

Challenges Laying Ahead for Future Digital Enterprises: A Research Perspective

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Abstract. Nowadays, digital enterprises are confronted with disruptive technological advancements in their constant quest for innovation and creativity. In order to evolve towards new forms of enterprises, driven by constant business model transformation, a number of challenges need to be addressed from a research and practice perspective. In this paper, a glimpse of the technological trends and visionary scenarios for Enterprises of the Future is provided, leading to the elaboration of the research challenges along the following dimensions: (a) Collaborative, Real-time, Proactive Business Analytics-as-a-Service, (b) Innovative, Web-based Business Models for New Kinds of Economies, (c) Federated, Innovation-driven Enterprise Collaboration Platforms, (d) Dynamic Discovery and Negotiation of the Intellectual Property Rights' Flow.

Keywords: Digital enterprise · New forms of enterprises · Technological trends · Scenarios · Research roadmapping · Research challenges

1 Introduction

The world is experiencing one of the most extraordinary periods in history. Returning to growth and higher levels of employment, combating climate change, and moving towards a low-carbon society require urgent and coordinated action. A convergence of forces is reshaping the global economy: emerging regions, such as Africa, Brazil, China, and India, have overtaken economies in the West as engines of global growth; the pace of innovation is increasing exponentially; new technologies have created new industries, disrupted old ones, and spawned communication networks of astonishing speed; and global emergencies seem to erupt at ever-shorter intervals. Any one of these developments would have profound implications for organizations and the people who lead them. Taken together, these forces create many challenges and opportunities, thus, a new context for entrepreneurship [1]. Entrepreneurship has never been more important than it is today in this time of financial crisis [2]. Innovation and entrepreneurship are

generally viewed as an engine of technological progress and economic growth and provide a way forward for solving the global challenges of the 21st century, building sustainable development, creating jobs and advancing human welfare [3, 4].

Today, we are living through moments of disruptive technological change accelerating the transition from a business-driven culture to a more ‘social-oriented’ one. Open innovation has become more influential and models of production and value creation are changing. The advent of big data, social media, cloud computing and the Internet of Everything that will eventually pervade business, government and society heralds a new motif of socioeconomic organization, exemplified by the App Economy that is already emerging as a collection of interlocking innovative ecosystems [5]. In this context, Business Innovation in the Future Internet has already taken new impetus according to analysts across the world. Enterprises of the future thus need to leverage Future Internet-based technologies to define their own paths to competitiveness and generate hybrid value constellations (combining business and social innovation networks).

Digital Enterprise is considered as a long-standing concept that has gained traction over the last decade: initially, intertwined with mere digitalisation of the traditional processes of an enterprise and eventually, encapsulating its digital transformation and digital value creation. Throughout the years, a number of relevant concepts, like Social Enterprise, Sensing Enterprise and Enterprise 2.0, have emerged and transpire similar directions for enterprises who want to thrive and prevail in the Digital era. In the context of our work in the EC-funded FutureEnterprise project, the term “new forms of enterprises” has been adopted to reflect the next evolutionary step of a Digital Enterprise, along the following definition: *New forms of enterprises are “Enterprises of the Future, driven by constant business model transformation and innovation, acting as multi-sided platforms built on -as well as emerging from- digital innovations at the global, as well as local level, to produce shared value including that beyond monetisation”*.

Along these lines, the present paper aims at discussing a number of instrumental research challenges that need to be tackled by researchers and practitioners in order for new forms of enterprises to evolve and flourish. In Sect. 2, the methodological approach is presented, leading to Sects. 3 and 4 that summarize the trend analysis and the visionary scenarios for Enterprises. Section 5 outlines the identified research challenges. Section 6 concludes this work and presents next steps along this approach.

2 Methodology

The methodological approach followed towards identifying research directions for future digital enterprises consisted of 5 main phases: (a) identification and analysis of “trends”, accompanied by the formulation of “mega-trends”; (b) extraction of “key uncertainties”; (c) conduction of an open crowdsourcing exercise; (d) elaboration of the different socioeconomic factors and of the role of enterprise; (e) elaboration of “future scenarios”; (f) identification of grand challenges and research challenges.

