PII

Deliverable D1.4

Techno-Socio-Economic Analysis Report

Editors:	PhD Diana Chroneer, Logistics, Luleå university of technology PhD Jeaneth Johansson, Accounting and control, Luleå university of technology PhD Malin Malmström, Accounting and control, Luleå university of technology PhD Anna Ståhlbröst, Informatics, Luleå university of technology
Deliverable nature:	Report (R)
Dissemination level: (Confidentiality)	Restricted to other programme participants (PP)
Contractual delivery date:	M30
Actual delivery date:	M31
Suggested readers:	PII consortium and community, EC
Version:	1.0
Total number of pages:	84
Keywords:	Socio-techno-economics, business model, federation, testbeds

Abstract

The main purpose of this report is to explore the socio-techno-economic key factors and activities of relevance for the development of a sustainable testbed federation in Europe. In this process there is a need of incorporating a business model framework for enabling decision making in value creation and value capturing. This study shows that the federation has great opportunities to reach a broad market via the key partners networks. In this federation a span of testbeds are involved which provides a large knowledge and resource base. By being involved in the federation, partners and customers get access to a great variety of technical competences as well as testing resources for remote tests. Through the use of the resources offered in the federation, customers can build their own virtual testbed which makes it easier and cheaper for them to perform tests before their technology enters the market.

Disclaimer

Impressum

[Full project title] Pan-European Infrastructure Implementation

[Short project title] PII

[Number and title of work-package] WP1, General framework

[Document title] Techno-Socio-Economic Analysis Report

[Editor] Diana Chroneer, Jeaneth Johansson, Malin Malmström, Anna Ståhlbröst, Michael Nilsson

[Estimation of PM spent on the Deliverable] 18

Executive summary

The main purpose of this deliverable is to explore the socio-techno-economic key factors as well as the activities that are relevant to develop a sustainable European testbed federation. To gain deep insights into these aspects there is a need to incorporate a business model framework to support decision making in value creation and value capturing in the Panlab network. By this mean, a long term perspective to accomplish sustainable testbed service businesses can be achieved. To gain a holistic analysis of the Panlab business model framework potential end-users (or test-pilots) needs and expectations are explored.

The innovation context of the federation can be described as "open". The partners cooperate in a network in order to together develop a platform for future businesses with a focus on creating a mutual business around testbed technology. In this context, the innovation process can be characterized as being technology-driven with a main focus on developing advanced technology where the actors has successfully been involved in the pre-commercialization phase of developing test-beds possibilities. However, in order to reach the pre-commercialization phase a diversity of competences needs to be involved in the creation of a federation to develop the offerings, find market segments and take the product to the market.

In the analysis reported on in this deliverable, is has been found that when dealing with technical innovations it is important to involve all stakeholders to increase the potential for market success. It is therefore of vital importance for the federation of testbeds to involve both their presumptive users as well as their customers to understand their needs as well as the social impact the innovations that are being tested in the testbeds might have. Having a social perspective in the federation, means both to include the customers of the testbed federation's resources in the process of developing the Panlab offering, and also to include the potential end-users of the technology being tested. User involvement in the federation is therefore two folded, it can be a strategy for developing the testbed's (and federations) offers by involving users in its development, and second it can be a service that can be offered to the customers of the federation where the federation take the responsibility to involve users in their customer's technology development process. Important to note here is the complexity of involving end-users in the development of the testbed technology since it requires high technological skills from the end-users. The maturity of the technology also influences end-users possibilities to contribute to the development of the technology where immature technology is more likely to render user feedback.

Developing technology and involving user are however not enough to create a sustainable federation of testbeds, it is also important to develop a sustainable business model for the federation. Business models can help to stimulate businesses and to learn about them; hence, it is a way of doing risk free experiments without endangering an organization. Hence, it is not only the technological advance itself that brings value in a business, it is rather the innovative composition of different aspects into unique offerings that create values for the customers. Business models can briefly be defined as a description of the company's core architecture and how it deploys relevant resources to create value in the marketplace. In this report the business model is viewed as a "puzzle" with nine building blocks: value proposition (VP), customer segment (CS), distribution channels (CH), customer relationships (CR), key resources (KR), key activities (KA), key partnerships (KP), revenue streams (R$) and cost structure (C$), upon which the analysis of the federation in this report rests. Linked to these blocks, specific questions need to be answered in the business model development process. PII federation's business model has a business model focusing on customers within the academia (customer segment). This business model is under development and has a well-defined infrastructure consisting of key partners within the federation, key resources (technological competence) and key activities (technology innovation). Resources that can be developed in the business model design are within user-driven innovation and business competences. These resources are of importance in order to build suitable relationships and channels to other types of customer and increase the business potential in the future.

The testbed market is characterised as immature and as to be in an early phase, and the testbed services in the PII project is struggling in the forefront of a fuzzy front end of innovation. Reaching

from the fuzzy front end to the commercialisation phase take at least (in the best case) five years. The development of a testbed federation is in many aspects similar to the creation process of new ventures hence, the early process of developing the ideas is in many ways technique driven where the technical competence of the partners are decisive for the generation of new ideas. The socio-techno-economic analyses indicate the main part of discussions performed in the project to a high extent consider the mere technical aspects of the project. The technology constitutes the platform of the project and it is of high importance to focus on such aspects. However, the business aspect is also highly relevant for possibilities of bringing the testbed services to the market.

The testbed services associated with the PII project is at present moving from Phase 2 to Phase 3 where distinct actions are needed to take place. Real customers need to be finds for development of attractive services that fill a function and help customer to develop their competitive advantages. The PII-webpage needs to be further developed and also show that "happy" customers are reached and that attractive offerings are available. Offerings can in this phase be directly designed and adjusted to the particular customers needs. Individual prices may be set depending on the nature of the particular "order" and this price could be set together with the particular partners involved in the specific "order". Businesses need not to be open for all partners. A service fee for covering costs connected to the needs PII-office need to be decided on. This may be a temporary fee used in the present Phase 3 and may be revised in Phase 4. The work in Phase 3 is critical for reaching the goals in the PII-project and is taking place during fall 2010. A first preliminary business model is in this phase designed and organized. The federation is at the end of the PII-project standing in front of a situation with a highly restricted customer base, high uncertainties connected to the revenue model and also limited businesses; the federation is still not self-financed. Adding to this, Phase 4 is a capital (resource) intensive phase that includes activities such as development of market strategies, broader market actions for accomplishing growth, and also design and organization of a full Panlab federation business model.

The Panlab federation is at the end of the PII-project standing in-between Phase 3 and 4 are thus also standing in front of the classical 2nd financial gap, called the second Death Valley. There is currently no developed market for testbed services, the market is under development. Customers are generally not yet willing to pay for services. Hence, communicating the value of testing as well as building relations with different customer segments by using a diversity of distribution channels are of vital importance in the future development of sustainable testbeds.

List of authors

Company	Author
LTU-CDT	PhD Jeaneth Johansson, Accounting and control, Luleå university of technology
LTU-CDT	PhD Diana Chronéer, Logistics, Luleå university of technology
LTU-CDT	PhD Malin Malmström, Accounting and control, Luleå university of technology
LTU-CDT	PhD Anna Ståhlbröst, Informatics, Luleå university of technology
LTU-CDT	Michael Nilsson, CDT, Luleå university of technology

Table of Contents

List of Figures

List of tables

1 Introduction to the socio-techno-economic analyses

The main purpose with the present report is to explore on socio-techno-economic key factors and activities of relevance for the development of a sustainable European testbed federation. We argue for the need of incorporating a business model framework for enabling decision making in value creation and value capturing in the Panlab value network and through this in a long term perspective accomplish sustainable testbed service businesses. The business model framework enables identification and analyses of relationship between key factors and activities. Specifically stakeholders perceived benefits and challenges of the federation are identified longitudinal throughout the project. Further, for enabling a holistic analysis of the business model framework of the Panlab federation end-users needs and expectations are explored. The findings of the socio-techno-economic analyses contribute to an increased awareness of activities and resources needed for further development towards generating business potentials. Further, this report provides implications for developing short term and long term value creation and capturing.

The techno-socio-economic-analyses are executed by LTU-CDT team (see biographical notes below). The role of the LTU-CDT team was to be an independent partner, carrying out independent observations in the project. The collection of information for the analysis has been directly supported by the core cluster co-ordinators (DIMES, EICT, MN and ISI) but also by other participating partners. The independent socio-techno-economic analyses aimed to continuously and carefully monitor the project management team in order to take corrective action. Feedback from analyses carried out were continuously linked-in to the project for guiding the project process e.g. for raising awareness of processes and through this enabling adjustments in the project.

The following outline applied in the present report is as follows; Section 1 includes an introduction to the socio-techno-economic analyses and Section 2 a presentation on the framework for the socio-techno-economic analyses. In Section 3 the applied methods are presented followed by reflections on the business model process in Section 4. Results and analyses are presented in Section 5. More specifically we address issues of competence management, stakeholders, key activities and processes, dominating norms and values in the social-context and environmental constraints in terms of e.g. market maturity. The final section includes implications and conclusions – towards a sustainable testbed federation.

2 Framework for the Socio-Techno-Economic analysis

2.1 Sustainable business development in open innovation

This chapter provides a theoretical framework for exploration of sustainable business development in open innovation context. More specifically we explore on, the socio-, techno- and economical aspects as private public partnerships and collaborations, decision making in business development, business model development, user involvement.

2.1.1 Private public partnerships and collaborations

Researchers and practitioners concordantly recommend that, to reduce the risks of failure and target resource spending more precisely, companies must align their key innovation and new product development (NPD) activities with actual and potential customer (Campbell & Cooper, 1999; Butscher & Larker, 2000; Gruner & Homburg, 2000; Kärkkäinen *et al*, 2001). This need to integrate customers into the innovation process was discussed to a great extent in the 1980s but gained new recognition during the shift to a new innovation paradigm: open innovation (Chesbrough, 2003). To have an open innovation process also enhances a companies' ability to respond quickly to changes in both the environment and the customers' needs (Chronéer, Bergvall-Kåreborn, Ek-Styvén, Engström, Johansson & Malmstrom, 2009).

Being innovative has become critical for today's organizations and the organizations that fail to innovate will eventually go out of business. Hence, the question is not so much about why innovations are important, but rather how innovation can be achieved (Bessant & Tidd 2007). Traditionally, innovation processes has been a closed process where firms hold on to the philosophy that successful innovation requires control and that innovations are best accomplished within the walls of the firm (Chesbrough 2003). Following this line of thought, companies need to generate all their innovative ideas themselves, and for many years, this model has been considered to be the right way to bring ideas to market (Chesbrough, 2006; Chesbrough & Appleyard 2007). However, towards the end of 20th century a number of factors, such as the mobility of knowledge workers started to erode the closed innovation approach. Adding to that, the closed approach to innovation with large R&D departments has become more expensive and its return on investments is decreasing due to e.g. escalating competition in product markets and shorter product life cycles. The growth of these factors have contributed to the emergence of the open innovation approach (Vanhaverbeke, Van de Vrande, & Chesbrough 2008).

The partners within the Panlab federation are characterized as conducting technology-driven innovation in an open innovation environment, briefly described below. That is, several partners have come together in a mutual project with the aim to develop testbed technology and thus create a platform for future testbed businesses.

2.1.2 Open innovation – techno analysis

The term open innovation was first coined by Henry Chesbrough in the beginning of 2000s. Chesbrough defines open innovation as a paradigm that assumes that firms can, and should, use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology (Davis 2006). Several factors have led to a change of the view of innovation and the "erosion" of closed innovation (Chesbrough, 2003). First of all, the mobility and availability of highly educated people has increased over the years. As a result, large amounts of knowledge exist outside the boundaries of the research centres of large companies. In addition to that, when employees leave their jobs, they take their knowledge with them, resulting in knowledge flows between firms. Second, the availability of venture capital has increased significantly recent years, which makes it possible for good and promising ideas and technologies to be further developed outside the firm's boundary, for instance in the form entrepreneurial firms. Besides, the possibilities to further develop ideas and technologies outside the firm, for instance in the form of spin-offs or through licensing agreements, are growing. Finally, other companies in the supply chain, for instance suppliers, play an increasingly important role in the innovation process.

However, the concept of Open Innovation does not signify an altogether new phenomenon (Christensen *et al*., 2005). Christensen *et al.* (2005) point out the concept of absorptive capacity which address the particular competence that companies build in R&D, not only for managing internal innovation but also for being able to access and absorb external ideas, science and other kinds of knowledge inputs to innovation (Cohen & Levinthal, 1990). Von Hippel (1986) among others, have also addressed the "openness" as the interactive, cross-disciplinary and inter-organizational nature of innovative learning. Christensen *et al*. (2005) emphasize that "Open Innovation" is more a comprehensive and systematic study of the "internal" corporate modes of managing such more externally oriented processes of innovation, from an introvert and proprietary to an extrovert and open paradigm. A critical element in creating a business model is to identify the two goals of the value chain: to create value throughout the chain and to allow the firm to claim a sufficient portion of the value to sustain its position in that system.

