135 (2003).
8. Hoyer, V., Fischer, M.: Market Overview of Enterprise Mashup Tools. In: Bouguettaya, A., Krueger, I., e Margaria, T. (cur.) Service-Oriented Computing – ICSOC 2008. pagg. 708-721. Springer Berlin Heidelberg, Berlin, Heidelberg (2008).
9. ProblemsFacedbyCloudComputing.pdf (Oggetto application/pdf), http://dl.packetstormsecurity.net/papers/general/ProblemsFacedbyCloudComputing.pdf.
10. Angelucci, D., Missikoff, M., Taglino, F.: Future Internet Enterprise Systems: a Flexible Architectural Approach for Innovation. The Future Internet Future Internet Assembly 2011: Achievements and Technological Promises. LNCS 6656, (2011).
11. Persaud, R.K.: Investigating the Fundamentals of Swarm Computing, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.9.9222&rep=rep1&type=pdf, (2001).
12. Valli, A.: Notes on Natural interaction. (2005).
13. Hayward, V., Astley, O.R., Cruz-Hernandez, M., Grant, D., Robles-De-La-Torre, G.: Haptic interfaces and devices. Sensor Review. 24, 16-29 (2004).
14. Agoulmine, N., et Al.: Challenges for Autonomic Network Management. Presentato al MACE 2006 1st IEEE International Workshop on Modelling Autonomic Communications Environments Ottobre 25 (2006).
15. T. Berners-Lee, J. Hendler, and O. Lassila. The Semantic Web. Scientific American, May 2001
16. Gruber T. R. "A translation approach to portable ontologies", Knowledge Acquisition, vol. 5, no. 2, pp. 199-220, 1993.
17. T. Berners-Lee (2006-07-27). "Linked Data - Design Issues". W3C. Retrieved 2010-12-18.
18. Cawood S., Fiala M., "Augmented Reality A Practical Guide", Publisher: Pragmatic Bookshelf, 328 pages. January 2008. ISBN: 978-1934356036
19. Bell M., "Introduction to Service-Oriented Modeling". Service-Oriented Modeling: Service Analysis, Design, and Architecture. Wiley & Sons. pp. 3. ISBN 978-0-470-14111-3. 2008.
20. Bell M. "SOA Modeling Patterns for Service Oriented Discovery and Analysis" Publisher: Wiley, Hardcover, 480 pages. January 2010. ISBN: 978-0-470-48197-

# Annex B: Consultation Methodology

The FInES Research Roadmap Task Force, launched within the FInES Cluster, has started its activities aimed at producing the new FInES Research Roadmap representing a new version of last year's document. This is an important (and challenging!) scientific activity that involves all the partners of the Cluster and the community at large. During the summer break, we started the production of the first draft B1 (named B1, since it is in Beta stage, adopting a typical software production practice to name 'beta' the pre-release stage of a product) and the largest number of experts have been invited to participate in the first Cluster Consultation Campaign.

The objective of FInES RR, as well known, is to identify the Research Challenges that will be assumed as a reference indication for the future activities of the FInES Cluster. Given the ambitious objective, it is paramount important that we achieve the largest possible involvement of the Cluster projects, and of the FInES community at large.

This annex reports on the methodology adopted for the first Cluster Contribution Campaign that addresses the key content of the first draft of the FInES RR. The organization of the FInES RR has been based on 4 Knowledge Spaces: (i) socio-economic, (ii) enterprise, (iii) enterprise systems – FInES, and (iv) enabling technologies. The 4 Knowledge Spaces correspond to the 4 central chapters of the document that we are submitting to the consultation. The table of content is reported below.

**Consultation methodology**

The consultation took place over the Web, by accessing a distinct online form for each chapter. The expected time required to fill a form was approximately 15 minutes, when limiting the action to the voting (voting was mandatory to submit the form).

The 4 forms have different content but the same layout. In each form you will find the following sections:

- The **text** of the chapter, articulated in sections, with supporting bibliographic references. Then, for each section:
- A **voting pane**, where you can express your agreement or disagreement on each section (there is a grading scale from 1: low to 5: high level of agreement);
- A box of text to **comment** and support your vote;
- A box of text where you can add your preferred **bibliographic references** not present in the form.

In addition to the brief text (about 3 pages) of the chapter, there is a list of keywords representing topics that may be expanded in the next iteration (please recall that a successive FInES RR draft, version B2, is expected by February 2012, after a larger consultation) Then the form will present:

- A list of **topics** that are suggested for expansion in the next phase
- A **voting grid** to allow you to express your opinion on the relevance of the suggested topics (again with a range from 1: non relevant, to 5: very relevant)
- A text box where you can **suggest topics** that are not reported in the list but are relevant for FInES.

**Overview of the Consultation activity**

As a summary of the Consultation activity that has been conducted with the participation of the SAG and the ESC, some overall figures are reported in the following tables.

**Table B-1: Degree of participation**

| | |
|---|---|
| **Members from the SAG and the ESC have contributed to the Consultation** | **13** |
| **Provided comments (total)** | **70** |
| - on the Socio-economic space | 6 |
| - on the Enterprise space | 19 |
| - on the Enterprise Systems, Platforms, and Applications space | 15 |
| - on the Enabling Technology space | 30 |

**Table B-2: Overview of the Socio-economic space Consultation results**

| **Topics with the highest degree of agreement** | **% of agreement** |
|---|---|
| T1.9 Smart society, smart cities, smart government | 92 |
| T1.10 Social transparency | 92 |
| T1.18 Globalization | 88 |
| **Topics with the lowest degree of agreement** | |
| T1.7 Consumerism | 44 |
| T1.15 Neo-positivism | 48 |
| T1.5 Humanistic capitalism | 52 |
| T1.20 Society of consumption | 52 |
| **Average of agreement on the 20 topics** | **72** |

**Table B-3: Overview of the Enterprise space Consultation results**

| **Topics with the highest degree of agreement** | **% of agreement** |
|---|---|
| T2.2 Enterprise modelling | 84 |
| T2.10 Business – IT Alignment | 84 |
| T2.11 Business Process Management vs Complex Event Processing | 84 |
| T2.12 Change management | 84 |
| **Topics with the lowest degree of agreement** | |

| | |
|---|---|
| T2.1 Enterprise Engineering | 68 |
| T2.9 Transparency and accountability | 68 |
| T2.6 Humanistic Enterprise | 72 |
| T2.7 Humanistic Management | 72 |
| **Average of agreement on the 16 topics** | **77** |

**Table B-4: Overview of the Enterprise Systems, Platforms, and Applications space Consultation results**

| **Topics with the highest degree of agreement** | **% of agreement** |
|---|---|
| T3.6 Complex Event Processing | 84 |
| T3.5 Change management | 80 |
| T3.7 Complexity Theory | 78 |
| **Topics with the lowest degree of agreement** | |
| T3.22 Virtual reality | 58 |
| T3.1 Augmented reality | 60 |
| T3.14 Knowledge pragmatics | 60 |
| **Average of agreement on the 22 topics** | **69** |

**Table B-5: Overview of the Enabling Technology space Consultation results**

| **Topics with the highest degree of agreement** | **% of agreement** |
|---|---|
| T4.11 Knowledge mining, text mining, Natural Language Processing | 76 |
| T4.4 Cloud computing | 68 |
| T4.14 Proactive and autonomic computing and networks, Complex Event Processing | 68 |
| **Topics with the lowest degree of agreement** | |
| T4.7 Haptic interface | 46 |
| T4.8 Inconsistent systems | 46 |
| T4.10 Linked Open Knowledge, Knowbot | 54 |
| **Average of agreement on the 22 topics** | **61** |

**Organization of the FInES Research Roadmap report**

Below we recap the organization of the FInES Research Roadmap report, according to which the forms have been organised.

**FInES Research Roadmap – Draft B1**

**Table of Contents**

# Annex C: A Vision on the Socio-economic Space in 2020+: Consultation Report

## Contributors

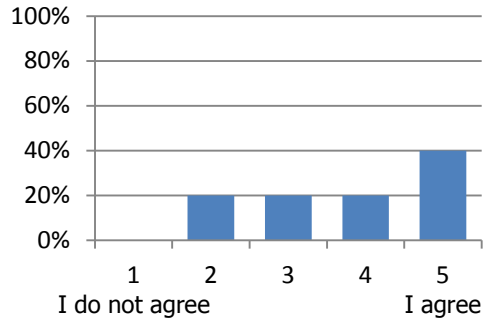
**5 persons** have contributed to this action

**Contributors' name:** Petra Ahrweiler, Asuman Dogac, Klaus Fischer, Antonio Grilo, Paolo Spagnoletti.

## C.1. The need for a socio-economic discontinuity

This section refers to the content of the "*The need for a socio-economic discontinuity*" section of the Chapter 1 on the Socio-economic space.

### C.1.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 20 |
| **3** | 1 | 20 |
| **4** | 1 | 20 |
| **5** (I agree) | 2 | 40 |

**Agreement level: 76%**

### C.1.2. Comments

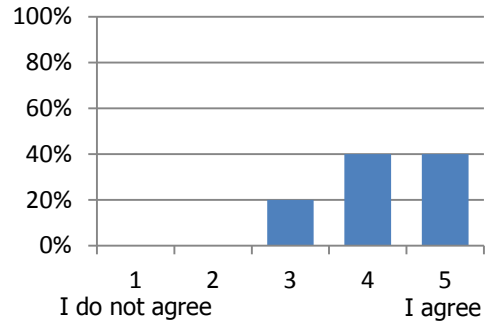
| Contributor | Comment |
|---|---|
| Klaus Fischer | I agree with the statements to a large degree. To maintain or even increase the standard of living is an important goal. However, it must be achieved in a socially adequate manner, meaning that the pure average is probably not the best measure in a situation where we have prosperous few and a large group of people living in poverty where the difference between the two extremes grows bigger and bigger. What happens right now in UK is only an example [the comment was written while in UK there were riots in the streets] how the result looks like when the frustration in a significant part of a society grows to strong. It is especially important to include young people and to give them a perspective in life. |
| Petra Ahrweiler | The perspective taken is much too course in my experience. |
| Antonio Grilo | The existing developed countries are still much in control of the economy. What has changed, so far, let's see if it will continue, is the trend of the growth. Let's no |

| | |
|---|---|
| | forget that Brazil was in deep economical trouble until 6 years ago, or the enormous difference in GDP per capita in China and India when compared with developed countries. These are also sources of opportunities for companies of developed countries. |

## C.2. Different growths for wealth and well-being in reduced economic expansion

This section refers to the content of the "*Different growths for wealth and well-being in reduced economic expansion*" section of the Chapter 1 on the Socio-economic space.

### C.2.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 1 | 20 |
| **4** | 2 | 40 |
| **5** (I agree) | 2 | 40 |

**Agreement level: 84%**

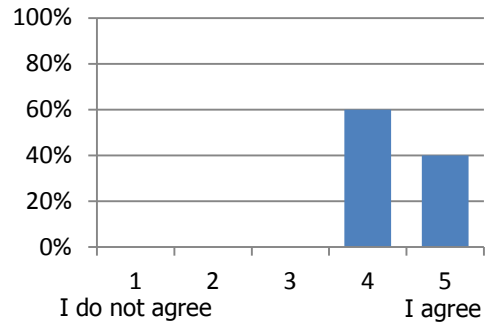
### C.2.2. Comments

| Contributor | Comment |
|---|---|
| Klaus Fischer | Sustainability is to me the most important aspect. Growth is a term that has in recent past dominated our economical thing. However, it does not really make sense to endlessly grow an economy on the basis that people buy products which they don't need and which they actually cannot afford. |

## C.3. Towards a totally connected Society

This section refers to the content of the "Towards a totally connected Society" section of the Chapter 1 on the Socio-economic space.