An initial identification of basic technological trends - together with macro-trends concerning Politics, Economy, Society as well as the ones related to Business,

Entrepreneurship, and Innovation - has been carried out to document in a structured way the trends that may affect the future of enterprises. The analysis has been carried out on: (i) the normative visions of the FutureEnterprise Expert's panel, comprising from high-calibre experts in the domain, (ii) the results from an online crowdsourcing exercise carried out between January and March 2014, (iii) comments and notes from a focus group of entrepreneurs held on March 2014, and (iv) a sample of 50 selected secondary sources (from an initial set of 300 documents), made up of:

- Reports and data sets from the European Union and international institutions such as the OECD, United Nations, World Bank;
- Organisational reports working every year on Global Entrepreneurship Monitor or the Global innovation Index;
- Articles and studies from academic research on the considered domains.

Identified trends have been then merged into “Mega Trends”, describing at higher level the way that the aforementioned domains are affected. A Mega Trend can be linked with more than one domains of study, as it is a combination of underlying trends. Based on the “Trends” and “Mega Trends”, various “Key Uncertainties” have been extracted, handpicked based on their influence to the creation of “New Forms of Enterprises”. Then the “Key Uncertainties” have then been placed on open consultation in order to filter out the unrealistic and improbable combinations of these “Key Uncertainties” and the final results have driven the consortium to a set of “Probable” and “Desirable” futures as envisioned by the community. These futures constituted the finalisation of the scenario building exercise, whose purpose is to explore different probable alternatives for the future of society and economy, and elaborate on possible impacts (in terms of both opportunities and risks) that the future of research on New Forms of Enterprises may hold. The starting point for the scenario generation activities was (as described above) the trend analysis, as it allowed the identification of the main impact dimensions that are likely to influence research directions in the area of Digital Business Innovation in the future.

A number of Business Models Innovations [6] (i.e. Closed-Loop Production; Physical to Virtual; Produce on Demand; Rematerialisation; Sell One, Give One; Cooperative Ownership; Crowd funding; Freemium; Innovative Product Financing; Pay for Success; Bait & Hook; Differential Pricing & Customisation; Microfinance; Micro-Franchise; Open Innovation; Multisided platform) have been studied along the following aspects: Existing enabling technologies, Dependency with innovation diffusion / acceptance factors (analysed under both the current situation in Europe and the future desirable scenario), Changes brought to existing business models (in accordance with the business model canvas elements), Key research directions needed to enable or boost every business model innovation, characterised with the expected impact on enterprises, SMEs and web entrepreneurs. Such an analysis has led to the identification of 25 research challenges, along with the projected timeline for their realization, and to their grouping into Grand Challenges, which represent significant research paths to be followed in the years to come, based on their relevance.

3 Trends

In order to understand the forces that drive enterprises to be born digital (digital native enterprises) or digitise their activities and seek innovation - regardless if it refers to a specific subset of their activities or to their organisation as a whole - it is of the utmost importance to study the underlying technological trends. It can be taken also for granted that, besides technological trends and advancements, additional factors exist that can affect the strategic decisions of both new and existing enterprises and degree of transformations of existing organisations; thus, trends of non-technological nature have to be taken into consideration too. Towards this direction, an extensive state-of-the-art analysis was realized and various differentiated sources were studied (e.g. OECD, United Nations, World Bank, private companies mostly of consulting nature) in order to identify, categorise and report key trends that can accelerate digital entrepreneurship and digital transformation of existing enterprises.

The analysis led to the identification of 7 categories of trends, covering a wide spectrum of areas, namely Political, Economic, Societal, Business, Entrepreneurship, Innovation and Technological. Putting more focus on the technological trends, every recognized trend has been classified on the basis of its strength and horizon.

Figure 1 visually depicts the complete list of technology trends accompanied by information on their strength and implementation horizon. The possibility itself to name with the term “cluster” a set of firms is related to the presence of structural linkages, i.e. systematic - although eventually weak - interactions.