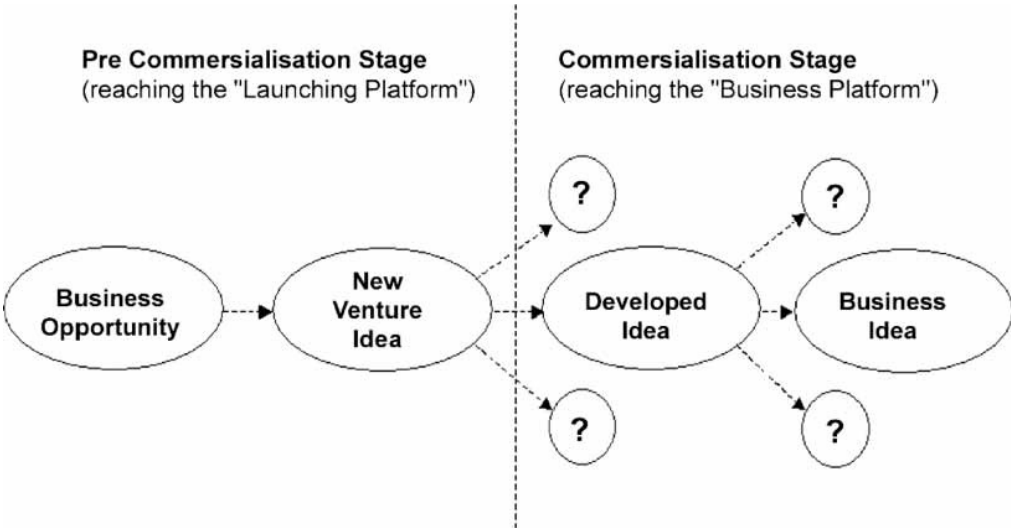
Even if the position in the innovation system and the stage of the technology provides an indicator of the scope and limits of innovation strategies open to different firms, the specific timing and framing of the innovation strategy, including the level of openness and the choice of complementary partners, is far from fully pre-empted by the initial structural position of the firms. Indeed, most successful innovation strategies entail not only firm-specific inputs of technical and managerial skills, a good analysis of the innovative opportunities and the competitive and cooperative context and an entrepreneurial vision. Christensen *et al.* (2005) point out that trying to understand the global innovation system, the nature and stage of the technological regime, and the particular coordination requirements, are necessary preconditions for devising and effective innovation strategy, including its level and mode of openness vis-à-vis complementary partners.

It is important to recognize that open models are not a panacea. Companies need to carefully evaluate the culture of their prospective partners to ensure that they can work together effectively over time. They need also to be prepared to invest the time to ensure that any contractual agreements are well considered and that they are fair to all parties. Further, they need to consider potential competitive implications of their own business in their network.

2.1.3 Market-pull vs. technology push

There are two general approaches to innovation: market-pull and technology push. Within the market-pull approach, the market is the main source of innovation, and new product development is a direct consequence of explicit needs expressed by the consumers. A primary assumption of this approach is that user needs are explicit elements that can be identified, captured and translated into new products that satisfy those needs (Dell'Era, Marchesi & Verganti, 2010). On the contrary, the technology-push approach looks at the innovation process from a completely different perspective. Rather than being driven by the market, innovation stems from a founder, or a company's research and development activities that, through the identification and development of new technologies. In this case, the idea can appear to be a random process (from the founder), and the specific development process can be quickly completed. But the processes of idea generation and the development work can hide several years of research and other work that makes a discovery possible (Klofsten, 2005).

Market drivers become relevant for incremental innovation, where incremental adaptations of product meanings are determined by the continuous and natural evolution of explicit 'cultural models' adopted by customers. However market factors lose importance in radical innovations, where innovations originate from new 'cultural scenarios'. In the technology-push approach the availability of new technical opportunities is the key driver in the innovation process (Dell'Era, Marchesi & Verganti, 2010). Also, the early process of ideas development is in many respects technique driven, where the technical skills of the founders are decisive for the new idea to be developed. For technology driven project, the process of ideas development does not really proceeds until the founders become more receptive to the world around them and involve external partners in the process (Klofsten, 2005). In order to reach a potential market and to build a called business platform for the commercialization process, one central actor is the potential client who becomes involved in the development work. in this commercialization process, it is important to incorporate other type of competence in the development process if the skills base of the founders concerning market knowledge and technical competence is limited.



Figure

Figure 1 The idea development process (Klofsten, 2005)

Klofsten (2005) describes in figure 1 the idea development from business opportunity to business idea. The basic thought is that the development of new businesses could be divided in two different stages: a pre-commercialization stage and a commercialization stage. In the first stage there is need to reach a so called 'Launching Platform', that is to develop an opportunity for the idea to be developed into a new venture. Resources need to be found and allocated to the idea development process so that it hence can be developed to a potential business idea. If this is successful the idea will enter the commercialization stage where an important step is to attain a **business platform.** This is a stage where the venture has managed to get through the critical early development process and is less vulnerable and is able to survive on its own power (Klofsten, 2005). Further, in order to enter the commercialization phase, other types of competences are needed, e.g. market skills and business competences

But to what degree the idea is anchored in the market can be more or less high. A high degree of anchorage (pull) means that the idea is close to satisfying the needs of one of the development partners (for example those of a customer) and that there is some commercial interest for the idea (Klofsten, 2005). To push an idea—that is to try to push it out on the market—requires more time-consuming and resource-demanding efforts. An idea with a high degree of pull could also be closely associated with the business opportunity level. The most advantageous situation for ideas development, seen from a short-term perspective, is naturally the combination of a high degree of concretization and pull of an idea (Klofsten, 2005).

The different perspectives of a firm to innovation can change as the firm matures (Utterback, 1996). Therefore, it is important to understand the type of innovation the firm is involved with, i.e. understand the factors that determine innovation (Love & Roper, 1999; Tatikonda & Stock, 2003) and the success of that innovation (Van der Panne *et al.,* 2003). The concept of product innovation is complex. It may even embody other innovation types, such as technological and process (Salavou, 2004). To understand the process of innovation, it is essential to understand its determinants. (Chronéer & Bergquist, forthcoming; Chronéer and Laurell-Stenlund, 2005)

2.1.4 Determinants of innovation

What determines innovation and therefore product development? Tatikonda and Stock (2003) identify the process of product technology transfer as a key activity in the process of new product development. This is similar to Love and Roper (1999), who widen the determinants of innovation beyond R&D to include technology transfer and networking effects. Salavou (2004) suggests a shift in emphasis from organisational to product innovativeness, i.e. a shift from the general question of 'what factors influence a firm's tendency to innovate" to 'what factors affect the innovativeness of a new product'. Rogers (2004) shows that evidence of persistence in innovative activities and the use of networks is associated with innovation in some sector-firm size categories. Specifically, small

manufacturing firms exhibit a positive association between networking and innovation. However, discussing product success is not enough. Learning to understand what makes firms fail with innovation might also be needed. Commitment from top management is critical to new product success.

There are other determinants of innovation. Calderini and Cantamessa (1997) show that exogenous determinants, i.e. computer-aided technologies, design methodologies and organisational structures, interact complexly and adapt themselves to a changing competitive environment.

Research exists stating that product development must be driven primarily by the needs of the customers rather than by technological possibilities (Butscher & Laker, 2000). Understanding market and customer needs is one of the keys to successful innovation (Roberts, 1999). According to Kok *et al.* (2003), market-oriented product development may be regarded as an organisational learning capability that encapsulates knowledge and skills, and as technical and management systems that enable learning about markets through information processing. However, Cooper (1999) found a strong market orientation and customer focus to be lacking in the new product projects of many.

For technology-based firms that rely on their technology for the ability to compete, a technology strategy comprises the definition, development and use of those technological competencies that constitute their competitive advantage. That is, as Dodgson (2000) states, competencies consisting of two elements, namely the resources currently available to a firm, and the innovative capabilities the firm possesses to define and change those resources. To summarise, technology strategy is an important aspect to "chart the way" for a business (Cooper, 2000; Chronéer, Johansson & Perzon, 2009).

Harmsen *et al. (*2000) declare that for a general overview, it seems reasonable to say that there have been two major views of innovation over the years. They argue that a company's innovation is greatly driven by its orientation, i.e. product orientation, process orientation, or market orientation. The competences directly related to the orientation, i.e. market competencies for market orientation, product competencies for product orientation, and process competencies for process orientation, will be the most central or core competencies of that company.

2.1.5 The Panlab federation open innovation context

The innovation context of the federation can be described as "open". The partners cooperate in a network in order to together develop a platform for future businesses with a focus on creating a mutual business around testbed technology. The innovation process can be characterized as being technology-driven with a main focus on technical competencies where the actors has successfully been involved in the pre-commercialization phase of developing test-beds possibilities. However, in order to reach the commercialization phase, that of creating a business platform, other types of competences are needed that can develop the offerings, find market segments and take the product to the market. Since the actors involved in the Panlab federation mainly are engineers and researchers, the federation need to acquire market and business competence elsewhere, that is to incorporate new external partners that have business skills linked to the ICT sector.

2.2 User involvement – Socio analysis

2.2.1 Stakeholders

When dealing with technical innovations it is important to involve the stakeholders to increase the potential for market success. It is therefore of vital importance for the federation of testbeds to involve both their presumptive users as well as their customers to understand their needs as well as the social impact the innovations that are being tested in the testbeds might have. Hence, the users of the intended technology need to be involved and encouraged to participate in the development of Future Internet technologies. Taking that perspective, the concept of open and user-driven innovation becomes an important part of the innovation process, both for presumptive customers of the testbed federation, but also for the end-users of the product being tested within the tested. Thus, having a social perspective means both to include the customers of the testbed federation's resources in the process of developing the Panlab offering, and also to include the potential end-users of the

technology being tested. User involvement in the federation is therefore two folded, one as a strategy for developing the testbeds (and federations) offers, and second to be offered as a service from the federation. In the following section a theoretical argumentation of whom to involve and why users (including both testbed customers and end-users) should be involved in the federation's processes is presented.

2.2.2 Open Innovation and Users

When the aim of a study is to understand users' needs, the motivation for involving users in the process is obvious and to really harvest the potentials user involvement holds, it is important to know whom to involve, when to involve them, and how to involve them.

Through the years, users have been defined in many different ways and the most apparent definition is that *users* are those who interact directly with the product to achieve a task (Sharp, Rogers, & Preece 2007), but there are other definitions of users as well. For example, Eason (1987), has categorized users in three categories; (1) *primary users* as those likely to be frequent hands-on users of the system, (2) *secondary users* as those who use the system through an intermediary, and (3) *tertiary users* as those affected by the introduction of the system or who will influence its purchase. Another kind of user that is important to understand in design processes is the *non-user* (Selwyn, 2003). These are defined as those who actively choose to completely, or partly, limit the use and amount of digital artefacts in their homes and private-life's. Important to note here is the norm where adoption and use of digital artefacts has been ruling for several years in user involvement research (Nyberg, 2008). However, to involve non-users in the user studies mean that the sensitivity against the notion of use and non-use increases and so does its meaning. However, the boundary for what is defined as use and non-use has not been settled.

Other concepts related to users is the *customer* and *consumer.* A *customer* is the person who is paying for the product, not necessarily meaning that the product will be used by that person, and a *consumer* is the person who both pays and uses the product. In the on-line world, especially in e-commerce, the consumer concept can be divided into two types, the *individual consumer* who are given most attention in media, and the *organizational consumer* who do most of the actual shopping (Turban & King 2003). In the context of the federated testbeds, users can be divided into customers of the federation and end-users. Here customers refer to those who is paying for the federation services and end-users are those who would use the technology, that is the primary users.

2.3 Reasons for User Involvement in the Federation's Innovation Processes

There are many reasons for why users could or should be involved in organisation's innovation processes such as the benefit of their innovativeness, the importance of having a diversity of perspectives on new products and services or to strengthen the users' competencies and commitment. However, whatever the reasons are for involving users it is vital to develop the organisational structures that support the process of user driven innovation, and it is important to give innovative users ways to combine and leverage their efforts since innovation by users tends to be distributed rather than concentrated among a few innovative users (von Hippel, 2005). Hence, to fully harvest the potential of future internet services, user involvement is important. As in any other development process, users' needs, requirements, ambitions, and hopes have to be generated, discussed, developed, elucidated, and probably re-scoped in order to develop an IT system that users will enjoy using. This refers both to the customers of the testbed federation as well as the potential end-users of the tested services.

The value of involving users in the development process of future internet services comes in many forms. For instance, has several studies shown that user involvement leads to innovative ideas (Kristensson *et al.* 2002). Research on user innovations has also shown that some of the most lucrative and novel innovations have been developed by users with the aim to adapt existing product to fit their needs more appropriately (Hyysalo, 2003; Bergvall-Kåreborn & Ståhlbröst, 2008; Bergvall-Kåreborn & Ståhlbröst, 2009). Hence, many commercially attractive products that is in the fore-front come from user innovations (Desouza *et al.*, 2008; von Hippel, 1998). In addition, the amount of ideas users

render as well as the heights of the innovative ideas are greater than those rendered only by developers (Di Gangi & Wasko, 2009). Research on user innovations has also shown that some of the most lucrative and novel innovations have been developed by users with the aim to adapt existing product to fit their needs more appropriately (Hyysalo, 2003; Bergvall-Kåreborn & Ståhlbröst, 2008; Bergvall-Kåreborn & Ståhlbröst, 2009).

Involving users as co-creators during New Product Development (NPD) produces ideas that are more creative, more highly valued by customers, and more easily implemented. Further, user involvement is useful for capturing latent needs of consumers that are so important to successful NPD. Kristensson *et al*. (2002) derive two interesting results from their study:

1. Users generate ideas that are more original than the ones generated by the company.
2. Users generally assess innovative ideas different from the company.

They also emphasize that user involvement in service innovation can contribute to the creativity in the service ideas produced. In respect of the development of new services then, managerial implication of this study suggests that business organizations, attempting to produce innovative and successful products, have a hidden resource in their customers. Hence, involving relevant stakeholders such as customer and users, in the development of the testbed federation increases the potential of market success.