### C.3.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 0 | 0 |
| **4** | 3 | 60 |
| **5** (I agree) | 2 | 40 |

**Agreement level: 88%**

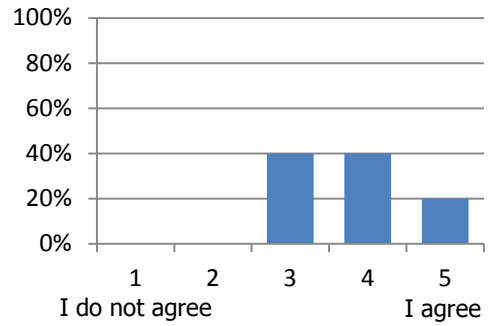
### C.3.2. Comments

| Contributor | Comment |
|---|---|
| Klaus Fischer | Information technology can help to organize our personal, public, and economical life. However, global wealth needs to be shared in a reasonable manner. Otherwise technology is itself used against the overall system as we can see it right now in UK and for somehow different reasons in some Arabic countries. |

## C.4. Innovation in a Knowledge-based Society

This section refers to the content of the "*Innovation in a Knowledge-based Society*" section of the Chapter 1 on the Socio-economic space.

### C.4.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 2 | 40 |
| **4** | 2 | 40 |
| **5** (I agree) | 1 | 20 |

**Agreement level: 76%**

### C.4.2. Comments

| Contributor | Comment |
|---|---|
| Klaus Fischer | What seems to be necessary is an overall plan for a society in which everybody at least roughly gets back what he or she contributes. Inclusion and not separation should be a leading principle. As it was stated above we are at a point of bifurcation because our established economical system has reached its limits. |

## C.5. Specific topics about the Socio-economic space

This section reports about the agreement expressed by contributors on the list of topics proposed in the framework of the Socio-economic space. The table below presents all the details, while the graphics focuses on the percentage of the agreement level.

**Table C-1: Degree of agreement on Socio-economic space topics**

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | **1** I do not agree | **2** | **3** | **4** | **5** I agree | **%** |
| **T1.1** | Innovation as a cultural attitude | 0 | 1 | 0 | 3 | 1 | **76** |
| **T1.2** | Homo Connectus: Convergence of homo-sapiens with the digital world | 1 | 1 | 1 | 1 | 1 | **60** |
| **T1.3** | Social computing | 0 | 0 | 3 | 1 | 1 | **72** |
| **T1.4** | Social complexity dynamics in a Multi-faced Society | 0 | 2 | 1 | 2 | 0 | **60** |
| **T1.5** | Humanistic capitalism | 0 | 4 | 0 | 0 | 1 | **52** |
| **T1.6** | Natural capitalism | 0 | 2 | 2 | 0 | 1 | **60** |
| **T1.7** | Consumerism | 0 | 4 | 1 | 0 | 0 | **44** |
| **T1.8** | Finance versus economics | 0 | 1 | 0 | 2 | 2 | **80** |
| **T1.9** | Smart society, smart cities, smart government | 0 | 0 | 0 | 2 | 3 | **92** |
| **T1.10** | Social transparency | 0 | 0 | 0 | 2 | 3 | **92** |
| **T1.11** | Social networks and Wisdom of Crowds | 0 | 0 | 0 | 5 | 0 | **80** |
| **T1.12** | World sustainability | 0 | 1 | 0 | 1 | 3 | **84** |
| **T1.13** | Life-work balancing | 0 | 1 | 0 | 2 | 2 | **80** |
| **T1.14** | Societal values | 0 | 0 | 1 | 2 | 2 | **84** |
| **T1.15** | Neo-positivism | 0 | 3 | 2 | 0 | 0 | **48** |
| **T1.16** | Social solidarity vs individualism | 0 | 1 | 0 | 2 | 2 | **80** |
| **T1.17** | Aging | 0 | 1 | 0 | 1 | 3 | **84** |
| **T1.18** | Globalization | 0 | 0 | 1 | 1 | 3 | **88** |
| **T1.19** | Urbanization | 0 | 0 | 0 | 5 | 0 | **80** |

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | 1<br>I do not agree | 2 | 3 | 4 | 5<br>I agree | % |
| **T1.20** | Society of consumption | 0 | 4 | 0 | 0 | 1 | **52** |

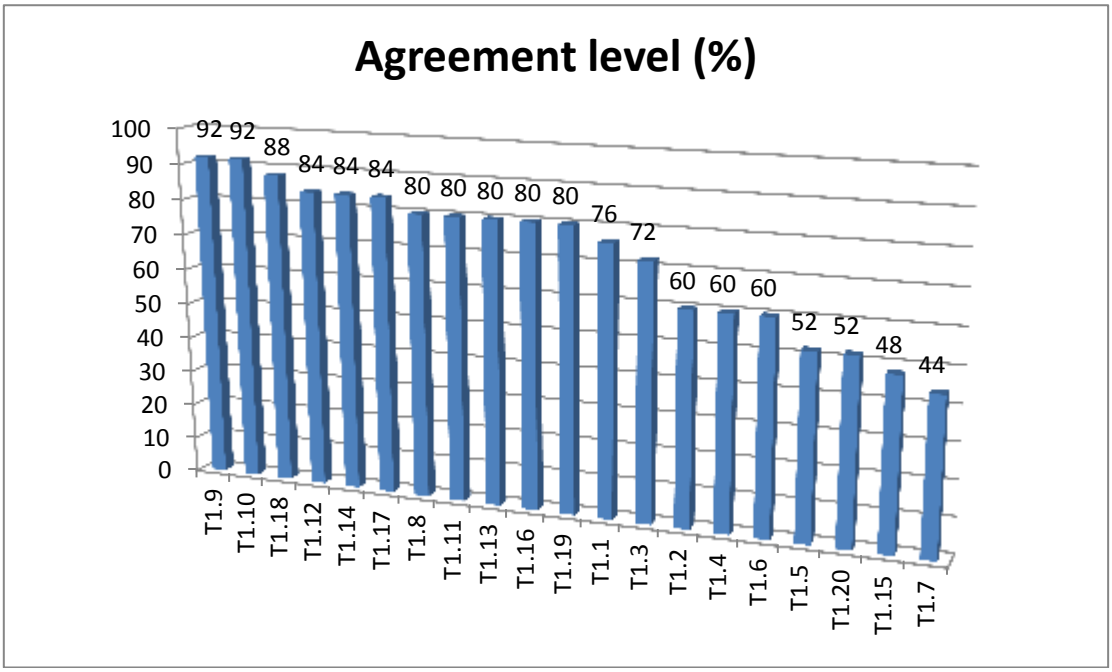



**Figure C-1: Percentage of the agreement level on Socio-economic space topics (T1.1 – T1.20)**

## C.6. Disposal of comments and conclusions

In the average, the contributors largely agreed on the proposed text. Among the most relevant comments, we may mention the issue that the emerging economies (e.g., China and India, in particular), besides representing a threat for certain categories of low to medium cost goods, represent an opportunity for developed economies to access new markets. This is in principle a sharable observation, especially in the short term. However, in the medium to long term the picture may change for a number of reasons. The first reason is that the mentioned developing countries are progressing rather rapidly, and therefore they will be more and more capable of improving the quality level of their offering, attacking the higher end of the market. In essence, it is true that in such countries a new middle class is quickly growing inducing a corresponding demand, but in parallel also their production systems are growing (in fact the two phenomena are related) being able to progressively match the latter, and therefore the penetration in those markets will be in the future increasingly difficult.

But another observation lies on a more socio-political ground. It is possible that in the future the cultural model of western consumerist economies will be harder to export, and connected to this

trend also the goods that today are the symbol of the affluent economies (e.g., fashion, luxury cars, jewellery, etc.) may turn out less appealing than today, also for the emerging societies.

In conclusion, it appears that the key message, concerning the need for a new socio-economic paradigm, capable to go beyond the consumerism that dominated the last centuries in the developed countries, is largely shared in our community. If we observe the score of the topics list, we notice that the highest score goes to Smart Society, Smart Cities, Smart Government, jointly with Social Transparency, while the lowest goes to Consumerism, Society of Consumption, and Capitalism, even if the latter is softened with the adjective 'humanistic'. In essence, also from the scoring of the topic list, it appears evident the emerging need for a change in our current socio-economic development model.

# Annex D: The Enterprise space: Consultation report

## Contributors

**10 persons** have contributed to this action.

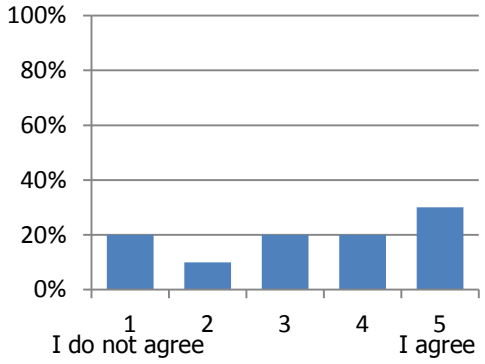
**Contributors' name:** Petra Ahrweiler, Asuman Dogac, Klaus Fischer, Antonio Grilo, David Osimo, Mor Sagmon, Weiming Shen, Paolo Spagnoletti, John Sutcliffe-Braithwaite, Lars Taxén

## D.1 Grand Objectives for the Future Internet-based Enterprises

This section refers to the content of the "*Grand Objectives for the Future Internet-based Enterprises*" section of the Chapter 2 on the Enterprise space. The section was divided in eight sub sections representing the eight proposed Grand Objectives: *GO1. Humanistic Enterprise*, *GO2. Inventive Enterprise*, *GO3. Agile Enterprise*, *GO4. Cognisant Enterprise*, *GO5. Community-oriented Enterprise*, *GO6. Cloud Enterprise*, *GO7. Glocal Enterprise*, *GO8. Green Enterprise*. For each of the Grand Objectives, it was asked to express a degree of agreement as reported below.