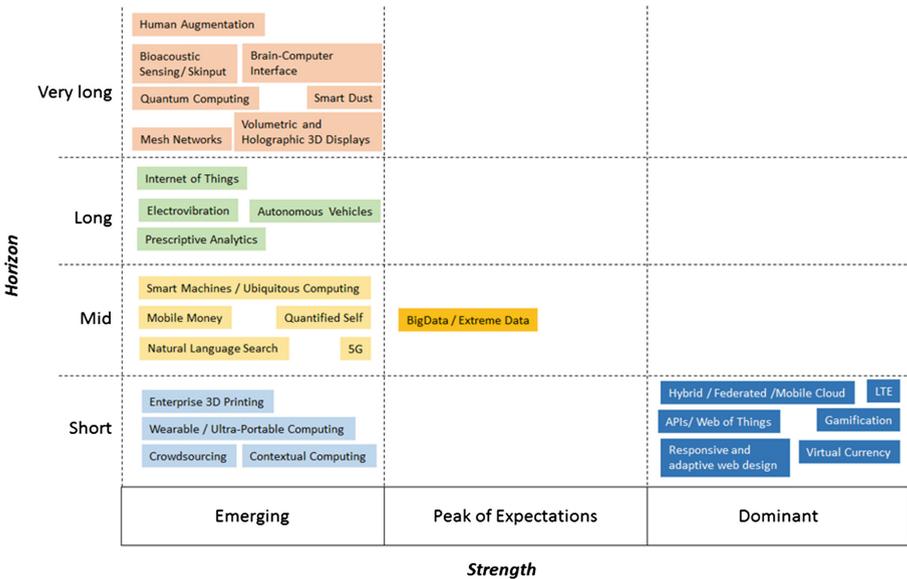


Fig. 1. Technology trends

With regard to its strength, a trend may be considered as:

- Emerging, when its diffusion is limited to a certain territory, and there is a small population with a consequent limited number of mainstream publications or reports discussing it as relevant.
- Peak of expectations, when its diffusion and acknowledgment are mainstream, overcoming a limited set of specialists. However, the trend's impact is still difficult to clearly evaluate, whether it is positive, negative, or else neutral (no effect on business or entrepreneurship), thus, pointing out or leading to a potential failure.
- Dominant, when its diffusion and acknowledgment are mainstream and the impact is clearly evaluated as it is evident in many different cases.

Finally, as far as a trend horizon is concerned, it can be Short (less than two years to be fully deployed), Medium (between two and five years to be fully deployed), Long (between five and ten years to be fully deployed) and Very Long (more than ten years to be fully deployed).

4 Scenarios

A visionary scenario analysis was then conducted based on a foresight exercise, including the analysis of the key areas coming from these trends, placing them in the context of various different future scenarios and envisioning, for each scenario, the future landscape and its implications in an enterprise. Following the classification of Popper [7], a distinction can be made between a methods' orientation (normative or exploratory), its nature (quantitative or qualitative) and its essence (expert-based, creativity-based, interaction-based or evidence-based). The objectives of a foresight exercise and the degree of uncertainty and complexity involved, guide the selection of methods for a particular exercise. A scenario is to be intended as a systematic vision of future possibilities [8]. In foresight research this usually means plausible possibilities and ones that do not rely on too extreme wild cards. They are used as tools for political or strategic decision-making and to explore the impact of particular decisions or developments in the future. More specifically, scenario-building aims to identify uncertain developments in the future and take those uncertainties as elements of the scenario narrative.

The aim of the scenario-design exercise developed as part of Future Enterprise is to explore different possible alternative futures in the context of the enterprises of the future, rather than predicting the future; then elaborate on possible impacts that the future mainstream on society of ICT tools in this domain may have. Both the time horizon of this exercise (i.e. 2030) and the interdependency of various developments affecting it (e.g. rapid developments in specific domains of ICTs) make the future of this domain of research dynamic, complex and uncertain. It is therefore difficult to use quantitative and evidence-based methods. Courtney et al. [9] describe this amount and type of uncertainty as a 'level 3', at which a range of different possible futures can be identified. They describe three types of foresight methods that can be used at this level: scenario writing back casting and early warnings systems. As the latter two approaches

are often incorporated into scenario writing, the method of scenario design has been used for this exercise [10].