Table 1 User-Driven Innovation vs. Traditional User Innovation Approaches (Desouza *et al.* 2008)

	User-Driven Innovation	***User co-creating Innovation***	***User-Centred Innovation***
Central entity	User/Customer	User and organisation	Organisation
Degree of user involvement	Innovation by user	Innovation with user	Innovation for user
Role of organisation	Coordinator	Communicator	Innovator
Type of innovation	Dynamic innovation	Open innovation	Closed innovation
Degree of control	Impossible to control	Difficult to control	Easy to control
Degree of coordination	Emergent coordination	Difficult to coordinate	Easy to coordinate

This means that depending on which user innovation, or involvement, approach that is implemented in the organisation, different business models are required to fully harvest the opportunities the innovation approach offers. For the Panlab federation, it might be a too big task to accomplish user driven innovation as a first step of user involvement. Instead the aim could be to start involving users in the process by communicating with them and by involving them in their development processes. Hence, when the aim is to really involve users in the development of future technologies, the term user-driven innovation becomes a central point in future internet research and technology development processes. Users can be involved in development and innovation processes in different ways. Some user innovation approaches are; innovation *for* users (user centred innovation), innovation *with* users (user co-creation) and innovation *by* users (user driven innovation). The user *driven* innovation is fundamentally different from traditional user innovation approaches, see table below (Desouza *et al*., 2008). In these traditional approaches, innovation is usually developed for the users with information about their needs or by involving users in the process to get information about their needs and requirements. In the table, it is showed that applying a user driven innovation approach influences many aspects in an organisation. For example the organisation's strategy in terms of, for example, control and role (Desouza *et al.,* 2008). Hence, it is important to be aware of, and to consider, these aspects when an alternate user innovation approach is sought.

2.3.1 Innovator Characteristics and Influential Factors

It is not always easy to identify which users that is most appropriate to involve in the innovation process either since different users can contribute with different things. However, when the aim is to involve users as innovators there are some characteristics which should be given special attention (Lüthje 2004; Lüthje, Herstatt, & von Hippel 2005). Users can be expected to innovate when they have expertise, are involved in product related activities (e.g. use Linux), or are in a leading use position in the market. Another thing influencing their willingness to innovate is the level of expected benefit together with their commitment to the product. If the level of expected benefit is high, the users become more willing to innovate (Lüthje *et al.*, 2005). This is also important to understand for the federation members, who is actually the users and what would their incentives to participate in the federation's innovation processes be, or who might the end-users be that can provide valuable input to tests of future internet services?

The activity level of user innovation is, over time, influenced by four factors; technology complexity, technology maturity, customer satisfaction and innovation barriers (Raasch, Herstatt, & Lock 2008). Firstly, it has been found that the technical complexity influence users' innovation activities, but it does not put it to an end, it rather moves into other areas instead. This means that when the technology is too complex, the users' possibility to actually contribute to the development and innovation process becomes smaller. Secondly, when the level of technological maturity is low, the user innovation activities are high and the reason for this is quite clear, when a new technology expands the possible design space of techniques that can be mined for improvements, the chances of users to come up with successful modifications are comparatively high. The effort from innovative users is also expected to decline or alter over time as the expected modifications will not go beyond the user's perceived value in terms of time, effort and expense. Hence, the users reallocate their activities to areas where the expected return on their efforts is higher. Thirdly, the level of customer's satisfaction with products change over time, this implies that also users willingness to innovation alter in relation to their satisfaction. Finally, barriers to innovation can be restrictions in the design (Raasch *et al.,* 2008), patents and strength of IP rights (Braun & Herstatt 2008). However, opening up parts of companies platforms can have benefits in terms of improving their organisation's image, strengthen the popularity of the offered products and from a long-term perspective, increase market share and profit (Braun & Herstatt, 2008).

2.3.2 Influential Factors and the Federation

When relating the four influential factors mentioned previously (technology complexity, technology maturity, customer satisfaction and innovation barriers) it can be concluded that there are several things that needs to be clarified and discussed within the federation. Firstly, the technical complexity of the technology being offered to the future internet customers and their users is rather high; hence it is difficult for users to actually contribute with innovative ideas. This either mean that the users that should be involved in the test and development processes should have high technical competence, or the tasks where users are involved and expected to innovate are focused on tasks with low technical complexity such as designing conceptual ideas for innovation, giving input on design of user interface or the functionality of applications. When it comes to the second factor, the level of technological maturity, this provides great opportunities for user innovation since the future internet technologies are rather immature in its current state. However, it is still important to keep in mind that it is important that the users needs to have a rather high level of technical competence to be able to contribute within this context. The third factor is focused on user satisfaction; here users can be involved based on their current satisfaction of internet services, however relating it to the federation is seem more reasonable that the users involved here are the customers of the federation or its potential customers, not the end-users of the services. Our argumentation for this is that the end-users in general have little to contribute with when it comes to Internet technologies since most people are reasonably satisfied with it. However, those involved in developing future internet technologies such as the potential customers have the necessary competence and insights to contribute in this context. Finally, the barriers to innovation such as the design of the both the federation and its tools as well as the patents and IP rights is also important to handle in the federation. Here written agreements with the clients are planned via the Panlab office. Hence, it is also important that the users (both customers and end-users)

are informed about their commitments in the federation as well as the federation's role. These are all aspects that are handled in by the Panlab office.

2.3.3 The lead-user theory

Franke *et al*. (2009) test and confirm the basic tenets of leader-user theory. These authors also found that the three components: being ahead of the trend, having high levels of need, and actual development of innovations, were significantly correlated throughout their sample. Their findings suggest that the variables that will be most effective for identifying commercially attractive user innovation will differ depending on study condition and goals. But the goal of identifying as many user-developed innovation as possible independent of commercial promise can be achieved by adding resource-related variables (technical expertise, community-based resources) with regard to users' technical expertise and availability of support from a user-community to the two lead-user components (high benefit expected, ahead of trend). That is, there is a need of different strategies depending on the goal the company has for involving users. If the aim is to efficiently identify attractive user ideas from an unknown population, all four criteria might be employed at once: the two lead-user components as well as both resource-related variables technical expertise and community-based resources.

But, user innovation communities are not a new phenomenon. It existed long before the advent of open-source software and has extended far beyond it (von Hippel, 2001). But it is a changeable phenomenon in new contexts. Innovation communities composed of users and for users, communities that according to traditional economic views should not exist, work well enough to create and sustain complex innovations without any manufacturer involvement.

When does customer innovation make sense? There are three major signs that can help you identify if you industry may soon migrate to a customers-as-innovators approach (Thomke & von Hippel, 2002):

1. Your market segments are shrinking, and customers are increasingly asking for customized products. As you try to respond to those demands, tour costs increase, and it is difficult to pass those costs on to customers.
2. You and your customers need much iteration before you find a solution. Some customers complain that you have gotten the product wrong or that you are responding too slowly. You are tempted to restrict the degree to which your products can be customized, and your smaller customers must make do with standard products or find a better solution elsewhere. As a result, customer loyalty starts to erode.
3. You or your competitors use high-quality computer-based simulation and rapid-prototyping tools internally to develop new products. You also have computer-adjustable production processes that can manufacture custom products.

2.4 Business Model development – Economic analysis

Why it is there a focus on business models today? There are several socio-economic impact and implications of applying open business model as an answer to today's societal challenges. This newly identified trend is particularly significant in the evolution of the service industry innovation (Nedimovic, 2009).

In general, Europe has a need of new innovative ideas and methods that will effectively address the societal challenges such as sustainability, healthcare, transport and travel, and the aging population. Open innovation is a way to bring remarkable contribution to the economic and social welfare. There is a shift from industry to services: service sector accounts for more than 70% of the total economic value added in th EURapid development of ICT (Nedimovic, 2009). Further, the shift from product to service: the apparent trend is the transformation in the business models to embrace the service economy – new service-oriented businesses. The proposed definition of open innovation in services grasps three important elements, notably extensive networking, user-centricity in the innovation process, and the provision of open service platforms by the service providers, that give a glimpse into the future of the innovation process and the provision of services (Nedimovic, 2009).

The purpose to open up the innovation process and utilizing users in the innovation process will require other means to do business, which will require new business models. Chesbrough (2007)

emphasizes that when building a new business model, companies must figure out what to do with their existing model. Developing a new business model can inadvertently suggest that the current one is somehow obsolete. Managing the coexistence of a new business model alongside an existing one can be difficult.

2.4.1 Why business model development?

The early authors have mainly written about the classifications of models in different categories, by contrast the latest literature has started decomposing business models into their "atomic" elements. Literature concerning business model emphasises that 'business models' can help to stimulate businesses and learn about them. Is a way of doing risk free experiments without endangering an organization" (Sterman, 2000). However, it is not the technological advance itself that brings value in a business. It is rather how they can complement each other to unique offerings (Mitchell & Coles, 2003).

Companies are always in a search for tools and methods that can assist them in calculating the value of having an open innovation process and involving user in the innovation. Chesbrough and Appleyard (2007) mean that open initiatives may allow for the creation of whole new complementary links in a value chain. They propose a strategic perspective that needs to be confronted; whether and when the costs of openness exceed the benefits of openness. Can there be such thing as too much openness? While more openness is always better in the enthusiasts' accounts of open initiatives, other academic research has found costs, as well as benefits, to developing and maintaining communities and networks. Open strategy balances the powerful value creation forces that can be found in creative individuals, innovation communities, and collaboration initiatives with the need to capture value in order to sustain continued participation and support of those initiatives. Traditional concepts of business strategy either underestimate the value of open invention and open coordination, or they ignore them complete (Chronéer & Mirijamdotter, 2009; Chronéer, 2006).

Users have proven to be a principal driving force of many innovations in different industries (Raasch *et al*., 2008). Therefore, more and more companies try to identify avenues to systematically involve users into their new product development. Lately, there has been a growing interest in user-driven or user-centred innovation, both in academia and industry, and about the drivers and impediments affecting the evolvement of user innovation activities over time. Raasch *et al.* (2008) examine user innovation over time and contribute to the extension of the existing model of user-driven innovation to a more dynamic setting. They found that the level of user activity does not follow a unidirectional trend, but rather develops depending on a number of contextual factors. This suggests that, given a stimulating setting, user innovation can be sustained over long periods of time. They propose that the activity level of user innovators at any point in time is affected simultaneously by five factors; technology complexity, technology maturity, market concentration, customer satisfaction, innovation barriers. These factors may jointly produce the cyclical pattern of innovative activity and progress.

2.4.2 Business model design

To have a more open view on innovation means that within the company a shift should take place in the way people look at the company and its environment. Involving other parties when developing new products and technologies can be of great added value, for instance cooperation with other firms in your own sector, suppliers, universities, and of course with end-users. Here, the business model plays a crucial role. How and when external knowledge is required and used is to a large extent determined by the companies' business model which describes how value can be created from innovations and which elements have to be sourced internally or externally (Chesbrough, 2003).

A traditional view of the purpose of business models is to develop pure cost and revenue streams (Mullins & Komisar 2009), which is the financial component in the business model. However, other components need to be integrated in the business logic for capturing full potential out of user driven innovation. The business model design can be visualized through four commonly used main components 1) the product and services that the firm offers (the value proposition), 2) the relationship capital the firm creates and maintain with the customers (the customer relationship) 3) The infrastructure and network of partners that are necessary to create value and to maintain a good

customer relationship (the infrastructure management), and finally 4) the financial aspect such as cost and revenue structures (Dubosson-Torbay, Osterwalder & Pigneur 2002). Open innovation typically imply a context where customers play a critical role in the creation of the product/service and thus also have a critical part in the creation of socio- techno- as well as economic values visualized through the business model design (Chesbrough, 2003). The business model logic aims to describe the important challenge of how values are created and captured together with different stakeholders such as customers/users and other partners in business networks. Therefore, it becomes vital for organisations to implement a flexible approach in using a diverse set of business models to facilitate the open innovation approach (Chesbrough, 2003).

2.4.3 Business model definition

Business models can be defined briefly as a description of the company's core architecture and how it deploys relevant resources to create value in the marketplace (Chesbrough & Rosenbloom, 2002). However, there is no consensus regarding the definition, nature, structure, and evolution of business models (Morris, *et al.,* 2005). In recent years, business models are considered dynamic and complex and emphasizes components rather than specific models or typologies (Osterwalder, Pigneur & Tucci, 2005), as this provides a better method of understanding how and where value is created and captured (Chesbrough, 2006). Several recent studies have synthesized previous work in the area of business model components. Based on such a synthesis, Morris *et al.* (2005) propose a framework for characterizing a business model that includes factors related to the offering, market factors, internal strategy factors, competitive strategy factors, economic factors, and personal/investor factors. According to Morris et al., their framework is not industry specific and could thus be used to design, describe, categorize, critique, and analyze a business model for any company.

Osterwalder *et al*. (2005), who propose a framework of four dimensions (pillars) based on a review of the literature on business models, which are divided into nine "building blocks": Value Proposition, Target Customer, Distribution Channel, Relationship, Value Configuration, Core Competency, Partner Network, Cost Structure, and Revenue Model (see figure 2). Chesbrough and Rosenbloom (2002) observe that a business model essentially performs two key functions: creating and capturing value. They suggest six functions of a business model and posit that each, through innovation, could generate new value in an industry: articulate the *value proposition;* identify a *market segment;* define the structure of the *value chain* required by the firm to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain; specify the *revenue generation* mechanism(s) for the firm, and estimate the *cost structure* and *profit potential* of producing the offering, given the value proposition and value chain structure chosen; describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complementors and competitors; formulate the *competitive strategy* by which the innovating firm will gain and hold advantage over rivals.