### D.1.1. Degree of agreement

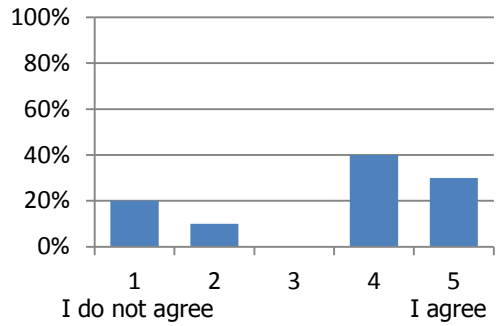
GO1 Humanistic Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 20 |
| **2** | 1 | 10 |
| **3** | 2 | 20 |
| **4** | 2 | 20 |
| **5** (I agree) | 3 | 30 |

**Agreement level: 66%**

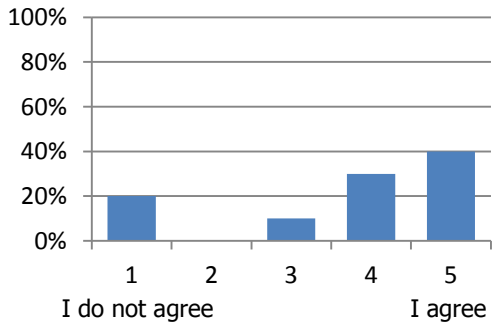
GO2. Inventive Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 20 |
| **2** | 1 | 10 |
| **3** | 0 | 0 |
| **4** | 4 | 40 |
| **5** (I agree) | 3 | 30 |

**Agreement level: 70%**

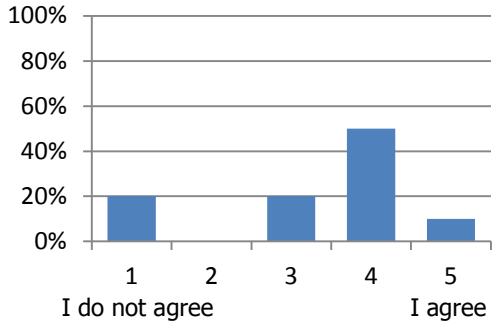
GO3. Agile Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 20 |
| **2** | 0 | 0 |
| **3** | 1 | 10 |
| **4** | 3 | 30 |
| **5** (I agree) | 4 | 40 |

**Agreement level: 74%**

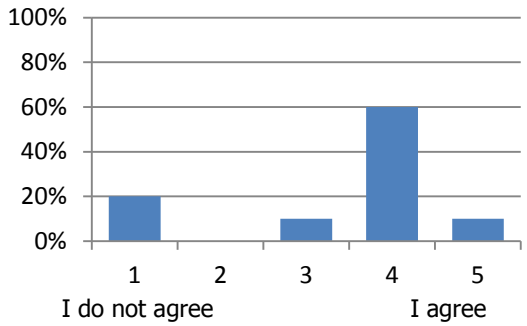
GO4. Cognisant Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do no t agree) | 2 | 20 |
| **2** | 0 | 0 |
| **3** | 2 | 20 |
| **4** | 5 | 50 |
| **5** (I agree) | 1 | 10 |

**Agreement level: 66%**

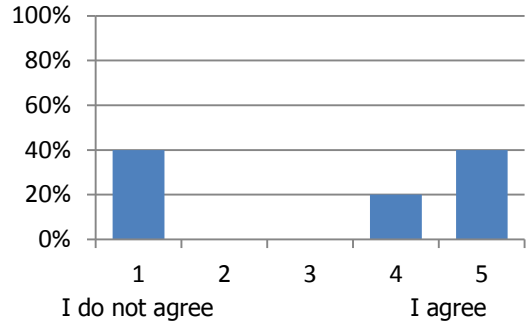
GO5. Community-oriented Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 20 |
| **2** | 0 | 0 |
| **3** | 1 | 10 |
| **4** | 6 | 60 |
| **5** (I agree) | 1 | 10 |

**Agreement level: 68%**

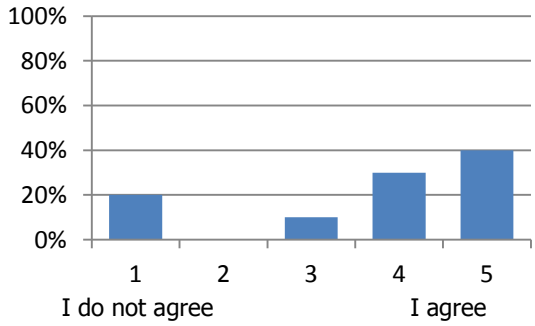
GO6. Cloud Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 4 | 40 |
| **2** | 0 | 0 |
| **3** | 0 | 0 |
| **4** | 2 | 20 |
| **5** (I agree) | 4 | 40 |

**Agreement level: 64%**

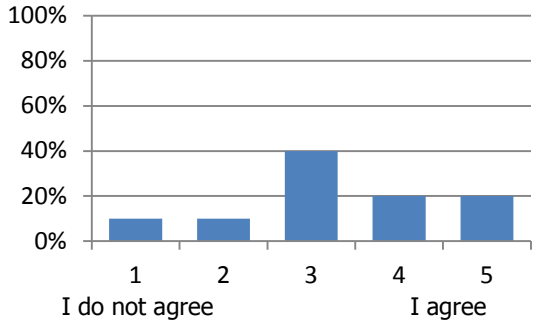
GO7. Glocal Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 20 |
| **2** | 0 | 0 |
| **3** | 1 | 10 |
| **4** | 3 | 30 |
| **5** (I agree) | 4 | 40 |

**Agreement level: 74%**

GO8. Green Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 1 | 10 |
| **2** | 1 | 10 |
| **3** | 4 | 40 |
| **4** | 2 | 20 |
| **5** (I agree) | 2 | 20 |

**Agreement level: 70%**

### D.1.2. Comments

Here, gathered comments about all the eight Grand Objectives are reported.

| Contributor | Comment |
|---|---|
| Paolo Spagnoletti | 1) The "value constellation" idea and its related concepts (i.e. density, flow, co-production, etc.), which have been introduced in the literature about 20 years ago, are now actually replacing the traditional assumptions of the value "adding" models (such as value chain) with the more up to date value "creating" models. These authors emphasize the fundamental shift in thinking that is required to find ways of creating value in a "post industrial" economy. For instance, the offering which starts to act as a "boundary definer", the crucial role of the "code" associated to the offering, the new role of the customer which is enabled in doing something through the offering instead of being relieved by the product/service provider, etc. are a few examples of the value constellation behaviour [9].<br>2) Referring to GO1 and GO8 I see also some links to the socio-economic issue of a mindful exploitation of human resources . This aspect has been underestimated in the last years but in my opinion it needs an increasing attention in order to ensure the equilibrium between the enterprises and their environment. This issue will have an impact on the HR strategies, policies and procedures which will be supported by IT systems (i.e. crowdsourcing, etc.) |
| Sutcliffe-Braithwaite | It is useful to characterise different styles and cultures; the question is whether these are of any real value in a world of turbulent change. Gurus put out their slogans and home-spun wisdom, and earn a great deal from 'training' a business to be something newly-painted.<br>It is clear that any business needs to position itself in this world of turbulent change. I therefore see FInES role as to provide the over-arching framework/ process/ capability to handle this, 'the unknown', leaving businesses and Gurus to do the shop-floor level of design. Businesses need the client part of such an enabling framework; its essence is a range of Policies to form the agenda for change- |

| | |
|---|---|
| | watching and action needed from what is discovered.<br>The business types simply do not exist. What does is the need for any enterprise to be able to assess and respond to any selection of such criteria and re-design accordingly - always a mix of emergent change. the framework will range from the advisory, to the supported to actually discouraged.<br>The nature of an enabling framework is its own set of skills affordances and ultimately investments in all the new types of business behaviours touched on.<br>FInES client is not enterprises alone but them operating in an environment of change at home, dues to change, globally due to change, and societally because society will not tolerate untenable working practices. Government and industry sector bodies as well.<br>As this scenario unfolds it becomes clearer and clearer that FInES is trying to make sense of a vastly different society from an enterprise perspective. All the factors noted such as knowledge,<br>therefore FInES job in the enterprise space is a meta-one: to provide the means to make sense of the unknown, possible trends, evolutions, and help to:<br>(a) support businesses to identify and select the types of capability to meet their style-wishes in a world of fast change<br>(b) also work with supra-business structures to global-watch (multiple perspectives according to types of business demographics etc etc<br>(c) to observe the environment of risk and position FInES research into how the meta-level(s) are changing - the field of levels of change and response<br>FInES is concerned with Enterprise evolution - not 2.0 but 2.n (actually the mantra of the only certainty is change). Its role is to identify and deal with the forces 0f change, the affordances for addressing them, the way such capability is embedded in EU competencies.<br>The meta-capabilities of a supra/govt initiative are part of FInES role, since in the end it is these allied to their clients, businesses and society, needs that need servicing.<br>FInES role starts with the usual set of 9W enquiries relevant to business change and then fans out into strategies, tactics knowledge, and deployment of the new infrastructure for change, since the job is not to define business models but these as examples of trends.<br>Of course the capabilities needed will lead to EU adopting actual strategies of change but these will be done entirely in cooperation with global similar bodies.<br>the classifications are types and subsets invalid as descriptions of types of enterprise |
| Klaus Fischer | I have a bit of trouble with the list and the table. My problem is that I would make a difference between the characterization of enterprises and the challenges these enterprises face. So I could except GO1 as the leading principle of an enterprise but GO4 and GO8 are challenges basically all enterprises face and they deal with these |

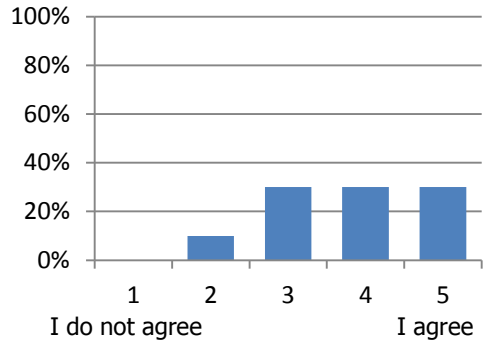
| | |
|---|---|
| | challenges better or not that well (so my ranking says that I do not consider these aspects that important when I want to characterize different enterprises). Regarding the basic characterization of enterprises I am actually missing a prototype that I would call "Community Enterprise". It is different from what is called "Community-oriented Enterprise" because the description of the latter seems to put social media in the core. In a "Community Enterprise" the community itself is in the core. Such an type of an enterprise is not completely new because a kolkhoz in Israel works according to this principle and although not without problems Israel is a democratic country. The Future Internet might help such enterprises perform even better than they did in the past and might even bring it in the position that they can compete with large enterprises that are organized according to capitalistic principles. |
| David Osimo | It would be good to add some evidence behind each trend.<br>Some of these appear as more normative, while others more predictive. 1, 5 and 8 appear as normative while 7 is indisputable. |
| Mor Sagmon | G03 - I suggest to add the humanistic aspect (G01) when considering the plus and minus signs of change. What impact does change has on the people? their well-being?<br>G04 - Suggest to add that cognisant enterprise knows how to transform knowledge into insight.<br>G05 - can also add that community enterprise means not only blending with the social media outside, but rather incorporate the social media characteristics in the enterprise within, hence: the "social enterprise".<br>G08 - green goes way beyond raw materials, waste and carbon footprint. Dimensions (not incidentally) neglected include the inherent conflict between the target of enterprises (sell more) and the #1 challenge of sustainability - over consumption (buy less). Another key dimension is the ecological footprint (as opposed to carbon footprint). One cannot avoid the tragic contradiction between sustainability and free-market. |
| Lars Taxén | GO1: I do not agree that assets are becoming 'immaterial'. This is a misconception. Assets always have a "knowledge" side and a "material" side. It is just the nature and balance between the two aspects that change. Even the worker on the Taylor line need some kind of knowledge. Similarly, people's 'intelligence' today need some material substance, if only a button on a computer screen at Wall street<br>GO6: I do not agree that the cloud in any way will blur enterprise boundaries. The cloud is just a technique for storing and accessing things, and as such it will of course have consequences for enterprises. But the socio-economic rationale for the enterprise will not change. Also, "material value" will certainly not be lost; storing information "in the cloud" still needs the very same, old-fashioned material data-base techniques (albeit maybe improved). Moreover, services still need a material base whether that is a human or something accessible over the Internet. |

| | |
|---|---|
| Antonio Grilo | I believe that the Inventive dimension is too demanding. The vast majority of company have little innovation let alone inventions, and this is unlikely to change. The aim at Inventive Enterprise is not realistic. I would rather call them the Mutating Gene Enterprise (despite the ugliness of the term) since it will require that companies may be constantly changing their Enterprise DNA for survival. |
| Weiming Shen | The Cloud Enterprise concept / goal is very vague.<br>Green Enterprise may be changed to Sustainable Enterprise. |

## D.2 The Operational Dimension

This section refers to the content of the "*The Operational Dimension*" section of the Chapter 2 on the Enterprise space.