Having in mind the limitations in current scenario building exercises (like the limitations imposed by the extreme 2-dimensions axes), a differentiated approach has been adopted, where a larger set of Key Uncertainties exists and the different **Probable and Desirable scenarios**, as voted by the experts. This way, not every possible combination of the aforementioned Key Uncertainties is examined (as this would generate a huge number of scenarios) but focus is laid on what is most likely to happen (Probable Scenarios), and also on what seems like an ideal future (Desirable Scenario). The different scenarios that are created are in this way based on the majority of the votes of the public and in this way provide a more realistic, unbiased and collective representation of insights on how our world would look like in some years from now, but also provide the collective perception of people of how an ideal world should look like in the future.

The **Key Uncertainties** for the purpose of the FutureEnterprise roadmap approach that have been selected for building the above discussed scenarios and which correspond with the trends and the megatrends identified in this deliverable and follow the PESTEL (Political, Economic, Sociological, Technological, Legal, Environmental) pattern are presented in the table below. Each column in the following table is independent from the others and presents the three values of each Key Uncertainty (the header row). In this context, a future scenario can be derived as a combination that includes only one value from each column of that table (Table 1).

Table 1. Key Uncertainties and Possible Values

Wealth & Well-Being	Legal Framework	Value Creation and Capture	Operations & Decision Making	Markets
Prosperity	Global Legislation	Corporate Social Responsibility	Machine Intelligence	Global Markets
Stability	Fragmented Legislation	Shared Value	Knowledge based	Glocal Markets
Scarcity	Self-Regulation	Shareholders Value	Crowd Wisdom	Local Markets

It needs to be noted, that all uncertainties and scenarios developed have as a central point of focus the “Enterprise”, as the interest of the roadmap would be the recommendations of activities that will help enterprises to evolve and shape into the entities that will drive business innovation and production in the future.

The Key Uncertainties previously discussed have been announced to the public in order to engage it towards providing its feedback by pointing out which they consider more likely to realise (Probable Scenario) and which they would like to happen (Desirable Scenario). Upon collecting a total of 102 responses, the authors analysed the various responses and set some threshold points order to distinguish the different combinations that prevail and that lead to scenarios that are quite different from each other. Based on a qualitative analysis of the patterns received, the threshold was set to

33% of votes for the probable scenario in order to derive 2 probable scenarios which are different from each other in at least 3 dimensions (key uncertainties), while as long as it concerned the desirable scenario, the threshold was set to 50% of votes, which clearly pointed out one scenario. The different votes and the threshold points set by the consortium are visible in the following two figures (Fig. 2).

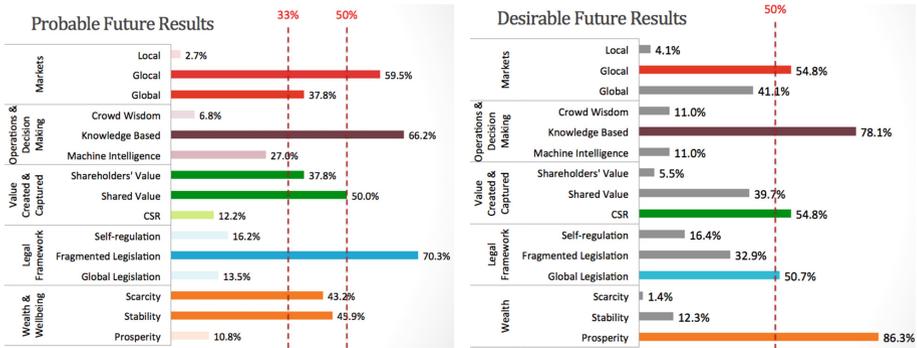


Fig. 2. Answers to Key Uncertainties regarding the Probable and Desirable Scenario

The three scenarios derived, which are also discussed in the next section are the following.