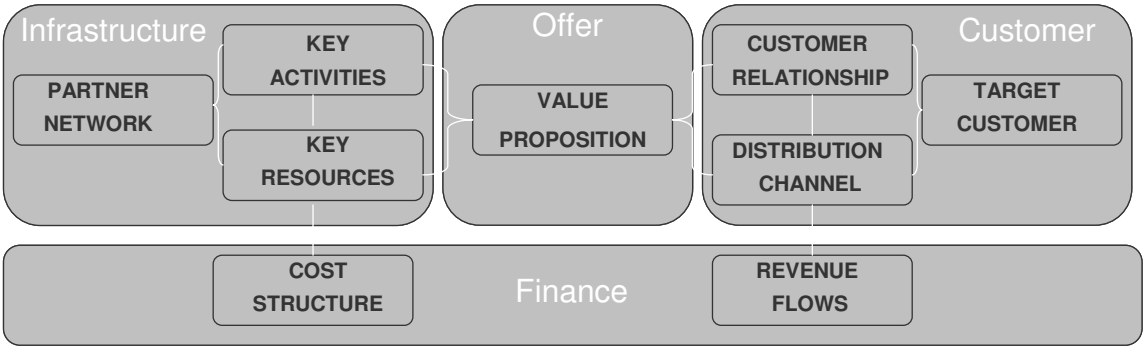


Figure 2 Business model framework (from Osterwalder et al., 2005)

We see a business model as a description of how a network of cooperating organisations intends to create and capture value from new, innovative services and products (Haaker *et al.* 2009). Business modelling may help infrastructural private public partnerships to develop business visions and strategies, identify and assess business opportunities, redesign and align business operations, share

knowledge about the business and its vision and ensure the acceptance of business decisions through committing stakeholders to the decisions made (Dubosson-Torbay, *et al.*, 2002).

2.4.4 The purpose of business model

The importance of business models has been pointed out by many researchers. Among them, e.g. Morris *et al*. (2005) propose that despite the presence of market opportunities, novel business ideas, adequate resources, and talent. This is further complicated by the fact that the shortening of product and business model lifecycles makes future profit streams from existing operations uncertain and businesses need to constantly seek out new opportunities (Hamel, 2000; Wiklund & Shepherd 2003). Shafer *et al*. (2005) argue that business models can be powerful tools for analyzing, implementing, and communicating strategic choices. However, in entrepreneurial firms, which often belong to the small firm category, business models are seldom formally expressed and often remain half unconscious within the entrepreneurs. According to Morris *et al.* (2005), the business model encourages the entrepreneur to (a) conceptualize the venture as an interrelated set of strategic choices; (b) seek complementary relationships among elements through unique combinations; (c) develop activity sets around a logical framework; and (d) ensure consistency between elements of strategy, architecture, economics, growth, and exit intentions. Strategic choices that characterize a venture are made both intentionally and by default. The business model makes the choices explicit. The model is a relatively simple way to delimit and organize key decisions that must be made at the outset of a venture. At the foundation level, the model provides a framework for deciding what not to do (e.g., what services not to offer) and assists the entrepreneur in assessing consistencies and recognizing trade-offs among decisions. At the proprietary level, truly unique configurations are produced that can result in sustainable advantage.

2.4.5 Internal and external business model factors

The business model can be divided into internal and external factors. The internal factors focus on firm-specific factors such as competencies (Sanchez & Heene, 1996), dynamic capabilities (Teece & Pisano, 1994), and idiosyncratic bundles of resources (Barney 1991). These firm specific factors potentially have strategic value as a result of their rarity, durability, inappropriability, imperfect imitability and imperfect substitutability (Schindehutte *et al*., 2008). By contrast, the external factors, environment or market forces, such as demand uncertainty, technological turbulence, and competitive intensity create industry-specific effects based on an external perspective. According to this perspective, the firm consists of a bundle of activities that interacts with components of the market such as customers, competitors, and stakeholders as it seeks a relative positional advantage (McGahan & Porter 1997). Comprehending such external factors on a cognitive level allow for appropriate design of business models and actions according to that model.

Dubosson-Torbay *et al.* (2002) business model design is therefore based on four principal components:

1. Value proposition/offer: The products and services a firm offers, represents a substantial value to a target customer (value proposition) and for which customers are willing to pay.
2. Customer: The relationship capital the firm creates and maintains with the customer, in order to satisfy customers and to generate sustainable revenues.
3. Infrastructure: the infrastructure and the network of partners that are necessary in order to create value and to maintain a good customer relationship.
4. Finance: the financial aspects that can be found throughout the three former components, such as cost and revenue structures.

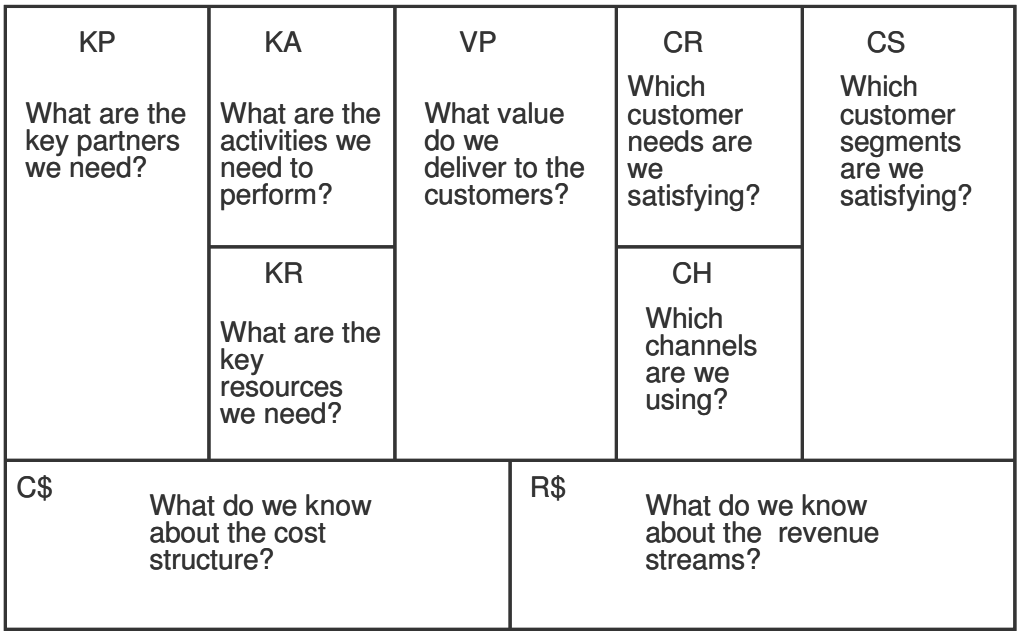


Figure 3 Business model blocks (from Osterwalder & Pigneur, 2010)

Osterwalder and Pigneur (2010) propose further that a business model can be viewed as a ”puzzle” with nine building blocks: value proposition (VP), customer segment (CS), distribution channels (CH), customer relationships (CR), key resources (KR), key activities (KA), key partnerships (KP), revenue streams (R$) and cost structure (C$), see figure above. Linked to these blocks, specific questions need to be answered in the business model development process.

The model integrates firm-internal aspects that transform factors to resources, through activities, in a structure, to products and offerings, to market. The logic is that in order to serve the product market, businesses need activities, input from the factor market (capital and labour) and the supply of raw material. The same resource-base and activities and organisation can produce different products and hence have a scope of different offerings (e.g. cars in two or more colours), but at some point during diversification, new activities are needed (e.g. cars in two or more versions) and potentially also new resources (e.g. diversification to include lorries), thus forcing the development of business models. With this view, (even a non-diversified) firm can have many different business models. However, the more profound the differences between products, the higher the probability that the businesses are organised independently from each other (cars and lorries make out distinct business units in most vehicle-based corporations).

There are causal relations between the different components. In order to serve a particular customer segment and compete with the products within that segment, the offering must have a favourable quality/price position. In order to achieve this, firms need to offer customer-perceived quality of physical product features and service, which in turn requires effective activities (e.g. large scale, competence) and organisational structure (efficient communication and division of labour and authority). This requires human, organisational and physical resources that have to be acquired on factor markets and from suppliers of production inputs. Although not depicted graphically, external actors are potential partners or competitors in all aspects of the business: in the bundling of products (e.g. computers and software), in activities (e.g. outsourcing ICT, buying services from advertising agencies) and in the configuration of resources (e.g. banks and insurance companies share customer data bases).

2.5 Theoretical bullet points and The Panlab federation

The business logic aims to describe the important issue of how the Panlab federation can earn money, i.e. creates value and generate revenues in front of key stakeholders such as customers and partners. The framework is here built on the business model presented by Osterwalder and Pigneur (2004). The present model is selected for discussions of the core areas of

1. Infrastructure
2. Offer
3. Customer
4. Finance.

This model fits well into the Panlab context and is also familiar for some of the partners. The infrastructure includes core strengths, competences of vital importance for creating and maintaining values in the Panlab business model. Offerings are the Services provided by the Panlab federation developed with the focus in their testbed technology where the key partners have their key competence. Customers refer to who the Panlab federation view as their main users of the testbed technology and how the federation reaches these customers. Finance refers to how money is received and costs taken care of in the Panlab federation.

These four core areas can be further divided as follows;

1. The value proposition of what is offered to the market;
2. The segment(s) of clients that are addressed by the value proposition;
3. The communication and distribution channels to reach clients and offer them the value proposition;
4. The relationships established with customers and users;
5. The key resources needed to make the business model possible;
6. The key activities necessary to implement the business model;
7. The key partners and their motivations to participate in the business model;
8. The revenue streams generated by the business model (constituting the revenue model);
9. The cost structure resulting from the business model.

But to develop a mutual business around testbed technology is not easily achieved (Johansson & Kurkkio, 2007). Osterwalder and Pigneur (2010) emphasize that partners involved in a mutual business model development must be aware of following steps:

1. **Mobilize:** the partners need to be prepared for the mutual business model design project. This mean to set the stage and to assemble all the elements for successful BM design. The partners need to: 1) discuss the motivation behind the project, 2) establish a common language to describe, design, analyze and discuss mutual business models. The purpose is to come to an agreement concerning: priorities, intellectual properties, and the issue of competition.
2. **Understand:** the partners need to research and analyze elements needed for the business model design efforts. In this step the mutual business model design team increase knowledge, collect information; customers, technology, and identify needs and problems.
3. **Design:** the partners need to generate and test viable business model options and select the best suited one. The information and ideas generated in step 2 must be transformed.
4. The next step is to **implement** the BM prototype in the field, i.e. to test the business model and its building blocks in the chosen market segment and customers at focus.
5. **Manage**: the partners need to adapt and modify the BM prototype in response to market reaction. In this step, the partners need to set up management structures to continuously monitor, evaluate and adapt the business model.

Osterwalder and Pigneur (2010) also emphasize that priorities are important to consider in business model development. It is not uncommon for two parties working together to have differing priorities and therefore resource commitments in advancing a new joint concept. As a consequence, the project may proceed in fits and starts as the parties continually seek to realign differing expectations. Further, organizations change over time as do priorities and champions. What was once important to one organization no longer is, yet the other partner still values it and wants to proceed.

In business model development, it is essential for actors to create a common understanding. Areas as terminology need to be coordinated between the respective parties. Partnering with a company from another country or cultural context is an obvious point of potential disconnect. However, even within the same country one company may, for example, define terms such as "system, application, interface,

etc.“ much differently from another. If not clarified, serious technical issues may arise. However, it is the type of pitfall that can easily be forgotten. Both parties need to ensure that appropriate time and effort are devoted to creating a common language for effective communication.

Concerning agreements, they are important to consider in business model development because of the uncertainty and unknowns typical when two parties decide to join forces to pursue a new idea, invention, business model, etc., coupled with differing interests by the parties. These agreements can become very complex (e.g., creation of new intellectual property emerging from the contribution of existing intellectual property from both parties and need for it to be defined explicitly). Among the issues that will need to be considered are governance between the parties or ecosystem, ownership rights, fields of use, exclusivity, resource commitments and potential timing, intellectual property, termination conditions and rights, and other contractual conditions.

Particularly in the area of creating new technology and product innovations by employing an open innovation model, one needs to be mindful of the difficulty in addressing intellectual property ownership. The core of the issue is, "You don't know what you don't know." Frequently, two or more parties are coming together to address some sort of problem or perceived opportunity. Each partner brings its respective competencies but the technical approach, patent potential and scope of the future business opportunity are fuzzy or unknown. Further, each partner contributes its intellectual property into the mix, but what might be created is uncertain.

Another category that needs to be considered prior to engaging in open model innovation is to consider what the longer-term competitive implications may be. The business landscape has numerous examples of companies that were once open model partners, now competing head-to-head in the same markets. It is sensible to devote some forethought to potential competitive implications prior to entering into an open model approach. These competitive implications can be specific to the likelihood of future direct competition between two or more of the open model partners or, more indirectly, by enabling a more structural change in the market such that one party establishes and commands a key position in the value chain and derives most of the benefit. Migration to direct competition is the form more frequently observed. In such circumstances, two or more parties come together with complementary capabilities creating or enabling a new technology, product and/or market. In doing so, skills and know-how are developed and frequently transferred between the parties. In addition, knowledge regarding the business objectives, financial returns, etc. is also inevitably shared (whether explicitly or in side conversations as the staffs of the organizations interact with one another).