### D.2.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 10 |
| **3** | 3 | 30 |
| **4** | 3 | 30 |
| **5** (I agree) | 3 | 30 |

**Agreement level: 76%**

### D.2.2. Comments

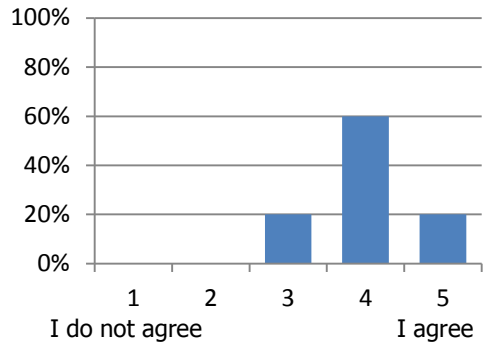
| Contributor | Comment |
|---|---|
| Sutcliffe-Braithwaite | The life-cycle of handling change is itself a constantly moving target and the description given suggests businesses can simply do it. Not so.<br>FInES job is to advise and devise the framework for putting into practice a wide eclectic set of change capabilities. These will rarely be individual business matters, but major aspects of a modern society's enterprises |
| Klaus Fischer | The described process is generic and structured. However, my experience in practice is that in the process there is also a lot of exploring by trying. The objective that should be reached is clear and there is also a rough idea of how it could be achieved. However, to actually reach it, one tries to implement some methods and process and tests them. If they work, fine; if not the approach is modified and this might even mean that physical systems are rebuilt or re-designed. But to a large degree it means that software systems are re-designed and adopted. |
| David Osimo | Nothing new here. Plenty of similar models. Just use a well tested model, don't invent a new one. |
| Lars Taxén | I certainly believe that there is a need for a fractal model of the enterprise; a 'DNA' of the organization if you like that provides a stable core for all level of the organization. I have suggested one such alternative in the construct of the Activity Domain (see ref below) |
| Antonio Grilo | I actually see it the other way around... I like the concept of Cyclical and Fractal, but not the Invent-Manage and Monitor. I believe that the split of the various stages/phases is likely to be more and more tangled with hardly any distinguish between inventive and build and manage, it will be more "on the road" approach. |

| | |
|---|---|
| Weiming Shen | It is too sketchy, and needs to be developed into well-defined methodology. |

## D.3 Supporting the advent of Future Internet-based Enterprises

This section refers to the content of the "*Supporting the advent of Future Internet-based Enterprises*" section of the Chapter 2 on the Enterprise space.

### D.3.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 2 | 20 |
| **4** | 6 | 60 |
| **5** (I agree) | 2 | 20 |

**Agreement level: 80%**

### D.3.2. Comments

| Contributor | Comment |
|---|---|
| Paolo Spagnoletti | Enterprise engineering is a management approach mainly diffused by practitioners who have developed a number of frameworks and models. I would suggest to refer to a more recognized and consolidated body of knowledge. Maybe the literature on Enterprise Architecture and Enterprise Architecture Management can help. |
| John Sutcliffe-Braithwaite | the framework is socio-technical engineering, i.e. the framework of complex social change, where, as we know businesses are never lone rangers riding out into the wild west.<br>FInES could be the body investigation change as a complex phenomenon of society and relating this specifically to the societal entity called 'enterprise' - bearing in mind all the subtle types touched on at the beginning.<br>The difficulty is knowing where to bound and ground the nature and extent of change. The answer would seem to be an evolving one that starts from models of what it is like now and may grow to be - this sees the affordance as actively pursuing change<br>Note the references conspicuously fail to address complex change, focussing on low level aspects. The danger of this is missing the holistic nature of the present trend ie what do you try and analyse? the answer is a society complexity framework that government and clients can engage with to monitor their own context for change within a larger and larger context |
| Klaus Fischer | It is clear that timely reactions to events where ever they come from is an important aspect of future enterprises. Business and economy is going faster and faster and for this reactions have to be faster and faster. However, it has always been the case |

| | |
|---|---|
| | that central control is "fighting" with decentralized decisions. Currently it seems that using modern information and communication technology are growing bigger and bigger (regarding their turn over) because less people are able to control larger parts of the enterprise. It is a question how long this trend will continue and what will make the centralized control fail that seems to be right now the guiding principle. |
| David Osimo | It is good but too vague, it's not a philosophical contest between positivism and complexity.<br>I would separate complexity modeling from E20, they are both relevant and probably complementary. See my comment about policy modelling and E20<br>http://egov20.wordpress.com/2010/10/11/what-agent-based-modeling-and-gov20-share-human-centric-and-network-savvy-tools-for-dealing-with-complexity/ |
| Mor Sagmon | I will suggest to also address the blurring of disciplines boundaries, where a successful future internet enterprise will smartly blend different specializations into a multi-disciplined approach. Especially, when considering G01, G05 and G08 above, the old definition of Enterprise Engineering is revealed in its inadequacy. humanities, natural sciences and the arts need to be considered in harmony to support a successful FI enterprises. |

## D.4. Specific topics about the Enterprise space

This section reports about the agreement expressed by contributors on the list of topics proposed in the framework of the Enterprise space. The table below presents all the details, while the graphics focuses on the percentage of the agreement level.

**Table D-1: Degree of agreement on Enterprise space topics**

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | **1** I do not agree | **2** | **3** | **4** | **5** I agree | **%** |
| **T2.1** | Enterprise Engineering | 0 | 3 | 3 | 1 | 3 | **68** |
| **T2.2** | Enterprise modeling | 0 | 0 | 3 | 2 | 5 | **84** |
| **T2.3** | Enterprise 2.0 | 0 | 0 | 3 | 5 | 2 | **78** |
| **T2.4** | Social Computing | 0 | 0 | 3 | 4 | 3 | **80** |
| **T2.5** | Risk Assessment and Management | 0 | 2 | 0 | 5 | 3 | **78** |
| **T2.6** | Humanistic Enterprise | 0 | 2 | 3 | 2 | 3 | **72** |
| **T2.7** | Humanistic Management | 0 | 2 | 4 | 0 | 4 | **72** |
| **T2.8** | Trust and security | 0 | 1 | 2 | 4 | 3 | **78** |
| **T2.9** | Transparency and accountability | 1 | 1 | 2 | 5 | 1 | **68** |
| **T2.10** | Business – IT Alignment | 0 | 0 | 1 | 6 | 3 | **84** |
| **T2.11** | Business Process Management vs Complex Event Processing | 0 | 1 | 0 | 5 | 4 | **84** |
| **T2.12** | Change management | 0 | 0 | 2 | 4 | 4 | **84** |
| **T2.13** | Knowledge management | 0 | 2 | 0 | 5 | 3 | **78** |
| **T2.14** | Social intelligence | 0 | 2 | 1 | 3 | 4 | **78** |
| **T2.15** | Simulation | 0 | 2 | 1 | 4 | 3 | **76** |
| **T2.16** | Performance indicators | 0 | 1 | 1 | 5 | 3 | **80** |

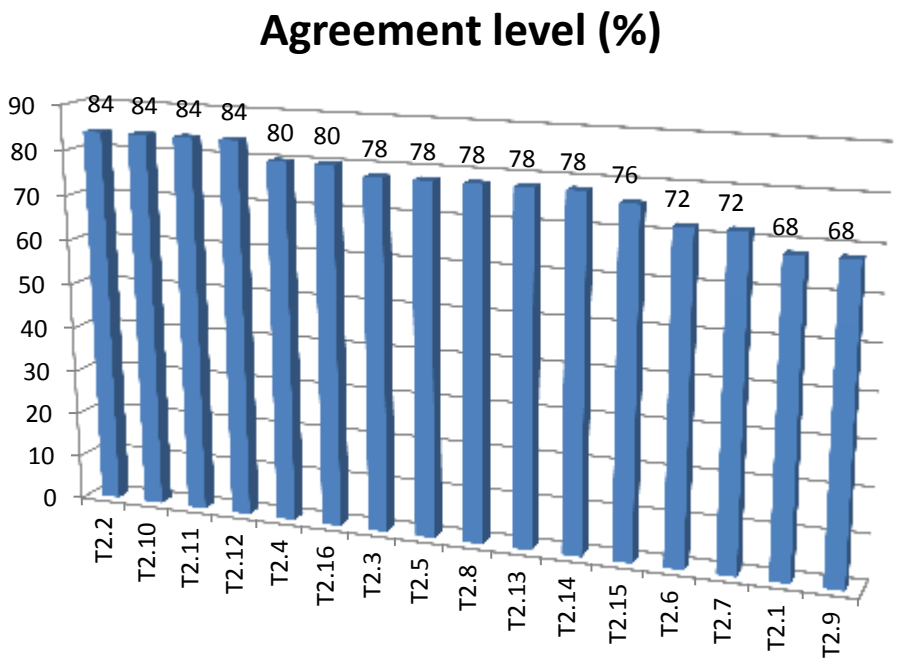



**Figure D-1: Percentage of the agreement level on Enterprise space topics (T2.1 – T2.16)**

## D.5. Disposal of comments and conclusions

Tracing the main characteristics of future enterprises is not an easy task: there are many possible angles and many, often diverging, opinions about key issues. The contributions to this chapter are testimonies of such diversity. But there are some themes that are largely considered as crucial, such as the capability to provide fast and effective responses to changes. But this is only one part of the problem, the other is to anticipate changes, i.e., to innovate. On this side, it seems that a certain scepticism prevails, highlighting the fact that, especially in this epochal phase, the problem of enterprises is more the survival that the innovative expansion. However, the editors (debatably) believe that this dichotomy is not correct, and the short term survival strategy leads to a mid-term default.

Another important point that emerges is the need to recovery of a centrality of people, a greater attention to their well-being, jointly with the attention to the environment (its quality is a key factor of well-being). But then, a contradiction is brought up: enterprises need to sell more while the socio-economic trend is that people will buy less and less. This is a key issue that the report tries to address (see [9] from Annex A.1).

Another interesting point that emerges is about the transition to a post-modern approach in organising and managing the enterprise, trying to address the ever increasing complexity. The report indicates, among the challenges, also this theme.

In conclusion, it is interesting to note that in the topics ranking, the most important (scoring above 80%) are Enterprise modelling, Business-IT Alignment and Change Management, while the only tow that score below 70% quite surprisingly are Enterprise Engineering and Transparency and Accountability.

# Annex E: The FInES space: Consultation report

**Contributors**

**9 persons** have contributed to this action

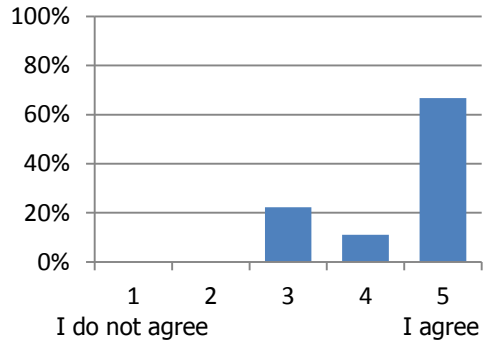
**Contributors' name:** Antonio Manzalini, Asuman Dogac, John Sutcliffe-Braithwaite, Antonio Grilo, Sergio Gusmeroli, Mor Sagmon, Paolo Spagnoletti, Lars Taxén, Weiming Shen

## E.1 The Knowledge Dimension

This section refers to the content of the "*The Knowledge Dimension*" section of the Chapter 3 on the FInES Space. The section is divided in three sections representing the three proposed Research Challenges (RC): *RC1. Unified Digital Enterprise*, *RC2. Linked Open Knowledge*, *RC3. Complex Systems Modelling*. For each of the Research Challenges, it was asked to express a degree of agreement as reported below.