- **Probable Scenario #1** - A global, federated network of self-organised communities (*Disruptive Communitarianism*), which includes the following values of the Key Uncertainties: Stability, Fragmented Legislation, Shared Value, Knowledge-based, Global Markets
- **Probable Scenario #2** - Distributed Islands of Capitalism (*Elysium*), which includes the following values of the Key Uncertainties: Scarcity, Fragmented Legislation, Shareholders Value, Knowledge-based, Glocal Markets
- **Desirable Scenario** – Prosperity, Social Caring and Equal Opportunities (*Garden of Eden*), which includes the following values of the Key Uncertainties: Prosperity, Global Legislation, Corporate Social Responsibility, Knowledge based, Glocal Markets

5 Roadmap

The research challenges that have been eventually identified in a collaborative way have been bundled in the following four grand challenges which represent significant research paths to be followed in the years to come:

Grand Challenge 1: Collaborative, Real-time, Proactive Business Analytics-as-a-Service, dealing with a radically different context for business analytics for the enterprise personnel, either high-level executives or shop floor workers. It encompasses the following research challenges:

- RC1.1 - Multi-source Data Analytics Services for Real-Time Production Critical Decisions. Analysis of data coming from widely deployed IoT and smart dust networks in the production lines of enterprises to constantly monitor information and data towards providing proactive notifications and decision support to the business personnel, regarding the optimum and uninterrupted operation of the enterprise and the maximisation of its goals.
- RC1.2 - Predictive and Prescriptive Crowd-based Analytics powering Business Innovations. Analytics and value added information generation shall be delivered to enterprises through real-time monitoring and analysis of internal and mostly external information sources (such as social networking systems) and of behaviours of targeted stakeholders, towards revealing potential innovation and market-related business opportunities.
- RC1.3 - Business Transformation Platforms combining Human Knowledge with Information Flows. Combining enterprise critical data flows with human derived ideas, knowledge and experience, artificial intelligence enterprise agents transporting knowledge, experience and data across all enterprise divisions (as well as beyond its borders in some cases), will be deployed to grasp on emerging opportunities and automatically transform business realities and processes in a flexible and agile manner.
- RC1.4 - Enterprise-wide smart, personalised intelligence and delivery systems. Next generation analytics, combining raw sensor data, historical logs and business knowledge and best practices, coupled together with smart and personalised recommendation systems to provide intelligence-rich services beyond plain information mining and visualization to various stakeholders over different access channels.
- RC1.5 – Generation and Exposure of SMEs Analytics over federated cloud-based platforms. Deployment of federated cloud-based platforms that interface with hundreds of proprietary and open source business solutions and data repositories, to transform SME data and expose them through meaningful and value-added cloud-based analytics, without compromising their classified business intelligence.
- RC1.6 - Smart and Collaborative APIs for cognisant business processes. Next generation APIs integrated to all business-related systems to allow the controlled exposure of information at real-time, turning every machine and IT platform into IoT elements, and being able to retrieve data as well, acting as cognisant objects collaborating together for a common goal, realising in that way the highest degree of objects and platforms interoperation.
- RC1.7 - Responsive and Dynamic Visualisation and Augmented Reality Services for Business Functions. Intuitive and responsive visualisations and augmented reality methods applied to all business related functions and processes, to combine physical, digital and virtual characteristics of products and services and enterprise knowledge, for demonstrating spherical and inclusive information surrounding products, services and business processes as well towards offering a homogeneous experience to their users.
- RC1.8 - Proactive ICT-powered preventive workforce safety and security systems. Exploitation of sensor data, from the business environment and from wearable gadgets, and extraction of early detection signs on threatening conditions for the safety

and the security of employees, resulting in the provision of smart recommendations for active or passive prevention measures.