3 The Panlab/PII business model process

The present explorative study including Socio-techno-economic analyses of the development of a Panlab testbed federation is based on multiple of data collection methods. This triangulation of methods aims to both validate data collected through different sources but also to crystallize and enrich the view of the socio-techno-economic aspects. Data is triangulated in terms of methods used i.e. interviews, observation, internal and external documents. It is also triangulated through a design of multiple perspectives taken i.e. on the federation, the regional cluster, partners in the regional cluster, and benchmark in connection to other stakeholders of testbed organizations outside the Panlab federation. Data is collected through interviews with representatives from: 1) the regional cluster on a) the own cluster and b) the Panlab federation, 2) the project organization on their view of the project, 3) collaborating Canadian cluster on the Panlab federation and own experiences of testbed development, 4) regional cluster (e.g. SMEs, large corporations, research centres and universities) on the work going on in the own cluster and the connection to the Panlab federation. Observations are carried on Panlab meetings and notes taken on discussions held. Internal documents are collected through internal surveys developed, i.e. social network analyses, documented information requested on business model aspects from the regions and the participating partners, internal documents provided by the project partners but also externally documents from e.g. other projects home pages and documentation. Documentation are both of a confidential and non-confidential nature. The social network analysis was developed by initially identifying key activities, which were also further discussed with a testbed provider not involved in the Panlab project and a representative from a large Swedish corporation using testbeds. Both representatives were engineers working in R&D-departments, one in a non-for profit R&D-organization and the other in a for profit organizations. Key activities in the social network analysis were revised in accordance with the discussions. The activities were of socio-, techno-, and economic nature e.g. on pure technical aspects, on social aspects such as collaboration and on economic aspects related to the business and finance (Johansson & Malmstrom, 2007; Johansson, Lundberg & Malmstrom, 2007).

The initial aim with the project was to collect data at three occasions but it was early in the project made clear that data needed to be collected at additional occasions Brussels, Oulu, Madrid, Berlin, Barcelona, and through a multiple of sources, the socio-techno-economic analyses became through this much more extended than initially considered and could through this also be used to a higher extent in the continuous project work. A central part of the data collection is that the participating respondents are promised anonymity. The overall evaluation process of the socio-techno-economic analyses consists of three studies carried out with approximately eight months intervals. Each study include different stakeholders´ view on past, present and future situations with the aim to identify technical, economical and social key- activities and factors judged by the stakeholders as important to create a sustainable federation. The business model process in the PII project is described in chronological order below.

3.1 Brief method description

In this study, we performed several studies with the relevant stakeholders in the federation. We started our study by performing a focus-group interview with the Finish cluster in Oulu. 7 representatives participated and the aim was to gather information about their view of the federation, their everyday situation as well as their expectations on the federation of testbeds. Further, in Oulu, we carried out interviews with the key-cluster representatives. We interviewed 9 representatives and the aim of these interviews was to discuss the federation and its aim from a socio-techno-economic perspective. We also conducted 5 interviews with 7 testbed providers in the Panlab federation to gain an understanding of their perspective on the federation from a socio-techno-economic perspective. Thereafter, interviews with the representatives from the Spanish cluster were performed. A total of 6 partners participated and the aim was to identify their expectations on the federated testbeds. At this occasion in Madrid, business model workshops were achieved with 7 project partners. We also interviewed representatives from the French, German and Canadian cluster to gain insights into their expectations

and needs related to the federated testbeds. Additional 4 interviews took place in Berlin during a business model workshop.

Adding to this, two end-user studies were performed with 198 users in the first round and 270 users in the second round. In these studies, the aim was to gather input regarding users motivation to participate in tests via innovation mediation organizations such as Living Labs and testbeds. These data-collections will be explained in more detail in the preceding sections.

To facilitate testbeds in their process of deciding which user driven innovation that might be the best to implement dependent on their organisations perspective on users, their situation and their expectations, the CDT-team has developed a short quiz to be used. This is found at: http://www.proprofs.com, and the password is: panlab II. The results from this quiz should be viewed as a first guidance on how the testbeds can think when it comes to implementing UDI in their organisation, not a definite truth. The questions in this quiz are based on theories regarding user driven innovation and open innovation.

The plan was also to conduct a survey with the partners within the federation to get insights about their status when it comes to user driven innovation and user involvement. In this survey the aim was to determine if the user driven innovation should be viewed as a service that the federation could offer to their customers, or if it should be viewed as a strategy for the federation as such. The link to the survey is: http://www.surveymonkey.com.

Analyses:

A description of data analyses carried out will be included in later sections of the report:

- Analysis of the federation from an overarching perspective identifying:
- SWOT
- Clustering within the project
- Joint businesses
- The social/techno-/economic relationships
- The inter-dependencies in the federation
- Possible directions of the future …
- Why and how the federation could be useful for the wider community.

3.2 Phase 1 - Brussels

The first Panlab meeting in Brussels included a presentation of each one of the participating partners where areas such as the partners' role in the project, earlier experiences, national and international cooperation partners, team competence and business relations were discussed. Potential businesses and customers were also discussed and referred to e.g. in terms of SMEs, large corporations, research institutes and universities. The main part of the discussions considered pros and cons for the key issue regarding selection of a proper technical base for the development of a testbed federation. Should the project consider the techniques of today or should they consider and base the testbed cooperation on a potential, but uncertain technique of tomorrow. Our analyses indicated at this point in time that the project had great potentials through the large social network, where many partners knew one another since earlier cooperation projects and where parties were willing to cooperate and share. The parties expressed high commitment to the project and also strong intentions of cooperation. Legal contract of the project was expected to assure for limitation of agency risks in connection to the project, thus also improving the possibilities for a well functioning and sustainable cooperation. The project had further a solid technical base in terms of access to technical infrastructure and competence in the project team. The project also assured for finance through a period of three years and the Panlab federation could through this bridge the first financial gap. Partners were also willing to share e.g. knowledge, information and resources implying potentials for a fast and resource efficient way. The former Panlab project formed a solid starting-point for future progress towards a Panlab federation. The project is characterized as being in the fuzzy front end of the innovation process and the project process is characterized as to be in a familiarization phase where expectations on the project are high and the

potentials immense. The discussion on weaknesses and threats has not yet started in this "honeymoon" phase.

3.3 Phase 2 - Oulu

The project meeting in Oulu aimed at both presenting the status of the project process in relation to the individual work packages but also at co-ordination of work between work-packages. A first step in the developing of a common framework in the project was to agree on a mutual frame of reference within the work packages. A second step was to inter-relate the frameworks from the individual work packages into a common frame of reference for the overall project. A common reflection among the partners was that the sense-making process within the own work package was demanding and time consuming since there were many people involved and people have their own frames of references and incentive structures. The focus in each one of the work packages was fairly limited in scope and foremost related to specific technical details in the development. The individuals in the work package teams were all professionals, the technical language used by the participants well known among the partners and this was a uniting factor, simplifying the work.

Integration between work packages was at this point in time perceived as even more challenging than the institutionalisation work within the own work package. The frame of reference had started to be formalized within the individual work packages and was once again challenged and in a need of revision. The purposes with the different work packages differ but were intergrated into the unanimous framework. The task was wider and technical scope was considered from a wider perspective, including various types of technical oriented tasks and knowledge areas. The presentations and discussions held at the project meeting in Oulu helped to improve the processes of developing common frames of references of importance for the future project progress. Most work had to this point focused on the technology development, a work where high specialist technical knowledge was needed by the interacting partners. The project focused on high technical uncertainty, and on development of central aspects of the outcome of the infrastructure.. This meeting based on close interaction between parties allowed for sense-making processes and for the development of social ties between project partners. Differences in culture, language and incentives among partners are some aspect dealt with through personal meetings. Such activities also enable project members to become further committed to the project, a central social aspect in innovative projects. The work in this phase refers for instance to definitions of criteria and metrics that will be used as a platform in the further work, providing a more common frame of reference among the partners. Process definitions, procedural definitions, metrics, templates and test definitions related to quality aspects are for instance developed.

The main part of the work in the work packages had so far focused on technical aspects while the project meeting provided an opportunity for raising the question on user needs and commercialisation. A central aspect raised was the development of a commercially viable organisation enabling the development of a sustainable testbed federation. Project partners raised the question on how to convince external industry partners and potential financiers on the potentials of the project. The need of acquiring future resources and thus particularly financial resources from the industry was considered as vital for the surviving of the testbed federation. This show that the sense-making process regarding the business aspects have started but no part of the project have still directly started to work on the business aspect as such, at least from the point of what is officially verbalized at the meeting. The project partners mainly talk the technology language at the moment and the discussions are mainly on a deep research / applied level where the partners find it difficult to articulate potential benefits accomplished through the project other than in relation to technology development and in the technical language. This also implies difficulties in convincing stakeholders not directly involved in the project of forthcoming benefits. A suggestion based on this is that values need to be made further explicit and verbalized not only in terms of technology provided.

Content of discussions held between project partners as well as scope of discussions between partners were based on the innovation and social network literature identified as crucial aspects for collaborative projects (Chesbrough, 2006; Chesbrough & Appleyard 2007). We developed a social network analysis to capture the project partners interaction and to what extent central activities where

discussed in the interaction. The purpose was to visualize central activities to deal with in the project, the importance of dealing with the activities in the collaboration and also to raise the awareness of the importance of interaction for enabling a successful process of the project.

3.4 Phase 3 - Heidelberg meeting

The third stage of our interaction and socio-techno-economic study was the meeting in Heidelberg. Prior to the presentation in *Heidelberg* the CDT-team carried out an end-user study focusing on understanding who the users are that wants to participate in tests, what motivates them to participate and what the end-users can gain from their participation. To collect data for this study a survey was published via Botnia Living Lab to their user community via testplats.com. The study at Botnia Living Lab was also designed as a structured survey using an on-line questionnaire. This questionnaire consisted of 26 questions and was sent to 4900 registered users. 271 users responded which is a response rate about 5.5%. The questionnaire was available on Botnia's website for a week and the participating users were rewarded with two lottery tickets. Among the 271 users, 44 did not match the pre-defined criteria that they should have participated in a test, and 29 did not answer the whole questionnaire, hence, these answers were sorted out which resulted in 198 valid answers. The results from this end-user study are reported on in result section 4.6.2.

At the meeting in Heidelberg the first implications from the study and the interviews, focus-group and social-network analysis were presented and discussed. The presentation focused on presenting three areas to discuss, these where economic, social and technical factors. Related to each subject, the CDT-team strived to highlight both strengths and threats the federation needs to take into consideration in their ongoing activities. The economic discussion emphasised issues such as how to finance the federation and which offerings they can suggest. In the social part issues such as the fuzziness of the social impact and the strength of the federation such as its global reach was highlighted. When it comes to technical factors, the presentation centred round threats such as supporting processes and customer requirements. The presentation also highlighted issues from a federation perspective where the CDT-team stressed threat such as:

- Industrial Financing
- Find a clear message of the usefulness of the service provided by the federation
- Association with others
- Security issues and availability for users
- Access to right people
- Level of engagement
- Poorly implemented business practice
- Poorly implemented technology
- Legal misuse
- Co-operation among partners

As well as opportunities such as:

- Reach a diversity of people
- Geographical reach (global reach in the future)
- Test and experiments
- Best efforts offer
- More guarantees
- Access to other work
- A facility that create long term benefits for the whole industry
- Companies learn to deal with complexity – interface, connection points

The objective of presenting the identified threats and opportunities identified so far was to facilitate the further development of the federation and to facilitate their process of designing both their processes and their offerings.

3.5 Phase 4 - Madrid

A later step in the data collection process was the Madrid meeting where the CDT-team focused on further data collection on socio-techno-economic factors. Analyses of findings before the meeting indicated that the project was still in a infrastructure and technology development phase. It became at this point in time obvious that the main part of the testbeds did not have running business models and none of the testbeds appeared at this point in time to be self-financed. Maturity in the regional clusters also differed. Moreover, there was still no considerable business model discussions going on in the project and the project participants had not yet started to discuss how to design and organize businesses. The partners wanted and also needed guidelines for starting the business model discussion process. Both the individual regional partners and the Panlab federation recalled an urgent need for such discussions. The regional partners were in front of the Madrid meeting asked to prepare a presentation on their current ideas on business models. The CDT-LTU team designed a template to be used in the discussion of business models. The regional clusters and the Panlab project organization was asked to consider the question on 1) For whom?, 2) What and 3) How?. The "***Who"*** questions were considered in connection to the market segment e.g. our market is, our customers are. The "***What"*** questions considered a) Market offerings and customer values offered are e.g. our product/service and values offered to the market are. The ***"How"*** questions was related to a) Serving of the market, b) Resources, e.g. we use these resources in terms of competence and technological equipment to serve the market, our financial sourcing (capital) to create a debt equity structure, c) Processes e.g. in ways to reach and maintain customers, combine resources in the transformation process, receiving compensations in return for services and products offered to customers or other financial support (e.g. membership fees, consulting/testing fees, sponsorship, grants), and d) Organization e.g. own organization, network structures, role in the network structure. The "Who", "What" and "How" questions where further considered in connection to both a 1) Current state and 2) Expected future state of the own business model. The three questions and the two points in time where further considered in terms of a) Strengths, b) Weaknesses, c) Opportunities and d) Threats.

The LTU team started the workshop with a presentation and discussion on definition and content of business model , and motivations for developing a business model for enabling value creation and value capturing. Representatives of the project organization and the regional clusters presented their business model layouts. It is here important to note that the workshop aimed at starting the discussion on what a business model can be and to visualize the possibility of using the business model discussion as a tool in the own development process e.g. for identification of central activities to work with The business models presented aimed to make sense of and also develop own scenarios on potential business models. A professional business developer from Eurescom presented a potential outline of the whole Panlab federation business model based on the LTU template. It became evident that many of the project participants were not familiar with the discussion on customers, offerings etc in this way. It was difficult for them to make the business model concept more specific.