### E.1.1. Degree of agreement

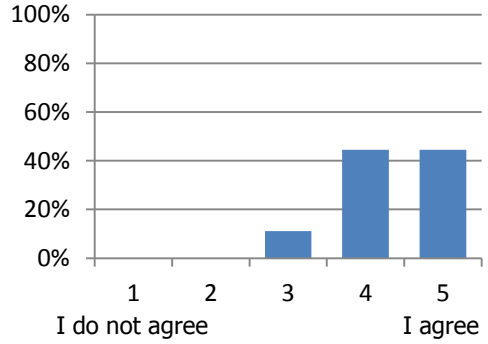
RC1. Unified Digital Enterprise: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 2 | 22 |
| **4** | 1 | 11 |
| **5** (I agree) | 6 | 67 |

**Agreement level: 80%**

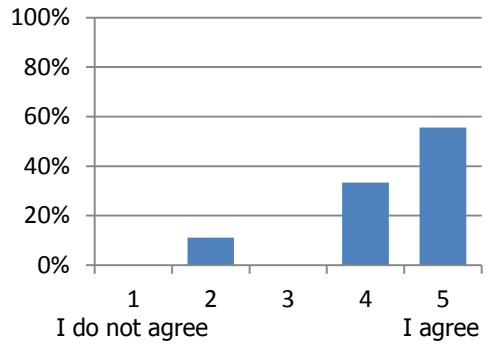
RC2. Linked Open Knowledge: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 1 | 11 |
| **4** | 4 | 44 |
| **5** (I agree) | 4 | 44 |

**Agreement level: 78%**

RC3 Complex Systems Modelling: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | | 0 |
| **4** | 3 | 33 |
| **5** (I agree) | 5 | 56 |

**Agreement level: 78%**

### E.1.2. Comments

| Contributor | Comment |
|---|---|
| John Sutcliffe-Braithwaite | We need to take care when we try and leverage existing concepts to fit a different conceptual view. More of the same is particularly worrying re knowledge. Overload is the danger, large does not mean 'focussed' and purposeful. The difficulty with Malone et al. is we have not defined the new concepts underlying our pursuit of something - just seeing A HOLY GRAIL DOES NOT HELP - it is usually an illusion , as is peddled so often in our modern 'lost' world:<br>RC1 UDE is equating the tool with the thing. This is the usual techy-believing they can change the world. Lots of good-words, we need conceptual clarity first.<br>RC2 - Yes, but what for? linked open knowledge is not some ever more elaborate representation or embellishment of 'form' but tied in with human purpose. Who defines what these three words actually mean?<br>RC3 - this is the core topic, it is tied to a radical departure from old models of enterprise, not throwing them away but giving them the capability to evolve.<br>We cannot deliver anything worthwhile by taking a stance that more-knowledge-engineering will cut the mustard. RC3 is the new paradigm, RC2 elaborates knowledge in a profoundly new way, and UDE makes the mistake of equating the tool with the thing itself |
| Antonio Grilo | Fully agree with these 3 RC |
| Sergio Gusmeroli | The main drawback of any conceptual representation of the reality (enterprise modelling in this case) is the fact that it is able to represent just a snapshot and a subjective view of it. The key question is: how FI Technologies are able to improve the K dimension of an Enterprise? I mean, realtime IoT and the sensing enterprise or collective internet of/by people: how could they help not just developing more accurate models but also keeping them up-to-date, personalised and contextualised?<br>The identified RCs are condivisible, but perhaps do not exhaust the K dimension. |

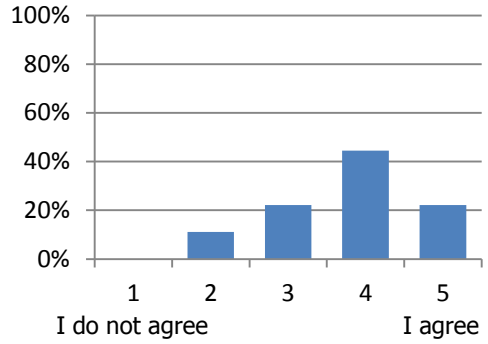
| | |
|---|---|
| Mor Sagmon | While UDE (RC1) and LOK (RC2) address the unification and interoperability aspects of knowledge, perhaps we should consider adding the consumption of knowledge and its business value.<br>i.e., given we have a reasonably good UDE and good integration between internal and external "open" data, we still need to develop highly effective, available and simple to use consumption models and tools, for all levels, providing with strategic insight as well as operational control and proactive intervention/reaction.<br>After all, what use is there for a solid body of coherent knowledge if we can't make value out of it... |
| Paolo Spagnoletti | typo on the preface "wining"<br>RC1: is the knowledge pragmatic issue related to individual and organizational capabilities? to what extent the cited EAF are applicable to SMEs?<br>RC2: reference on crowdsourcing etc. needed (i.e. Norman and Ramirez)<br>RC3: which is the role of human agents in this context? are they assimilated to technical components? |
| Lars Taxén | RC1: A very important RC. The reference architecture has to be chosen with great care in order to become operational. Zachman, PERA, CIMOSA, TOGAF, DoDAF, etc. are all much too complicated to be of any substantial value. You should look for fractal models, i.e., models that use a recurrent kernel. Otherwise things will be too complicated. |

## E.2 The Functional Dimension of a FInES

This section refers to the content of the "*The Functional Dimension*" section of the Chapter 3 on the FInES Space Chapter. The section is divided in three sub sections representing the three proposed Research Challenges (RC): *RC4. Innovation-oriented enterprise production platforms*, *RC5. Unified Digital Enterprise (UDE) Management Systems*, *RC6. Cooperation and collaboration platforms*. For each of the Research Challenges, it was asked to express a degree of agreement as reported below.

### E.2.1. Degree of agreement

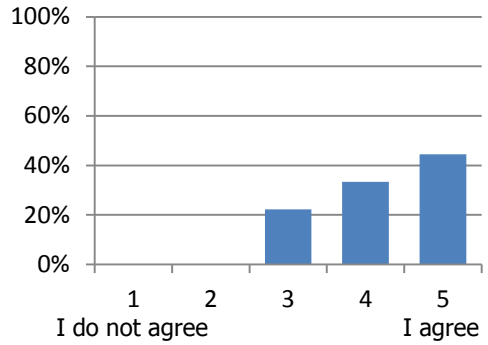
RC4. Innovation-oriented enterprise production platforms: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | 2 | 22 |
| **4** | 4 | 44 |
| **5** (I agree) | 2 | 22 |

**Agreement level: 68%**

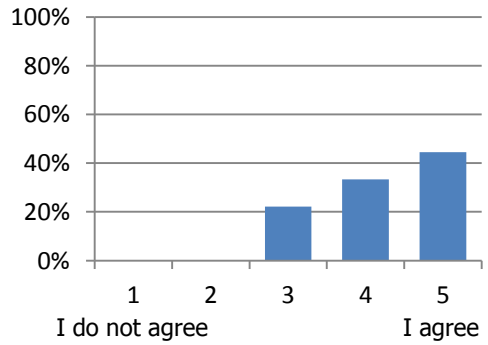
RC5. Unified Digital Enterprise (UDE) Management Systems: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | 2 | 22 |
| **4** | 3 | 33 |
| **5** (I agree) | 3 | 33 |

**Agreement level: 70%**

RC6. Cooperation and collaboration platforms: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 2 | 22 |
| **4** | 3 | 33 |
| **5** (I agree) | 4 | 44 |

**Agreement level: 76%**

### E.2.2. Comments

| Contributor | Comment |
|---|---|
| John Sutcliffe-Braithwaite | We need to re-think the conceptual basis of 'enterprise' in as fundamental way as we now study biological evolution. UDE means very little until this fundamental is defined, when UDE becomes its affordance (and only that). the nature of this new world must be able to articulate and give coherence to the (many) buzz-words we tend to use, The fundamental changes are global conditions, multi-dimensioned, and needing a paradigm change (before it is too late).<br>RC4 - key word, but why? Our job is to link innovation to the identified dimensions of change. We can leave business to craft the solutions when we set them the conceptual scientific foundation on which to build-out specific solutions. I also identify our role as including how to handle the emergent holism. The solutions thinking is not implementable without the foundation - hence the mistake of seeing the PDCA cycle (same idea!) as a waterfall=method<br>RC5 - We need to take care when approaching UDE 'Management' in terms that are uncomfortably close to Taylorist/Fayol views from the industrial revolution. Many of modern ideas dress up the same mind-set in new words like 'enterprise hygiene and throwing ever more, faster responses onto the enterprise victims. And knowledge management can become the new 'pantechnicon structure<br>RC6 - gets nearer to the integrated human-technical world. Not tweaking techy advances but redefining what the old concepts mean in the new vision (complexity/ecologies/emergence are the new artefacts of the new-world view) |
| Antonio Grilo | Disagree with the functional areas of the Innovation-oriented EPP. This functions are likely to be mashed-up rather than individualised. The challenge will be to uncover the functions that are likely to emerge from the more "traditional" type of functions. |
| Sergio Gusmeroli | I would call this § not "operational", but process-procedural, including not just operative life but also planning and mgmt.<br>The key question is: are WfM and BPM methods, tools and solutions able to meet the new enterprise business dimension, which is made of activities which are non-procedural, non-hierarchical, fuzzy & probabilistic, human-centric, serendipitous, parallel jobs?<br>For Instance<br>How to model and support innovation highly participative processes?<br>How to take into account the blurring border between job and leisure?<br>How to support knowledge sharing and knowledge protection processes?<br>How to support the transfer of information between real-digital-virtual worlds? |
| Mor Sagmon | Perhaps also consider the change management aspect of on-going operation of an |

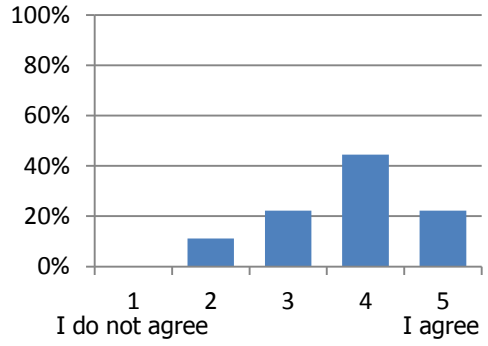
| | |
|---|---|
| | enterprise.<br>With re. RC6 - in addition to human and machines interacting, we may want to consider another player - biological elements. |
| Paolo Spagnoletti | typo "platfrorms"<br>RC6 is overlapping the "invent" functional area of RC4. Maybe this relationship should be mentioned in the text |

## E.3 The Engineering Dimension of FInES

This section refers to the content of the "*The Engineering Dimension of FInES*" section of the Chapter 3 on the FInES Space chapter. The section is divided in three sub sections representing the three proposed Research Challenges (RC): *RC7. Proactive FInES Mashup*, *RC8. Autonomic Computing Components and Subsystems*, *RC9. Flexible Execution platforms*. For each of the Research Challenges, it was asked to express a degree of agreement as reported below.