Grand Challenge 2: Innovative, web-based business models for new kinds of economies, exploring the definition, experimentation and constant evolution of novel business models that challenge traditional operating models, follow the paradigms of the Sharing Economy and the Circular Economy, and capitalize on novel technologies and Future Internet assets in business environments in order to introduce unique innovation propositions at multiple levels, ranging from the innermost configuration and the core offerings of an enterprise, to the customer-facing, networking elements of its business system (user experience). It encompasses the following research challenges:

- RC2.1 – Circular Supply Chain Management. Novel methods and platforms to bi-directionally manage the supply circle operations, to optimize a cycle of disassembly and reuse, to explore efficient recovery and treatment techniques and to create secondary marketplaces need to be developed in order to translate potentially circular products to attractive value propositions for enterprises and end-users.
- RC2.2 - Collaborative Prosumption Models. Applications of next generation technologies (from 3D printing to Wearable technologies and from Social Computing to Internet of Things) and the exploration of intersections between traditionally separate ways of working makes everyone an enterprise in a “peer-to-peer” fashion that eventually not only empowers multi-sided platform thinking, but also disrupts existing industries and creates new markets.
- RC2.3 – Collective Ideas Flow on ever-evolving and interactive Business Plan Lifecycles. Advanced modelling and simulation techniques to understand and simulate how the flow of ideas, that have been expressed internally or beyond the enterprise boundaries, affect the underlying business reality and performance in order to embed collective intelligence in business settings and to proceed with the necessary, ever-evolving adaptations of the adopted business model.
- RC2.4 – Instant, crowd market validation of Business Innovations. Through advanced enterprise gamification and social networking techniques, instant collaboration channels across the supply chain, involving users, suppliers and employees, shall be established, serving the purpose of instant validation of any potential business innovation on which an enterprise plans to invest.
- RC2.5 – Reverse engineering of innovation. With the help of next generation business modelling and simulation techniques, reverse engineering of a business model from its parts shall become feasible, assisting any stakeholder understand the business plan which is recommended to pursue for their offerings when they are trying to “copy” external innovations.
- RC2.6 –Innovation Diffusion & Adaptation Patterns and Techniques. Novel techniques to investigate the innovation patterns across markets in systemic ways, diffuse and adapt innovations beyond the geographic and organizational boundaries still need to be explored in order to assist a company or an entrepreneur to apply inverted /reverse innovation.

Grand Challenge 3: Distributed, Innovation-driven Enterprise Platforms, embodying a radically different context for business innovation and collaboration among organisations, where platforms promote collaboration among enterprises and web entrepreneurs, boost productivity and enable business innovation in consistent lifecycles; from invention to production, from supply chain management to ERP systems, and from customers' adoption to collaboration with internal business functions or external partners. It encompasses the following research challenges:

- RC3.1 - New forms of Enterprise Marketplaces. New forms of marketplaces allowing collaboration among organisations to develop solutions that meet business problems in better, more efficient ways using novel transaction methods and allowing community-driven validation and authentication in decentralised, distributed manners.
- RC3.2 - Real-time, Interoperability and Openness in Enterprise Platforms. Rendering existing enterprise systems available and connectable through common, secure, real-time enabled APIs, enabling trustful transactions among different organisations and offering standardised analytics, protecting at the same time the privacy of all sensitive data of the transaction parties.
- RC3.3 – Subscription Mechanisms to Real-time, Anonymised Business Analytics. Subscription mechanisms and interfaces to infuse real-time, anonymised analytics making them available to third parties, taking advantage of on the spot sensors, wearable devices, logging data and close-communication protocols in combination with mesh networking technologies, to collect and process data.
- RC3.4 – Innovative Project Management Platforms driven by Lean Paradigms and allowing Experimentation. Platforms providing tools, methodologies and management techniques in order to build experimenting frameworks and increase innovation rate, promote internal and external collaboration, and make use of interfaces with crowdsourcing platforms and linked-data to facilitate knowledge management and market research.
- RC3.5 – Independent Platforms for Inter-organisation Relationships and Trust in doing Business. Unstructured data analysis and KPIs evaluating the situation of an organisation, allowing financial situation identification, and building trustful relationships among different organisations, all powered by analytics to evaluate prospective markets, identify consumer patterns, and facilitate decision-making towards stronger synergies and business networks.
- RC3.6 – Recommendation systems in B2B transactions and partnerships deals. New generation recommendation systems, powered by real-time data, to provide useful recommendations to organisations about new B2B offerings, capable of improving their performance, facilitate operations and solve existing problems.