Many of the participants were not familiar with business model concepts or had a simplified view of business model content, a focus on simplified description of costs and price processes. Questions that arouse were: Can't you say what the cost for the Panlab federation is? What is the right price for us? There was an urgent need to extend the business models discussion to include both the aspect of business model design and business model organization that illustrated how different designs and organizations influence the costs attached to e.g. offerings. A reflection was that the main part of the regional testbeds and related businesses were in the development process and that the main part of the testbeds did not have running business models, none of them were self-financed. Offerings could not be specified by the partners. The absence of offerings made the discussion on price close to impossible to answer, what were the customers expected to pay for? An urgent need for specification of the Panlab business model organization and Panlab business model design were identified. The discussions also highlighted illustratively the business model development in technology oriented projects. Further, a need for more involvement of business oriented people in the project was

requested. Business competence was needed both on the regional level and federation level. A need by the project partners to be committed to business model development was also discussed.

3.6 Phase 5 - Berlin

At the project review in *Berlin* the CDT-team presented theie current results from their studies. The presentation contained information about what had been achieved, the current results, and their planned actions. In the meeting prior to the review, the results was presented and discussed among the project partners. These discussions confirmed our results and also shed light on important issues for the partners. The presentation included issues such as sense making processes that takes time in new and complex international collaboration, the unclear vision of the added value provided by the PII federation. This needed to be clarified and explicitly defined. In addition, the fact that possible offers to potential customers still were undefined was discussed. One importance conclusion at this time in the project was that the technical competence in the project was very high, while there was a need to further include business people in the regional networks to enhance chances of market success.

The CDT-team also presented a SWOT analysis where social, technical and economic aspects were discussed. At this occation, additional interviews were carried out with test-bed providers; partners within Octopus, University of Patras, Media Network, Fraunhofer FOKUS and Waterford. There was also plans to interview COSMOTE but the time and opportunity did not appear. The focus of these interviews was to gain insights into their expectations on the federation in the past, their present expectations and their expectations in the future. The interviews were a continuance from earlier interviews where the results from previous interviews was discussed and referred to. In addition, the interviews covered themes such as socio-techno-economic issues they both experience and foresee. The interviews took between 1-2 hours each and were recorded and transcribed verbatim. The collected results from these interviews are presented under part II of this document.

Viewing the interviews from an overarching perspective, it became apparent during these interviews that there were still many issues that needed to be sorted out to create a sustainable federation among the testbeds. One issue that frequently was discussed, was the testbed providers' difficulties to see how the federation could be organised. It was not clear to them how the processes should be, how payment should be achieved etc. Another issue was the added value of the federation for their customers. It became obvious (again) that they did not have a clear vision of **who** their customers were or **what** they could offer to them. In terms of technology, they had the vision that these issues will be sorted out and function within a short period of time. This study ended up the conference article (Ståhlbröst, Bergvall-Kåreborn, & Holst 2009) presented at the ISPIM conference in Vienna June 2009.

The CDT-team also carried out an additional end-user study during May 2010 to deepen the understanding of what motivates users to participate in open innovation activities. In this study, we have used an online survey to collect data from the users. This survey was publicised by contacting a significant number (n2545) of users in Sweden during the spring of 2010 via e-mail. These users are gathered in a user database at Botnia Living Lab, which has been built up since year 2003. The aim of this database was to create a gateway to users who are willing to take part in innovation activities on a voluntary basis. This particular study was introduced to the participants as a self-reporting opinion survey regarding "Your participation in innovation activities". The survey drew responses from 270 users, which gave us a response rate of 10.6%. One plausible reason for the low response rate can be that many of the invited users are involved only occasionally in Botnia Living Lab activities; hence, they might not feel qualified to answer. Getting answers from all of these users could have been valuable since these users' perspectives might have rendered a different view on motivation to participate in innovation activities. However, the aim of the study was to get response from the users who want to be, have been or are involved in innovation activities; thus, the users who did not respond might be outside our scope of interest. This survey consisted of five question areas: background questions (demographic characteristics such as gender, education etc.,), Internet usage habits, technology adoption type, and motivation for participating in innovation activities in the community and resulted in an article to be published in International Journal of Innovation and Entrepreneurship Management (Ståhlbröst & Bergvall-Kåreborn, Fortcoming).

3.7 Phase 6 - Berlin

The general purpose with the business model workshop in Berlin was to increase awareness and to create a common understanding of the European testbed federation business model and to identify different scenarios of business model design (this to clarify issues that were discussed in phase 5). The work aimed to continue the work with identification of offerings, customers, markets and segments as well as to start the discussions on an implementation strategy. A shared language is a basic point in the development of a common business model and it is therefore important to work in a structured and systematical manner rather than ad hoc.

The LTU-team started the business workshop with a presentation on trends in the ICT-sector and the testbed service industry connected to the environment of open versus closed innovation, user involvement in innovation. Principles of open and closed innovation as well as user involvement strategies in innovation were discussed. The presentation also included discussions on challenges today connected e.g. to priorities among participants, intellectual property, agreements and trust, competition and direct competition among participants. Benefits of networking were also discussed. The main part of the discussion focused on business models, business model development and trends in business modelling. We started the business model discussion by arguing for the need of solid business model design and organisation for reaching the goal of accomplishing a sustainable testbed federation (a going concern). We further discussed the functions of a business model in connection to the work with 1) articulating of value propositions (i.e. the value created for users by the offering), 2) identification of market segments (the users to whom the offering and its purpose are useful) and the 3) structure of the value chain required by the firm to create and distribute the offering, and 4) determine the complementary assets needed to support the firm's position in this chain, 5) specification of the revenue generation mechanisms for the firm, and estimate the cost structure and profit potential of producing the offering, given the value proposition and value-chain structure chosen, 6) description of the position of the firm within the value network, linking suppliers and customers, including identification of potential complementors and competitors and also 7) the formulation of the competitive strategy by which the innovating firm will gain and hold an advantage over rivals. (Chesbrough, 2006). The business model building blocks were introduced as a methodology to be used by partners in the work with business model development and was connected to the key questions of "what", "who" and "why" (Osterwalder & Pigneur, 2010). We also discussed how to reach a mutual business model and emphasised five critical phases in this work, i.e. 1) Mobilisation of a) participants motivation and b) a common language to describe, design, analyze and discuss business models, 2) Understanding of the own business model, of work connected to research and analyses of key aspects in the business model and identification of needs and problems, 3) Designing and selection of a viable business model based on information and ideas, 4) Implementation of the business model prototype, 5) Management of the business model and thus adaption and modification of the business model prototype in response to the market reaction. The business model discussion was further divided into the two separate and interlinked pars of 1) business model design and 2) business model organization.

The presentation and discussions were related both to existing literature in the field of open innovation, user driven innovation and business models and to analyses of empirical findings from the Panlab project. The discussions considered all three socio-techno and economic aspects.

The presentations were followed by further work on the regional clusters and their current and potential offerings, markets and segments and contributions into Panlab federation. The workshop participants were before the meeting asked to identify topics of particular importance for further discussions, they were also asked to present the ongoing work in their cluster and organization.

The workshop focused on the current state in the project regarding the business model work and the participant current and previous experiences of commercialisation of new technology and business implementation. Focus was particular on identification of customers and segments, and also on values created in front of different types of customers through the testbeds and a European testbed organization.

3.8 Phase 7 - Dublin

At the project meeting in *Dublin,* we presented the results from the meeting in Berlin, as well as the activities we had carried out so far. The presentation contained information about what had been done, the results for far and the planned actions. At this meeting we reported on the results from the Berlin business model workshops and we highlighted questions that need to be discussed and clarified within the project consortium. These questions concerned issues such as;

- What is the added value the federation offers?
- What is the value proposition/offer?
- What customer needs does the federation fulfil?
- Who are the target customers?
- Responsibility:
  - for test results when different resources are combined
  - for the selling of the federation resources
- The federation customer relationship process – from identifying and communicating with the customer to delivering the test results and evaluating its value
- Fully automated or manual process, or a bit of both?

We also stressed some challenges related to the networking aspect that we had identified. These challenges were related to:

- Priorities: Different agendas/roles, different maturity level among partners, different offerings, different expectations
- Intellectual Property: Ownership, fuzzy/unknown future business opportunities
- Agreements and trust: Everything can't be in contracts – personal relations
- Compliances: Some partners have invested a lot in the project and have strong personal interest
- Indirect and direct competition: Between two or more partners

The results from this discussion ended up with a request that we should share the responsibility among the partners and assign the partners involved in this task that we would stimulate the discussing.

3.9 Phase 8 - Barcelona

At the review meeting in Barcelona, June 2010, the CDT representative presented the status and results of the study; the business frame work, the expected benefits from the federation, networking challenges, the maturity of the business framework and the planned remaining actions. In the preparation meeting prior to the review, the results was presented and to the project partners. The presentations initiated some discussions which also were reflected in the review report. Topics like complementing with a SWOT analysis comparing PII with other initiatives, adding advantages and disadvantages. An action plan was developed after the review meeting containing; analysis of alternative technologies for test bed usage and deployment, description of the offerings to customers, analysis provided usable results in PII context and additional conclusion. The final version of the study includes the recommendations from the latest review.

4 Results and analyses

Part II includes presentation of findings from the Panlab project, analyses and conclusions drawn. The analysis is categorized according to the business model blocks according to Osterwalder's and Pigneur's (2010) framework described in section 2.4.5. Challenges for the development of sustainable testbed businesses are also identified and discussed. In this section we start to identify the business model's infrastructure consisting of the key partners within the Panlab federation and their key resources.

4.1 Infrastructure

The PII infrastructure is here considered in terms of key partners, key activities and key resources.

4.1.1 Key Partners

The Panlab project is based on cooperation between 21 collaborating key partners aiming to develop a sustainable Panlab federation. The partners were primary selected on the basis of complementing one another. The key partners belongs to different types of organizations e.g. universities, research organizations, large corporation, small firms, for profit and non-for profit organization. The key partners also add different function such as providing and/or using testbeds and administrating the project filling an intermediating function. The regional clusters in the Panlab project differed e.g. in terms of project partners involved and how mature they were in business model development related to e.g. testbed development and offerings. The partners had different competence bases and also different expectations on the project. Common factors among the key partners were the high involvement of technology competence and low involvement of business competence. The key partners had high expectations on the project outcome and spin-off effects in terms of socio-techno and economic characteristics due to participation in the project. Identified incentives by key partners are presented below:

- Decreasing own business risks and own risks in technology development in the early phase. (Risks connected to infrastructure, customers and value propositions).
- Increasing and/ or maintaining levels of regional employment rates
- A complementary base of key partners (e.g. operators, service providers, support service) that together can:
    - provide a value added offering e.g. in terms of flexibility, professionalism, quality and efficiency
    - contribute with a large number of customer channels e.g. in terms of flexibility, professionalism, quality and efficiency
    - contribute with a variety of resources e.g. in terms of flexibility, professionalism, quality and efficiency
- Increase the personal network and find new collaboration partners
    - Increased access to external network (social capital)
    - Decreased need of internal resources
- Increase the geographical span of key partners (International and national)
- Multi-types of key partners (Profit and non-profit organizations, SMEs large organizations, Companies, research centres and universities)
- Decreased risks for failure in technology development and businesses.
- Fasten time to market through collaboration
- Technological development and integration between key partners
- Exchange of business between key partners
- Shared knowledge (e.g. technology, services, business, administration)

- Future collaborations in other projects / businesses
- Key activities: Improvement in R&D-processes
- Increase potentials of revenue and decreased costs
- Increasing the own customer base.

Despite the positive expectations there are also challenges in a collaborative project like PII when diversified characteristics of key partners from different countries, different regional constellations and different degrees of maturity in the clusters, different types of key partner organizational structures and different professions. Results from the social network analysis on key partners indicated that a few partners were highly involved in interactions while some partners were less involved. The degree of involvedness and what the project areas were focused on in the interactions were for instance connected to the particular organization's role in the project.

Feedback on findings from the social network analyses and implications by the findings was presented in front of the participating partners at PII meetings. Suggestions for the project partners was to involve a larger number of project partners, for discussing not only technology issues in of the project, but also to increase the external focus and to expand the competence base for enabling discussions of e.g. user needs, customer needs and businesses. Throughout the project, the importance of including business competence among all key partners has been emphasised. As a consequence, some key partners have involved business competence. Despite this fact, an important implication for the future of the PII federation is to include a significant amount of business/ commercialisation competence in the next step of the business model development in order to increase chances of the federation and its key partners to actually thrive on the technology infrastructure developed.

Important findings from the projects refer to the social aspect of collaboration between key partners where level of trust among partners influenced the work with the development of infrastructure and businesses and also the development of a sustainable testbed federation. Even though some aspects of trust can be dealt with through legal contracts such basic level of trust needs to be complemented by building of social relations among key partners. Three aspects of trust have been identified as central in the PII-project:

1. Trust in key partners for opening up the own organization for exposure of core knowledge to other parties, and thus allow for knowledge transfer.
2. Trust in key partners for opening up the own organization for risking own customer relationships, i.e. that others provide high qualitative products as agreed, and thus allow for integration of customer bases.
3. Trust in that the key partners gives and take workload within the project, and thus allow for "fair" distribution of workload.