### E.3.1. Degree of agreement

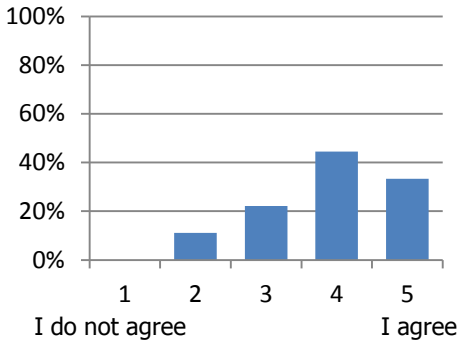
RC7. Proactive FInES Mashup: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | 2 | 22 |
| **4** | 4 | 44 |
| **5** (I agree) | 2 | 22 |

**Agreement level: 68%**

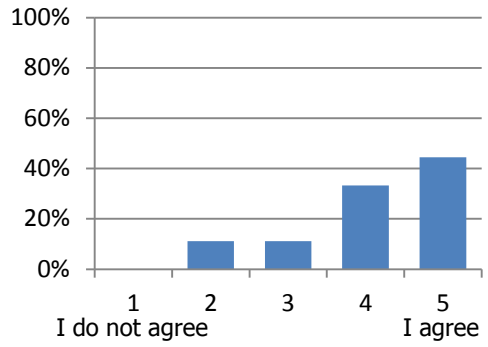
RC8. Autonomic Computing Components and Subsystems: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | 2 | 22 |
| **4** | 4 | 44 |
| **5** (I agree) | 2 | 22 |

**Agreement level: 70%**

RC9. Flexible Execution platforms: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 11 |
| **3** | 1 | 11 |
| **4** | 3 | 33 |
| **5** (I agree) | 4 | 44 |

**Agreement level: 74%**

**E.3.2. Comments**

| Contributor | Comment |
|---|---|
| John Sutcliffe-Braithwaite | We need to identify the significance of the socio-technic new order and not define it in 'old terms'.<br>RC7 - extends engineering to people instead of identifying what the symbiosis of people and the new-world requires by way of new engineering. It tries to extend early computing systems to a new order (not sufficiently articulated, and doing that is the fundamental EU Research task). You cannot reverse-engineer or extend legacy thinking to address fundamental new conditions.<br>RC8 - there is no such thing as an intelligent object, and so such thing as collective intelligence. Manifestations of crowd behaviour are biological hangovers, the only valid collective intelligence is thinking people agreeing with each other - our job is to identify what this means for enterprise interoperability and interconnectedness<br>RC9 - wrong message there is a killer application, just as there is a new world paradigm emerging and we need to research and provide the application framework for it. Yes, we will interface downwards to business enterprises and society that wants to adopt the new -world-order. They will invent, we will provide the science and new affordance.<br>My overriding conviction is we provide the fundamental new thinking and enterprises get on and apply it. FInES is the driver of paradigm change. Above all we have nothing to do with 'mechanisms to keep under control...'<br>QUIS CUSTODIET IPSOS CUSTODES - answer is society itself see my paper to the Policy Modelling workshop at ECCS'11 |
| Sergio Gusmeroli | Here the analysis should be more focussed on FI platforms and in particular how the concept of GSDP (global service delivery platform), service-oriented IDE (Integrated Development Environment) and applications Stores are being implemented in the FI PPP core platform and its generic enablers.<br>What are the principles to instantiate this Core Platform for Enterprises? |

| | |
|---|---|
| | Is the distinction between utility (fundamental basic) services/components and value-added (specific applicative) services/components valid in FINES? |
| Paolo Spagnoletti | typo "RC4" instead of "RC7"<br>I would suggest to substitute the reference [9] with a wide recognized book on Software Engineering (i.e. Pfleeger).<br>It seems to me that there is some overlapping between these three items. Maybe the relationships among them should be further specified. |
| Lars Taxén | RC9: I do not believe that "the hoary problem of Business-IT Alignment" will be intrinsically solved. The human aspect of this will always be needed. |

## E.4. Specific topics about the FInES space

This section reports about the agreement expressed by contributors on the list of topics proposed in the framework of the FInES space. The table below presents all the details, while the graphics focuses on the percentage of the agreement level.

**Table E-1: Degree of agreement on FInES space topics**

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | **1** I do not agree | **2** | **3** | **4** | **5** I agree | **%** |
| **T3.1** | Augmented reality | 0 | 2 | 4 | 1 | 2 | **60** |
| **T3.2** | Autonomic objects and networks | 0 | 0 | 4 | 3 | 2 | **68** |
| **T3.3** | Business OSINT | 1 | 0 | 4 | 2 | 2 | **62** |
| **T3.4** | Business-IT misalignment | 0 | 1 | 3 | 1 | 4 | **70** |
| **T3.5** | Change management | 0 | 0 | 1 | 3 | 5 | **80** |
| **T3.6** | Complex Event Processing | 0 | 0 | 1 | 1 | 7 | **84** |
| **T3.7** | Complexity Theory | 0 | 0 | 2 | 2 | 5 | **78** |
| **T3.8** | Creative commons | 0 | 1 | 4 | 2 | 2 | **64** |
| **T3.9** | Crowdsourcing | 0 | 2 | 3 | 1 | 3 | **64** |
| **T3.10** | Enterprise Architectural Framework | 0 | 1 | 1 | 3 | 4 | **74** |
| **T3.11** | From Linked Open Data to Linked Open Knowledge | 2 | 0 | 1 | 3 | 3 | **64** |
| **T3.12** | Innovation & continuous re-design | 0 | 1 | 1 | 5 | 2 | **70** |
| **T3.13** | Knowledge mining | 0 | 2 | 2 | 1 | 4 | **68** |
| **T3.14** | Knowledge pragmatics | 1 | 0 | 4 | 3 | 1 | **60** |
| **T3.15** | Knowledge rendering | 0 | 0 | 4 | 2 | 3 | **70** |
| **T3.16** | Semantic annotation and filtering | 1 | 1 | 2 | 3 | 2 | **62** |
| **T3.17** | Semantic interoperability | 0 | 0 | 1 | 5 | 3 | **76** |
| **T3.18** | Simulation and 'What-If' systems | 0 | 1 | 1 | 4 | 3 | **72** |

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | 1<br>I do not agree | 2 | 3 | 4 | 5<br>I agree | % |
| **T3.19** | Smart objects exploitation | 0 | 0 | 3 | 4 | 2 | **70** |
| **T3.20** | Social computing | 0 | 0 | 3 | 2 | 4 | **74** |
| **T3.21** | System mashup | 0 | 0 | 2 | 5 | 2 | **72** |
| **T3.22** | Virtual reality | 0 | 3 | 3 | 1 | 2 | **58** |

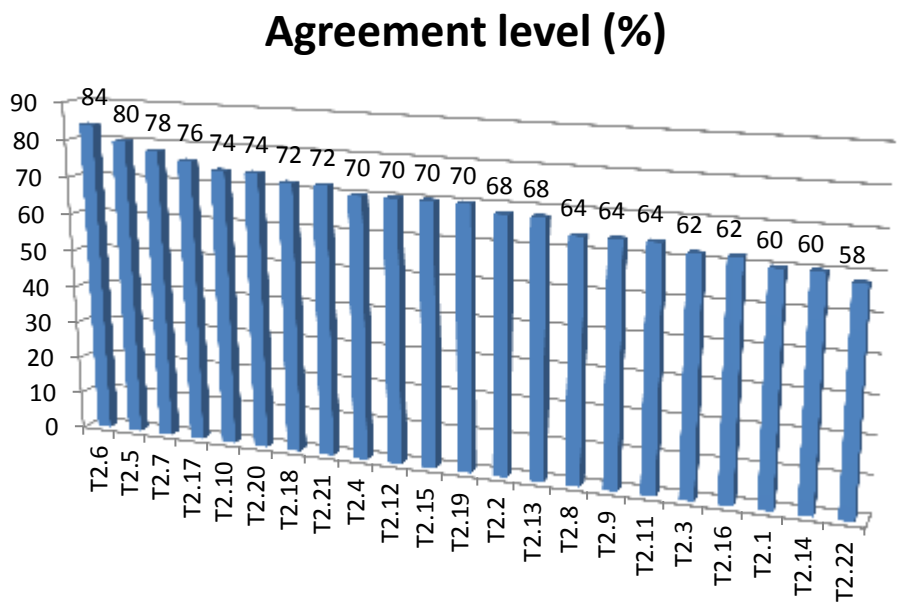



**Figure D-1: Percentage of the agreement level on FInES space topics (T3.1 – T3.22)**

## E.5. Disposal of comments and conclusions

This is the central chapter that addresses the core of the research activities of the FInES Cluster. It is based on a tripartite organization, with sections dedicated to the systems and platforms (i) for knowing (the business, the reality, the problems and opportunities, etc.), (ii) for doing business, and (iii) for building FInES artefacts. This organization was well accepted, providing the highest average score to the knowledge-oriented themes, followed by the operational themes. The last scoring is the more engineering-oriented area: probably perceived as too technical; but it absolutely central since in order to have socio-technical solutions supporting the first two, it is necessary to build engineered solutions.

One important concern that emerges from the comments is related to the fact that more and more business operations cannot follow well organised phased approaches. Processes and achievements stem form non-linear activities, sometimes even chaotic. The idea to use engineering methods to

'keep under control' the evolution of systems, processes, etc., seems to lose ground, while solutions to manage complex events will be more strategic in the future.

The above position is also reflected by the higher scoring topics in the reported list: Complex Event Processing and Change Management. Conversely, it is somehow surprising that the lower scoring is dedicated to new forms of digital interaction (Augmented reality and Virtual reality) and to the idea of improving the usage of the increasingly available knowledge (Knowledge pragmatics).

# Annex F: Future Technologies for FInES: Consultation report

## Contributors

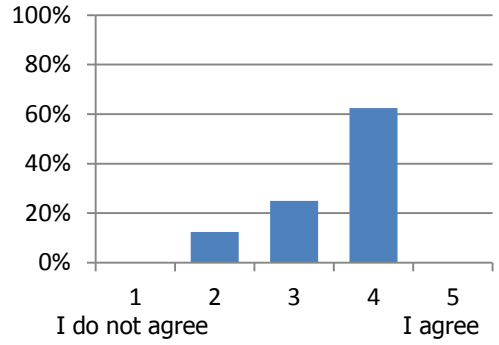
**8 persons** have contributed to this action

**Contributors' name:** Lars Taxén, Sergio Gusmeroli, John Sutcliffe-Braithwaite, Paolo Spagnoletti, Martin Zelm, Antonio Grilo, Weiming Shen, Mor Sagmon

## F.1 Future Networking Technologies

This section refers to the content of the "*Future Networking Technologies*" section of the Chapter 4 on the Future Technologies for FInES.

### F.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 12,5 |
| **3** | 2 | 25 |
| **4** | 5 | 62,5 |
| **5** (I agree) | 0 | 0 |

**Agreement level: 56%**

### F.1.2. Comments

| Contributor | Comment |
|---|---|
| Lars Taxén | There is an underlying ontology here which I do not share. In my view, everything we can access with our senses is real. Thus, "virtual" entities are as real as "natural" or "artificial" in the sense that they are meaningful for somebody. With this, I want to point to the importance of being explicit about what the underlying ontology (i.e. what things exist in the world) is. This is particularly important with respect to the many references to "knowledge" in this chapter. For example, I do not share the ontology that 'knowledge' can be assigned to 'objects'. Knowledge is a truly human thing; if you take away humans, there is no such thing as 'knowledge'<br>References:<br>Fahey, L., & Prusak, L. (1998). The eleven deadliest sins of knowledge management. California Management Review , 40 (3), 265-276. |
| Sergio Gusmeroli | it has to be expanded |

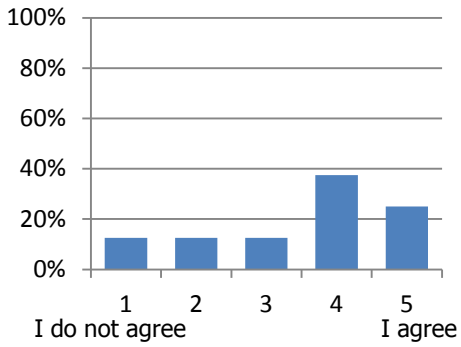
| | |
|---|---|
| John Sutcliffe-Braithwaite | Please add the term 'societal' to the heading.<br>This list is PEOPLE FIRST, AND ALL THE REST ARE DESIGNED ENTITIES - where the designs are human areas of interest.<br>FInES interest is in how these meld into a societal competency (our businesses, our organisations, ourselves, our world sustainability etc |
| Paolo Spagnoletti | I would suggest to do not refer to a "project proposal" for this kind of document (see [4]) |
| Martin Zelm | Seems OK |
| Antonio Grilo | It is likely that major future digital entities, like today Google or Facebook, be the entry-point of authentication for Internet-based systems, rather than each application/system has its own authentication and security processes. |
| Weiming Shen | "4D" may not be an appropriate wording here. |
| Mor Sagmon | With re. the level of security anticipated, I think it will be more cautious to say that the FI will REQUIRE secure services, rather than PROVIDE such services. I believe it is more likely that security challenges, in the form not foreseen at this time, will always be a challenge, especially with the convergence of technology and social engagement where ethical and legal challenges are yet to be properly addressed.<br>I believe as wi-fi/RF communications will become more ubiquitous and support larger bandwidth, the more we will start considering the health trade off that comes with it, and might face new challenges in rolling-back technology while preserving progress.<br>References:<br>http://www.icems.eu/papers.htm<br>http://www.bioinitiative.org/report/index.htm<br>http://sagereports.com/smart-meter-rf/ |

## F.2 Future Knowledge technologies

This section refers to the content of the "*Future Knowledge technologies*" section of the Chapter 4 on the Future Technologies for FInES. The section was articulated in three points: *4.2a. Diffused Knowledge Base Technology*; *4.2b. From raw data to knowledge assets*; *4.2c. Innovation-oriented knowledge assets*. For each of the above points, it was asked to express a degree of agreement as reported below.