Grand Challenge 4: Dynamic discovery and negotiation of the intellectual property rights' flow, addressing effective management, monitoring, identification and creation of IPRs and knowledge generation and handling, through the use of innovative ICT tools and platforms that will exploit the collaborative features of existing platforms and the power of analytics. It encompasses the following challenges:

- RC4.1 - Open Repositories and Marketplaces for IPRs. Implementation of repositories that will accommodate the storage of and effective search amongst the various intangible assets, as well as of intangible assets' marketplaces incorporating specific models for access to enable innovation acceleration and defining novel IPR modelling methods.
- RC4.2 - IPR Recommendation and Governance Platforms. Next generation smart platforms for the efficient and effective recommendation and governance of IPRs, allowing discovery of IPR, relevant to a specific issue of interest, relevant recommendation mechanisms and automated reasoning of specific conflicts based on existing IPR schemes.
- RC4.3 – Traceability of IPR Licences across their derivatives. Coping with patent schemes and IPRs when developing a new product/service in the one side of the coin. An equally challenging task is to locate and identify the various patents and IPR contained in derivatives of products/services. This research challenge refers to the design and implementation of methods and mechanisms that will allow clear and effective recognition and traceability of all active patents and IPR contained in specific (series for) products/services in order to facilitate all stakeholders aiming either to use or exploit in entrepreneurial activities the aforementioned products/services.
- RC4.4 - Smart Platforms for Real-Time IPR Negotiation Real time. The structured ways of describing IPRs and the detailed modelling of them (see RC.3.1) is expected to not only facilitate the quick discovery and use of them, but constitutes a prerequisite for supporting negotiation activities between interested organisations that would like to access and use IPRs for any imaginable reason. Smart platforms should handle the negotiation of such IPRs in real-time, at execution time of transactions, cutting down negotiation costs and time, proposing alternative IPR schemes and pre-defined agreement contracts in order to satisfy the interest of all involved parties to the best possible extent.
- RC4.5 - Community-based Platforms for Shared IPR and Patents' Generation. Tapping the power, the dynamics and the wisdom of the crowd to achieve IPR and Patents' generation through open platforms allowing collaboratively conceptualising, describing, modelling and formalising new IPRs and Patents and offering them back to the community for adoption, standardisation and exploitation.

6 Conclusions and Next Steps

In the aftermath of the recent financial crisis and in light of the emergence of disruptive technological paradigms, how to conduct business in an ever-changing environment appears more challenging than ever. The surging app economy, manifested within a platform-oriented, mobile-driven and collaboration-rooted era, has already paved new paths for digital business innovation. Stimulating break-through innovation for added value products and services is in fact well acknowledged at research and policy level and embedded in the mind-sets of leading enterprises, successful entrepreneurs, and forward-looking researchers, yet recognised philosophies of doing business 'better'

(e.g. “Think Fast, Move Fast, Fail Fast, Learn Fast, Succeed Fast” [11]) are still not integrated in the strategies and approaches of many companies, especially in Europe.

In the present paper, a number of research challenges to be tackled in the years to come in order for enterprises to evolve towards new forms of enterprises have been elaborated. Next, iterative steps along our approach include: (a) further elaboration of the research challenges based on case studies along the Digital Business Innovation aspects and (b) recommendations on how to maintain a “live” roadmap, with contributions by any interested stakeholder.

Acknowledgments. This work has been partly funded by the European Commission through the Project FutureEnterprise: Road mapping, Research Coordination and Policy activities supporting Future Internet-based Enterprise Innovation (Grant Agreement No. 611948).

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