Trust has been discussed specifically in PII meetings e.g. in Berlin where key partners both emphasised the importance of trust and identified a fear for opening up in front of key partners. Whilst the level of trust appears to be and issue that have an impact on the speed of the progress in the project, some still emphasized that the social aspects had nothing to do with the technology development progress. Therefore, it needs to be emphasised that speedy progress in technology development is difficult to achieve unless there is a certain level of trust present between key partners. An implications from this is the importance of addressing social aspects for building higher levels of trust and involve competence that have the abilities to deal with trust issues. In Berlin, discussions were held on the common challenges of collaborative projects where commitment and trust are essential ingredients but generally projects have difficulties in overcoming such challenges. Projects that are able to overcome such challenges may possess considerable competitive advantages in front of other competitive projects and may also become more advanced and successful in technology diffusion and business commercialization.

4.1.2 Key resources

Within the framework of the PII-project, the available resources supplied by the European commission, FP7 and key partners allowed for development of testbed infrastructure in a short term perspective e.g. in terms of mechanisms and tools for describing, storing, locating and orchestrating

testing services as well as means for automatically provide composite testbeds across multiple administrative. The short term resources were necessary to accomplish a basis for a long term development of a sustainable European testbed infrastructure.

Findings from the study indicate that financial bootstrapping of resources[1] is a central part in the resource allocation of this project in an early fuzzy front phase, characterized as resource intensive in terms of knowledge, capital and infrastructural resources where there also are high risks connected to return on investment. The horizon for gaining the return on investment is distant and the uncertainties high for actually obtaining any return on investments. Sharing and exchanging resources are ways to deal with immediate financial constraints but also in the long run a way to accelerate and through this achieves resource leverage (Malmström, Wincent & Johansson, forthcoming). Further, a long term effect of resource sharing and exchange may reduced need for physical material and still achieve a substantial amount of tests. This has implications on both development of sustainable businesses and contributing to sustainable environmental resources. In addition, governmental sources and European commission projects are needed in these phases since there is a lack of commercial venture capital to assure for future value creation through R&D-projects encompassing extended and time consuming sense-making processes before reaching the commercialisation phase.

The complementary resources contributed by the large network of key partners and their competence bases and established social relations with important stakeholders are strengths in the project that also improves the potentials of the project to reach its full potential (Malmström, 2002; 2007). The wide and deep scope of competence bases in the PII-projects provide a solid base that may be important for developing the content and quality of value added offerings in the testbed federation where different types of competencies are needed (e.g. technology, services, business, administration) (Malmström & Wincent, forthcoming). Commitment by the partners in the project, particularly in relation to the development of the technology base for the infrastructure has been important resource for the progress in the project. However, the project also encounters challenges in gaining access to future resources beyond the mere technological focus in resource allocation. The main part of the project resources was allocated to the technology and infrastructure development in the project and further resources need to be allocated to market studies, marketing, promotion, implementing of a production process or implementation of an organization for developing future sustainable testbed businesses. This is also the next phase in the development of a federation due to the origin of technology push (Klofsten, 2005). Sharing and exchanging resources have decreased risks for not gaining access to relevant and required resources for offering sustainable technology development and this is also an important base for future development of sustainable businesses.

Discussions on how competences in the project composition influence the work in the project were reflected on. The participants describes the project team as a relatively homogenous group, they all have academic background in technology and this has influenced the development of the business framework negatively due to for instance lack of business focus, market focus, customer focus and financial focus. Incentives by individuals from technology oriented parts of the academia is foremost to carry out technical research characterized both by theoretical and applied research. Such research is typically not commercialised or directly commercial. Suggestions for future project team composition is to include a broader variety of competences, i.e. technical, user / customer, business oriented people (Malmström, 2002; 2007). It can be concluded that different types of competence are needed in collaborative R&D-projects like the PII project in line with prior research that have identified five types of competences, i.e. 1) Technical and application competence, 2) Partnering competence, 3) system integration competence and 4) market / business and consulting competence (Windahl, Andersson, Berggren & Nehler, 2004) and 5) design competence (UDI) to be important in R&D projects. The pre-commercialisation phase of the PII project foremost includes three out of the five types of competences while for entering into a commercialisation phase there will be requirements of a higher focus on the fourth and fifth type of competence i.e. the business, market and design competence. Further, integration and balance between the five types of competences are needed in

[1] Financial bootstrapping refers to different ways for avoiding use of external financial resources such as banks and venture capital. Many successful companies used financial bootstrapping in the start-up phase e.g. Dell Computers (Malmstrom, Ersson & Westerberg, 1999).

future business model development. This will also allow for the development of the PII federation core capabilities, i.e. the ability to execute repeatable patterns of actions in the PII federation businesses.

4.1.3 Key activities

The aim of raising awareness of key activities issues is to improve potentials of achieving short term goals and for dealing with the planning of future activities for development towards sustainable testbed businesses. Key activities for the development of a sustainable testbed federation were identified in the PII project and the aspect of activities has been continuously dealt with in the project and also discussed. In addition, the identified activities were also further discussed with a testbed provider not involved in the Panlab project and a representative from a large Swedish corporation using testbeds. The identified key activities were categorized into five core groups, i.e. technology, education, resource management, business activities and management control activities.

The main focus in the project regarding key activities has been on the ***technology activities*** and development of a solid base of infrastructure and technology for the offerings. Establishment of federation testbed services take time and there is a need for implementing promotion activities a long period of time before the commercialisation of the testbed services. The key partners recognised the need of activities for collecting information and also get to know more about customers' interest, needs and types of market channels that could be used when promoting the testbed services. The key partners also stated the importance of activities for developing a marketing policy based on customer information collected and gained. The key partners identified a need for carrying out different kinds of ***marketing activities*** in the project but stated a lack of resources for such activities in the project budget. One suggestion was to re-allocate resources for the particular activity but this appeared not to be possible within the current frame of project resources. As one of the key partners also state "*The principal aim with the current project is to provide new infrastructure invoked in teagle and that is not too easy. Activities and people's efforts are thus also directed toward this task… There is only a small portion of resources in the project to do anything in this direction.*" The technological activities will continue to be the base in a future established testbed federation but the key partners also identified a need of having a budget for business framing activities in future projects (Malmström, 2002; 2007).

Educational activities have also been carried out in the project and these activities also provided feedback on users need in connection to the technology. Information from the educational activities both helped to improve the technology, make the technology more user friendly as such but also to inform potential customers on values that may be provided through the Panlab offerings. The educational work will continue both from the aspect of developing the technology and services provided but also for the development of target markets for the Panlab services. Positive feedback and also constructive feedback for the future work were provided through these sessions.

Additional important key activities for management of the Panlab office organization is to deal with issues of ***management control.*** Management control may be carried out to different degrees both through vertical and horizontal possesses. Vertical processes imply traditional hierarchical control of the project process while horizontal control process foremost refer to co-ordination of tasks and activities among participating key partners. The context of low market maturing and high degree of technology where services are still to overcome the bridge between research and commercialisation suggest complex requirements on management control that can master the critical need of activities that are both high in degree of creativity and efficiency for enabling timely development of sustainable testbed federation services. It can from this point of view be a conflict between the creativity activities and control activities that need to be dealt with. (Kurkkio, 2010).

Table 2 Key activities

Key activities	
Categorization of activities	**Activities**
Technological activities	Identification of suitable technology for the PII infrastructure
	Development of selected technology
	Implementation of selected technology
	Test of technology / design
	Plan/adopt for use of PII infrastructure
	Long term management of technology for establishing a sustainable testbed federation
	Recurring technology development
	Technological collaboration activities
Resource management activities	Resource management, both short term and long term
	Enabling resource sharing and knowledge transfer
	Resource related collaboration activities
Education activities	Education of testbed providers on the testbed infrastructure
	Education of users on the testbed offerings
	Educational related collaboration activities
Business activities	Identification of how to attract users of the testbed federation services
	Pricing of the services
	Sales of the service
	Coordination of the service offerings through the testbed federation office
	Short term financing of the infrastructure
	Long term financing of a sustainable testbed federation
	Long term management of a sustainable testbed federation
	Business related collaboration activities
Management control activities	Horizontal and vertical control activities

4.1.4 Testbeds identified within the PII federation

There are several testbeds developed by the partners within the Panlab federation. Some of them are briefly described below (http://www.panlab.net/). Their application areas and potential customers/ users are also identified by the partners.

Testbed 1: ANEMONE. The European project called ANEMONE aims to set up an open testbed focused on information technology. This testbed is distributed between all the partners of the project across the Europe. Each site has its own characteristics in terms of access network, coverage, users, services, etc. The testbed is open for any entity which would like to test some component hardware, software, protocol, to perform experiments/demonstrations or whatever in relation with this technology. ANEMONE testbed is a living entity, the services and applications, the access networks, users evolved. Up to date information are available on the website of the project (http://www.ist-

anemone.org). The objectives of the testbed is to provide an open access to entities which evolved with these technologies (IPv6, Mobile IPv6, NEMO, etc.). To make them save time, they will not have to set up a testbed to make experimentations of their solution, they can use the ANEMONE testbed. It is the first testbed that is open to every one who needs to test components or to perform experiments/ demonstrations on these technologies (mobile IPv6, NEMO, etc).

Testbed 2: ArcLabs. Arc Labs enables industry and research organisations, which would otherwise be unable to acquire sufficient hardware and software resources, to realise their business and strategic goals. The centre provides test and validation technologies for various areas within telecommunications. The centre has a nationally unrivalled mobile communications facility which provides a Living Lab for real and rapid development, prototyping, interoperability, conformance testing and validation of wireless and mobile research. There are two testbeds, one externally accessible and one internal. Other related ArcLabs testbeds are listed in the Classifications section. Testbed for the use of the IMS ARCS project partners and project development and testing objectives. The test facility is enhanced by means of a human resource component - an end user community willing to participate in application testing, so called Testpilots. The testbed infrastructure serves organizations that wish to verify and potentially integrate appropriate prototypes into a fully equipped wireless network that incorporates the end-user dimension. These organizations would typically be SMEs, Start-Ups and Academic institutions. IMS Archs testbed will serve as a development and test platform for end user services and service enablers developed using IMS ARCS.

Testbed 3: Beyond-3G Testbed which focuses on telecommunications. They provide seamless mobility reasearch, next generation network infrastructure research through testbed federation. The objectives of DAI-Labor's Beyond-3G Testbed is to provide a test and development environment for next generation network research activity and a high-tech environment for developers and testers where various technologies are supported. The offering consists of combined platform of all three players; the network operator, service providers, and the users for research and development on different aspects of telecommunications.

Testbed 4: Converging Networks Laboratory focusing on telecommunications. VTT's Converging Networks Laboratory is place to innovate, prototype and test products in a future convergent network infrastructure. The services that offers are performance measurements, application and services testing over different networks basic research on wireless MAC layer, IP protocols, mobility management Applied research for future IP applications and services Technology demonstration build-up, consulting. The offering consists of configurable live wireless and mobile networks and IP services in the same location. CNL facility is the first step towards production networks. The market that the testbed is targeting are: telecom, communications, future ICT technologies, ICT applications.

Testbed 5: GENESIS testbed. GENESIS project is building a testbed where several scenarios can be implemented for interoperability assessment and validation of NGN systems. GENESIS testbed offers both a laboratory implementation of a NGN network and a real scenario in a rural area covered by a WiMAX network. It enables the recreation of different scenarios for the evaluation and validation of NGN systems, services and terminals. A set of tools for traffic engineering, monitoring and performance evaluation are available and might be adapted in order to meet the requirements of user's specific tests. Advanced services are also provided by GENESIS partners for demonstration and testing purposes: Auto-Conference, Multimedia Services. The testbed is offered for projects which would like to build complex scenarios for testing NGN system, services and terminals. Target market for the testbeds are IT & Telecommunication projects, network operators, device manufacturers and applications & services developers.

Testbed 6: Grid'5000. Grid'5000 is a highly reconfigurable, controlable and monitorable experimental platform gathering 9 sites geographically distributed in France featuring a total of 5000 processors. Although, its design targets experiments in the area of Grids, its high degree of reconfigurability makes it suitable to carry out experiments in the area of service infrastructures, cloud computing and the Internet of Servers. Guidelines to use the testbed allow users to carry out experiment at large scale with several thousands of processors from different sites. Allocation and deployment are performed by several tools provided to the users. Several other tools are given to monitor the testbed during the experiment as well as injecting failures. The targeting market is within information technology

Computer science mainly but open to the industry in the framework of a formal collaboration between an institution involved in the management of the testbed and a private or public company.

Testbed 7: iLab.t Virtual Wall. The Virtual Wall facility is a generic test environment (based on the Emulab software, www.emulab.net) for advanced network, distributed software and service evaluation. The Virtual Wall nodes can be assigned several node functionalities, like terminal, server, network node, impairment node. The testbed is used for IBBT's own research (and is funded in that way), but is opened to external partners for their own research or in common projects. The targeting market is within information technology sector, and research.

Testbed 8: iLab.t Wilab offers environment Emulator on top of a large scale sensor and wireless testbed. The iLab.t Wireless Lab is an extensive wireless mesh and sensor network infrastructure installed at IBBT office premises. The iLab.t Wireless Lab allows for easy and flexible testing of functionality and performance, of stress, interference and scalability, and log of the sensor and WLAN nodes' events. The IBBT wilab team offers support during implementation as well as during operation. Wilab provides a permanent testbed for development and testing of sensor network applications via an intuitive web-based interface. Registered users can upload executables, associate those executables with motes to create a job, and schedule the job to be run on the testbed. During the job all messages and other data are logged to a database which is presented to the user upon job completion and then can be used for processing and visualization. In addition, simple visualization tools are provided via the web interface for viewing data while the job is running. Wilab will facilitate research in sensor network programming environments, communication protocols, system design, and applications. Objectives of the testbed are: experimental validation of novel wireless architectures, applications and network protocols in a real-life large-scale environment, stress testing of wireless network solutions, interference studies. The targeting market is within research.