### F.2.1. Degree of agreement

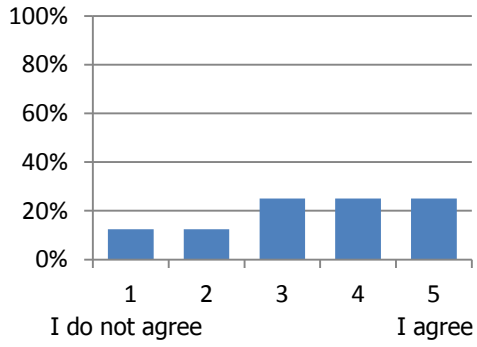
4.2a. Diffused Knowledge Base Technology: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 1 | 12,5 |
| **2** | 1 | 12,5 |
| **3** | 1 | 12,5 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 56%**

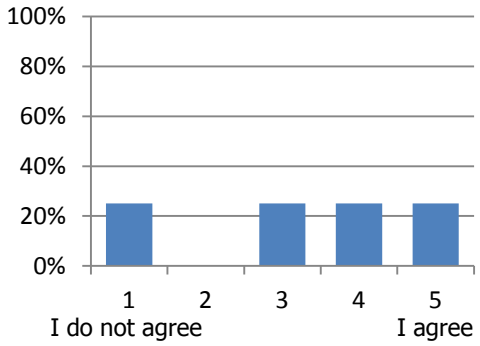
4.2b. From raw data to knowledge assets: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 1 | 12,5 |
| **2** | 1 | 12,5 |
| **3** | 2 | 25 |
| **4** | 2 | 25 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 54%**

4.2c. Innovation-oriented knowledge assets: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 2 | 25 |
| **2** | 0 | 0 |
| **3** | 2 | 25 |
| **4** | 2 | 25 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 52%**

**F.2.2. Comments**

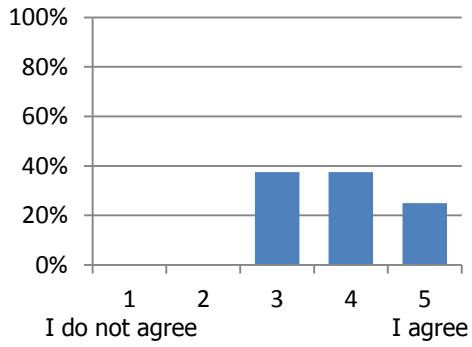
| Contributor | Comment |
|---|---|
| Lars Taxén | Again, see my previous comment. The statement "the role of humans in the creation of knowledge assets will progressively turn marginal" is in my view utterly false. |
| John Sutcliffe-Braithwaite | I would like 4.2 to be named "Future socially-enriched knowledge Technologies"<br>Rationale is that only this dimension can reflect the dimension of human purpose behind all enterprise activity and peoples' lives - and thus address the knowledge overload problem.<br>Hence I would like a 4.2d "socio-technic knowledge"<br>Data, knowledge, sensing, all are resources for purposeful human understanding, purpose, policy, etc and need new knowledge technologies to process these. The critical challenges are social-complexity and cognitive complexity |
| Paolo Spagnoletti | do we need 4.2c? It may be considered as a part of 4.2b |
| Martin Zelm | Do not understand the content of 4.2 |
| Antonio Grilo | I believe that raw data units will not be relevant and are likely to become redundant. Rather, functions derived from data are likely to be the basic unit. I hardly believe that Diffused Knowledge Base Technology will be necessary as new technology will be able to cope with "cloud computing" demands. |
| Mor Sagmon | 4.2a Advancements also in seamless compression are expected.<br>The natural entities role is not reflected in this section. Perhaps natural entities will play a role in all areas: storage, knowledge assets and innovation-oriented knowledge assets. |

## F.3 Future application technologies and complex systems engineering

This section refers to the content of the "*Future application technologies and complex systems engineering*" section of the Chapter 4 on the Future Technologies for FInES. The section is articulated in five points: *4.3a. Proactive and autonomic computing*; *4.3b. From deterministic to fuzzy computing; 4.3c. Beyond system consistency; 4.3d. Supervisory application technologies; 4.3e. Top-down problems definition and bottom-up systems aggregation*. For each of the above points, it was asked to express a degree of agreement as reported below.

### F.3.1. Degree of agreement

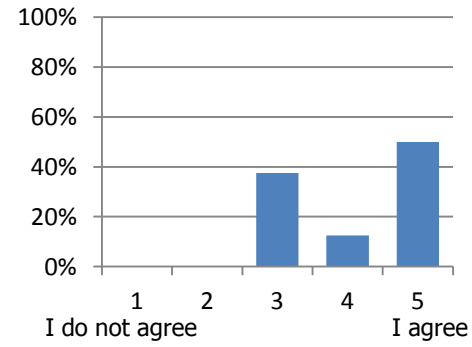
4.3a. Proactive and autonomic computing: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 3 | 37,5 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 62%**

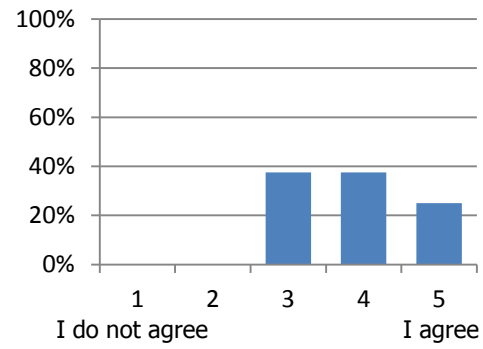
4.3b. From deterministic to fuzzy computing: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 3 | 37,5 |
| **4** | 1 | 12,5 |
| **5** (I agree) | 4 | 50 |

**Agreement level: 66%**

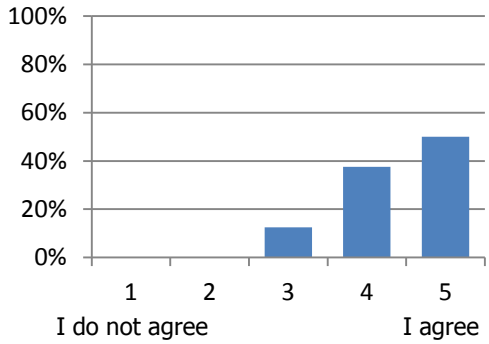
4.3c. Beyond system consistency: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 3 | 37,5 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 62%**

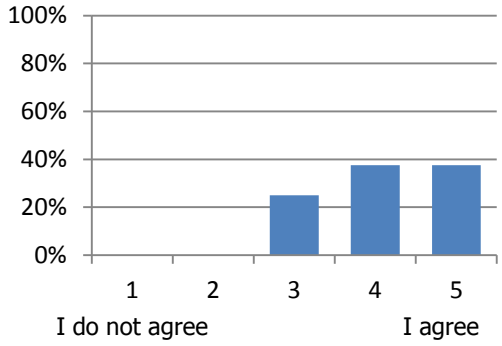
4.3d. Governance application technologies: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 1 | 12,5 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 4 | 50 |

**Agreement level: 70%**

4.3e. Top-down problems definition and bottom-up systems aggregation: degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 2 | 25 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 3 | 37,5 |

**Agreement level: 66%**

**F.3.2. Comments**

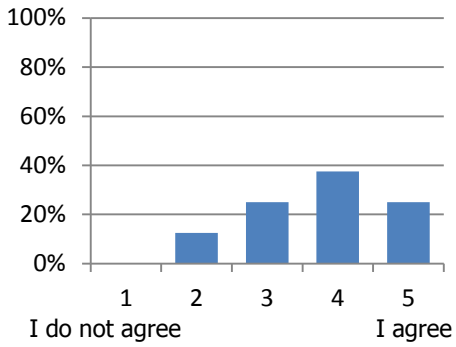
| Contributor | Comment |
|---|---|
| Lars Taxén | 4.3e: The statement in ref [5] I believe is very true:<br>"Steve Wagner, principal engineer for the Center for Enterprise Modernization, agrees. "Complex-system engineering is less dependent on technology than traditional systems engineering. Traditional systems engineering becomes an enabling capability to address the more complex "business" relationships you are trying to create. Our work now encompasses the business component to create a greater capability."<br>You cannot do away with traditional SE; however it needs to be advanced, for example, in the anatomy approach described in the reference below.<br>References:<br>Taxén., L. (Ed.) (2011). The System Anatomy – Enabling Agile Project Management. Lund: Studentlitteratur. ISBN 9789144070742. |
| John Sutcliffe-Braithwaite | Please add the word "societal" before the word systems. This reflects the fusion of social-computational-complexity sciences.<br>What characterises 4.3 a-e is that as defined they emphasise clever computing and fail to integrate clever people (see opening by-line!). the ugliness and problems of all these domains is lessened by moving towards a "socio-technic" new paradigm:<br>- fuzziness becomes societal Requisite Variety (Ref Ashby); actually human cognition and culture played out across the world and previous and future generations<br>- (implied) inconsistency is the acting-out of multiple MetaFrames of Reference (MetaFoRs), which is requisite variety however inconvenient to authority, generating new pictures and stories of human purpose and achievement<br>- please change the term 'supervisory" with its Taylor/Fayol connotations, to the modern OK terms "Governance, Policy, Purpose, Well-being, Sustainability etc etc. The core requirement is to process human reflexive thought (ref Occelli, Rosen et al)<br>- please change the terms top-down and bottom-up to the current OK terms 'Multi-level Dynamics' (ref FET DyM-CS). The new socio-technic methodology is Meta-modelling - i.e. what computer scientists have always designed outside the system but now needs to be continuously evolving, and embedded in the socio-technologies<br>- consistency is a continuous evolving consensus |
| Martin Zelm | Enterprise systems are said to become increasingly large. What about such systems for SME networks? They will always exist and may not grow so much. |
| Antonio Grilo | Very much aligned with this paragraph! |
| Mor Sagmon | I think it would be appropriate to also point to the "globalization" nature of businesses, in which boundaries of organizations, in terms of source data, processes |

| | |
|---|---|
| | and services, are blurred. The desire to tap into valuable sources, external to the organization, in real-time and automatically, poses a new challenge, especially in light of the fact that a single, "global" interoperability standard is lacking. Business applications will need to be engineered in a way that such external, unforeseen type of information and services to be consumed, are considered. See also 4.2c above. |

## F.4 Future computation and storage technologies

This section refers to the content of the "*Future computation and storage technologies*" section of the Chapter 4 on the Future Technologies for FInES.

### F.4.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 12,5 |
| **3** | 2 | 25 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 2 | 25 |

**Agreement level: 60%**

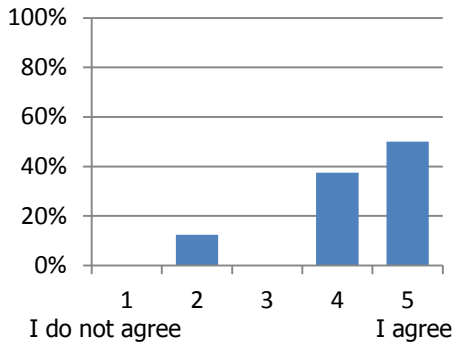
### F.4.2. Comments

| Contributor | Comment |
|---|---|
| John Sutcliffe-Braithwaite | Again, I would have awarded a Gold Star in my marking if the title had included the word "Societal" please!<br>The Cloud is actually the constant perturbation of billions of people, enterprises, global systems - in short every societal MetaFrame of Reference - constantly interacting, cooperating, competing, collaborating through interoperability constructs (actually designed society....<br>The techy term cloud is vendor lock-in....<br>The outcome is not knowledge assets but new or modified, (sometimes obsolete) social-Frames of Reference, through which their component parts, such as resources, data, become 'meaningful' i.e. their context becomes understandable and actionable etc<br>This is the new science of computational socio-geonomics, all the examples listed are valid, but it is a much richer domain than these. |
| Martin Zelm | Operating without a central authority is a key concept which applies in other domains as organisations, technical / business systems and last not least the universe (?) |
| Antonio Grilo | Again many doubts on the rational of this paragraph, for the reasons pointed out earlier. |
| Mor Sagmon | Indeed, semantics will probably play a bigger role than mentioned here.<br>Also, consider pointing to the aspect of biological storage, with its own (new) limitations and advantages. |

## F.5 Future Natural Interaction

This section refers to the content of the "*Natural interaction*" section of the Chapter 4 on the Future Technologies for FInES.

### F.5.1. Degree of agreement




| Vote | # of responses | % |
|---|---|---|
| **1** (I do not agree) | 0 | 0 |
| **2** | 1 | 12,5 |
| **3** | 0 | 0 |
| **4** | 3 | 37,5 |
| **5** (I agree) | 4 | 50 |

**Agreement level: 68%**

### F.5.2. Comments

| Contributor | Comment |
|---|---|
| Lars Taxén | See my previous comments on 'knowledge' |
| John Sutcliffe-Braithwaite | Please put more emphasis on socio-technology especially as the 'natural' interaction is an ambiguous term, connoting the physical world. I think you mean 'societal/enterprise' interaction - and this is just as much technology as the examples given, in fact societal technology gives meaning to them via cognition, culture, and memory. |
| Paolo Spagnoletti | I would add here a reference to the notion of Individual Information Systems |
| Martin Zelm | Overall, many obvious requirements and understandable research challenges in technology. Some items exist already and will need enhancement, others are more innovative. In total, the drawn picture is visionary and at the same time evident, also for non-experts. |
| Antonio Grilo | Very much agree! |
| Mor Sagmon | Perhaps a bit beyond 2020, but worth mentioned is the area of mind-reading by machines, where waves radiating our thoughts and feelings are captured and interpreted by machines, allowing automatic activation of tasks. |

## F.6. Specific topics about the Future Technologies for FInES

This section reports about the agreement expressed by contributors on the list of topics proposed in the framework of the Future Technologies for FInES. The table below presents all the details, while the graphics focuses on the percentage of the agreement level.

**Table F-2: Degree of agreement on Future Technologies for FInES space topics**

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | **1** I do not agree | **2** | **3** | **4** | **5** I agree | **%** |
| **T4.1** | Advanced negotiation techniques | 0 | 0 | 3 | 3 | 2 | **62** |
| **T4.2** | Advanced Enterprise Service Bus | 0 | 0 | 4 | 3 | 1 | **58** |
| **T4.3** | Augmented reality | 0 | 0 | 3 | 2 | 3 | **64** |
| **T4.4** | Cloud computing | 0 | 0 | 1 | 4 | 3 | **68** |
| **T4.5** | Component-based Software Engineering | 0 | 1 | 1 | 4 | 2 | **62** |
| **T4.6** | Data, information, knowledge quality | 0 | 0 | 3 | 1 | 4 | **66** |
| **T4.7** | Haptic interface (ref. 12) | 1 | 1 | 5 | 0 | 1 | **46** |
| **T4.8** | Inconsistent systems | 2 | 1 | 2 | 2 | 1 | **46** |
| **T4.9** | Intelligent Personal Digital Assistant | 1 | 0 | 3 | 2 | 2 | **56** |
| **T4.10** | Linked Open Knowledge, Knowbot | 0 | 1 | 3 | 4 | 0 | **54** |
| **T4.11** | Knowledge mining, text mining, Natural Language Processing | 0 | 0 | 3 | 1 | 5 | **76** |
| **T4.12** | Model-driven Development (MDD) and Model-driven Architectures (MDA) | 0 | 1 | 3 | 3 | 1 | **56** |
| **T4.13** | Multi-Agent Systems | 0 | 0 | 4 | 1 | 3 | **62** |
| **T4.14** | Proactive and autonomic computing and networks (ref. 13), Complex Event Processing | 0 | 0 | 2 | 2 | 4 | **68** |
| **T4.15** | Probabilistic computational models (e.g., Bayesian, hidden Markov models) | 0 | 0 | 4 | 2 | 2 | **60** |
| **T4.16** | Semantic annotation & filtering | 0 | 0 | 5 | 0 | 3 | **60** |
| **T4.17** | Semantic data analytics, semantic | 0 | 0 | 2 | 3 | 3 | **66** |

| # | Topic | Degree of agreement | | | | | Agreement level |
|---|---|---|---|---|---|---|---|
| | | 1 I do not agree | 2 | 3 | 4 | 5 I agree | % |
| | routing (data know whom to reach, when, in what form) | | | | | | |
| **T4.18** | Service-Oriented Architectures and Platforms | 0 | 1 | 1 | 3 | 3 | **64** |
| **T4.19** | Simulation and 'what-if' engines, Decision Theory | 0 | 0 | 4 | 1 | 3 | **62** |
| **T4.20** | Trust and security, digital (multiple) identities | 0 | 0 | 2 | 4 | 2 | **64** |
| **T4.21** | Symbiotic human/machine knowledge discovery | 0 | 0 | 3 | 2 | 3 | **64** |
| **T4.22** | Fuzzy analysis based on human expert assessment and computational propagation | 0 | 0 | 2 | 3 | 3 | **66** |

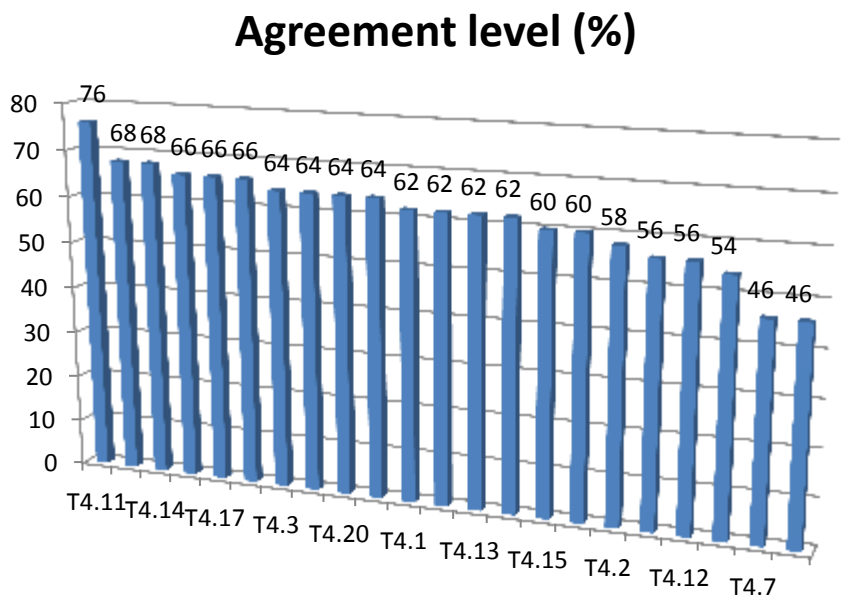



**Figure F-2: Percentage of the agreement level on the Future Technologies for FInES topics (T4.1 – T4.22)**

## F.5. Disposal of comments and conclusions

This Annex deals with the comments to the Future Technologies for FInES. The comments, as usual, helped substantially to improve the draft on the FInES Research Roadmap, providing useful material

and alternative points of view. Besides, there are couple of issues that need to be highlighted. The first issue concern the scores of the different sections. Surprisingly, the lower end is occupied by two basic technological areas: future networking and future knowledge technologies. It is well known that the two areas are fundamental for the future of our society and industrial systems. Therefore, it is possible that the sections were not so much accepted for the way they have been addressed and presented rather than for the subjects addressed.

The second, connected to the first, concerns some the 'negative' comments that are only marginally helpful to reshape the elaboration. For instance, one comment says that we cannot talk about 'Knowledge Technology' since the knowledge is never an 'artificial' entity, it only exists in the head of people. This is a long lasting debate that it is better to avoid here, and therefore it is better to remain with the majority of the experts that consider KM as a well established discipline. Another criticism is about other fundamental notions, such as virtual vs. real, material vs. immaterial, saying that there is not a difference, since all is concerned with the human perception. Again, we avoided to be too philosophical (even if we have been a bit, sometimes, somewhere). Therefore, since in the common sense perception there is a difference, we adopted it.

Among the sections of this chapter, the highest score has been assigned to the 4.3d – Governance application technologies. This is interesting since while the reality is getting more and more complicated, there is a shift of priority from 'doing business' to the governance, monitoring, and controlling the business, at large. Here we have good and bad news. Good news is the growing awareness, and also a good response from technology producers who are improving the quality and effectiveness of tools in this area. The bad news is that, despite the power of the tools that will be released in the future, we are approach the complexity limit of governance. Above a certain threshold, we will not be able to keep 'everything' under control, with a unitary vision of what is going on 'down there', in the real world. According to the theory of Requisite Variety (citation due to John Sutcliffe) a controller needs to have a larger number of states than the controlled system, in order to be effective in all possible situations. It is clear that as the reality becomes more complex, the number of states diverges and therefore it is unfeasible to produce an artefact endowed with a larger state cardinality. The conclusion is that we need to surrender the idea of keeping everything under control and provide the components, subsystems, etc., larger degree of autonomy.

We conclude with some considerations of the list of topics and their score. Here there is a surprise, in fact the highest score (76) is obtained by the technologies related to the knowledge acquisition problems, while in the Knowledge Technologies section (4.2) has received the lowest score among the sections. The second highest (68) has been gained by the autonomic systems area: this is a good sign that goes in the direction indicated above, that is to decentralise the control, transferring an increasing level of control to subsystems. On the lower end we have the Haptic interface (T4.7), that concerns tactil and sensorial interactions of users and objects, and Inconsistent Systems (T4.8), i.e., systems that give up the need of coherence in all possible aspects, at any time. This result is quite surprising, since the two topics are somehow witnessing what is already happening today (think for the T4.7 about some videogames or, in an industrial context, flight simulators). In particular, the T4.8 is the only way to get more realistic systems, since reality is far from being coherent, and the pretention to have coherent systems to mirror an incoherent reality has scarce chances of success.