Testbed 9: Media Interoperability Lab offers converging technologies from the fields of broadcasting, internet and telecommunications,. The Fraunhofer FOKUS Media Interoperability Lab creates new media applications distinguished by a high degree of interactive, personal and group-oriented usability. The Lab utilizes the well known Open IMS Playground and makes use of already available features of this unique infrastructure, demonstrating the interaction between common NGN services and IPTV. The partner is an independent research organisation, that are able to provide tailor-made solutions and support without any vendor lock-in. Possible markets are telecommunication Industry, Operators, Service Providers, Application Developers, Broadcasters, Content Providers, Integrators, Academia

Testbed 10: Im@g'in Lab. This testbed offer two types of infrastructures: - a high speed fixed infrastructure connected to a heart of IMS technology network - a broadband wireless infrastructure based on LTE technology. The offering focuses on conformance testing, interoperability testing, new services testing with end users, and collaborative projects. Objectives of the testbed is to provide our customers (e.g. SME's, Researchers, Universities, Operator) cost effective access to the latest fixed and wireless technologies and to panel of end-users, so that they improve the quality of their products and services and the time to market delay

4.1.5 Additional testbed information

Starhome and FT-PSC project: In general a roaming broker enables roaming between two networks that do not have direct roaming relationships, by using an identity of a 3rd mobile network which does have roaming relations with both the visited and the home networks. Starhome has built an IMS roaming broker that should be tested in various roaming scenarios. Since it bridges between different IMS networks, the compatibility with different IMS vendors is most important. The FT-PSC project (Federated Testbeds - Public Safety Communications) will provide few IMS test beds for conducting roaming tests. However it is highly recommended to increase the number of IMS test beds via external resources. Panlab exactly provides an access to a number of IMS labs maintained by different vendors. The Teagle tool facilitates the access to those labs by providing a single interface.

Telefónica I+D : Telefónica is opening some of its network functionalities to third party companies through a SDP (Service Delivery Platform) exposing a number of open APIs (SOAP and REST based) that can be used by companies and developers to build a new generation of telecommunication

enabled applications and services. The TID SDPLabs is an environment meant for development and experimentation, which can be offered to third parties companies and developers around the world to develop their applications in an environment that offers real and simulated core telecommunication network capabilities. A third party company using the testbed TID SDPLabs will be able to make use of the following initial set of Telefónica's network capabilities: Messaging, Contacts and Presence.

Octopus network, University of Athens, and VTT Technical Centre of Finland: Several network management frameworks have been specified during the last two decades by various standardization bodies like IETF, 3GPP, DMTF, ITU, all trying to specify interfaces, protocols and information models by taking into consideration the respective network infrastructure i.e., telecom world, internet and cellular communications. The current challenge for the network management systems is the reduction of human intervention in the fundamental management functions and the development of the mechanisms that will render the Future Internet network capable to autonomously configure, optimize, heal and protect itself, handling in parallel the emerging complexity. In the autonomic network vision, each network device (e.g., router, access point), is potentially considered as an autonomic element, which is capable of monitoring its network-related state and modifying it based on policy rules that the network administrators have specified. The scope of this use case is to experiment on the improvement of QoS features (e.g., packet loss, delay, jitter) using the Self-NET software for self-management over a live network environment and exploiting monitoring and configuration capabilities that different administrative domains provide (i.e. access network and service layer). The effectiveness and the feasibility of various parameters optimization of existing network protocols avoiding manual effort is also tested.

Technicolor, Images & Reseaux, and COSMOTE: Web TV is a common application over the open Internet but enhancements of this service is contemplated thanks to additional components permitting to add Quality of Service. Typically real time video adapters and transcoders are under investigations to ensure more efficient delivery of the video streams over the internet. The adapters offer to resize the video content with respect to terminal characteristics. The transcoders permit to face different network bandwidth capabilities. The two components proposed here are the starting and ending points of the web TV service. The particular use case setup offers the possibility to perform tests upon:

- A Video on demand Service platform
- End users in a real 'mobile operator' context.

Potential service customers include i.e. a firm developing an IMS compatible MRF (Media Resouce Function) providing buffering and video transcoding capabilities or an operator that intends to differentiate from ordinary WebTV service offer and trial the aforementioned MRF.

University of Patras: In order for one to test an adaptive admission control and resource allocation algorithm, it is necessary to set up an appropriate testbed of a distributed web application like RUBiS benchmark, an auction site prototype modeled after eBay.com. It provides a virtualized distributed application that consists of three components, a web server, an application server, a database and its workload generator, which produces the appropriate requests. Furthermore it can be deployed in a virtualized environment using Xen server technology, which allows regulating system resources such as CPU usage and memory, and provides also a monitoring tool, Ganglia, that measures network metrics, such as round trip time and other statistics, and resource usage in virtual machines.

A Federation Customer wants to test his own VOIP client application against operation conformance. Specifically the application's performance regarding:

- Sound and recording capabilities and conformance
- Dialtone correct operation and conformance

The customer's test suite consists of the following two test cases:

1. From the customer VOIP application a call to an extension number ie #301 will be made towards the Asterisk server in order then to be redirected to the ECHO VOIP service.
2. From the customer VOIP application a call to an extension number ie #401 will be made towards the Asterisk server in order then to be redirected to the DTMF VOIP service.

Fraunhofer FOKUS: This use case illustrates the design steps via Teagle for an environment in which one can execute stress testing. It starts with configuring a low end server that is exposed to a

specified traffic load via the SIPNuke tool. It obviously breaks under the load within a short time. Following the breakdown of the server the use case uses again Teagle to configure an environment that uses a higher capacity server in a cloud computing environment.

In sum, the partners within the federation have developed several testbeds that are targeting markets like: telecom, communications, future ICT technologies, ICT applications. The main offering of the testbeds are focusing on tests of applications targeting market as telecommunication and information technology sector, and research.

4.2 Value proposition / offerings

The PII-federation project includes twenty testbeds within three principal sectors of activity, i.e. information technology, telecommunication and audio visuals. Further testbeds are expected to be included in a near future. The current PII value proposition, i.e. services offered are mainly a collection of independent services provided by different partners. These service offerings are expected to be continuously enriched in order to serve as a credible research playground for European researchers in the area of Future Internet. Expressed differently, the PII service offerings will consist of a customer specifically designed offerings provided by a large number of key partners resulting in multiple offerings, a full flexible offering design.

Values:

- Testbeds allow for real life high quality tests, and are thus reliable for the customers.
- Cost savings for customers is an important aspect of the testbed service offerings. Customers are expected to need a variety of different types of services and it is thus difficult for them to set up several types of internal testbeds. Customers can through the Panlab office access different types of services needed from one source and does not need to set up tests from each test themselves. Testing thus becomes more efficient for customers. Quality of established test can thus also be higher for the testbed service provided by Panlab. (Efficiency, costs).

An issue discussed is also to enable cost efficient services to the customers to be able to provide a service at a lower cost than the customer could have offered themselves.

Offerings:

- ***Scope (number) of offerings:*** The participants also discuss how the number of offerings influences the values provided through the federation services: The participants also discuss the important of reaching a critical mass of federation offerings complementing one another. This level is not reached at present. It is today below the critical mass of use cases, “there are not enough for creating a valuable tesbed, we need to add additional stuff and reach a critical mass”.
- ***Quality in offerings:*** A problem discussed is how they could offer something when they still not had a perfect technical base, they reasoned that the technical base need to be improved before they could promise any service or offering at all
- ***Offerings in co-operation with customers:*** Participant from a large organization who both have own testbeds (not included in PII) and also use external testbeds emphasised the importance of designing testbed services together with them. They emphasised the importance for the project not to develop the testbed use case from an internal technology perspective but also to consult the potential customers before they developed the services. They referred to the different levels of complexity in the company’s testing needs and use-cases developed outside the organisation could seldom be applied directly. It is not possible to accept them right away. Fixed services were not considered as interesting for them, they could not adjust their needs from the testbed service and it would take to much resource to adjust the fixed service to their needs, that would not be considered as efficient in their organization. An additional issue was that the organization seldom used outside testbeds and this was foremost connected to policy decisions in the organization to primary focus on the internal testing service. Internal testbeds also implies a lower degree of dependency by the organization and they did not need to open up business secrets. There have been initial discussions with this company in the future and the participants argue for the potential to start the discussion again.

- It is also possible to identify tests that can be carried out at a low cost to save resources.
- The current number of offerings in the project is still limited and seen as an area of highest importance to continue to work on. The participants find it important to bring forth a plan for how to deal with this.

The multiple offerings with testing of technology expects to generate value for customers in terms of e.g. quick and easy quality assuring of the customers own products. The federation offers an infrastructure and a platform in where different actors can meet and enable possibilities to generate future businesses. The Panlab federation is however, in an early phase of defining the value proposition implying that services provided are limited in number and also of a tentative nature.

The PII-offerings lies in the border line between theoretical research output, applied technology research and development output, and commercialised output. An important challenge for PII is to continue the work with defining of specific values created in front of customers. An easy and comprehendible guide on specified testing services that can be carried out in each testbed and how services from different testbeds can be combined into offerings adjusted to customer needs are here needed.

The purpose with the testbed federation offerings is to both focus on value creation and value capturing and through this target customer segments that could not be served efficiently using established business processes or to offer new value propositions to their existing customer base. The offerings may further both be a trigger for the customers own value creation in front of their new and old customers as well as for creating internal values for the customers' e.g, in terms of increased operational efficiency. (Cf Markides. & Anderson, 2006)

ICT is not the only factor, nor is it sufficient, but it can play an important role in providing a cost-effective solution to developing new business designs. ICTs underpin strategies that deliver new "who-what-how" innovations by overcoming previous value chain constraints (in Markides. & Anderson, 2006).

In sum, the partners can provide easy access to a large high qualitative European testbed market via the Panlab federation distribution channel. Further, they can provide a customer centric access point to a diversity of testbed resources adjusted to customer needs.

Expected benefits / values:

1. Development of international and national testbed markets through the Panlab federation.
2. Collaborations improve possibilities of satisfying customer needs.
3. Decreased risks for providing of invalid offerings.

Value proposition:

1. Increase content and quality of value added offerings in the national markets for testbed services.
2. Increased number of offerings and product/service packages.
3. Flexibility in development of product and service packages increases.

Value proposition: There are also other possible values that the federation can propose for a specific customer segment. These are remote testing, time saving and the availability of a variety of resources.

Financial effects.

1. Long term effects on wealth at an aggregated societal level: national-level. Increase turnover in the national market for testbed services.
2. Increase revenue for key actors / businesses in the national testbed market Increase in turnover.
3. Scale economy.

The Panlab federation is in an early phase of defining their value proposition. This implies that the key partners providing values are not sure of what they offer. The federation offers an infrastructure and a platform in where different actors can meet and enable possibilities to generate future businesses etc.

A problem identified by the regional partners was the transformation process between theoretical research output, applied technology research and development output and commercialised output.

4.3 Customers

4.3.1 Customer segments

The collaboration with testbeds in seven nations implies a large number of facilities and also a potential of accessing customers in a widespread geographical European market. The testbeds and the regional clusters have connections with a large number of potential customers in the different nations, also implying customers in many different potential sectors and industries. Further, the project includes different types of key actor organizations and size of actor organization such as e.g. operators, service providers, research and development organizations, and supporting and administrating organizations which gives a flora of customer types that represents both profit and non profit organizations.

The large number of key actors participating in the project and the large network attached to each of the partners decreased risks for not having a viable customer segment for offerings. The partners in the project foresee a diversity of potential users/customers such as:

- Research organisations (universities, institutes etc)
- SMEs (mainly within the telecom sector)
- Testbeds (both national and international)
- Corporate customers/industry
- Individual users who wants to get acquainted to new technology
- Community users: developers, students, researchers
- Other projects (both national and European)

The most commonly expressed customer of the Panlab federation and their services is the research organisations. These organisations are expected to have strongest need of the federation's services and they are also expected to use the resources as a part of other research projects. However, this cluster of customers does not really contribute to create a sustainable testbed federation that are viable without project funding. It is also vital to have a long-term perspective, which projects as such do not offer. Common challenges identified both in this project, and in studies on innovations, is the importance of gaining access to real customers at an early stage in the innovation process. It is all too time consuming to wait for complete technology solution before turning to customers, customers may be an important actor in the future development of the offer (Markides & Anderson, 2006). This is also the case with the PII federation, they need to start interacting with potential customers to test their ideas and to gain the customers input. They also need to increase the number of customer segments by including a variety of sectors / industries and thus increase the customer base.

In the table below we show examples of benefits and challenges that the federation can face by focusing on different customer segments. These benefits and challenges have been discussed in the interviews with testbed providers. However, these customers are not definite; the aim is rather to show what can be expected with each segment. This table should also be viewed as a tool for thought by which the PII federation can boost their discussions about customer segments.

Table 3 Benefits connected to customer segments

Customer segments	Expected benefits / values	Expected challenges
Research organisations	Have indulgence with technical flaws since the federation is working with innovations that are continuously updated	Do not have large resources
	Have the technical competence to actually contribute to the federation's development through user driven innovation	Work within limited time-scope in projects
	Are technically competent to understand the potential of the testbed federation	The focus is often on early innovations far from the market

	Have the technical skills to design their own virtual testbed	Are not business (market) driven
	The testbed resources can be used as a sandbox for test of immature technology, hence experiences from using the federated testbeds can be gained	
	Focus on innovations	
SMEs	Close to market	Might not have the technical skills to test on their own
	Business focus	Limited resources
	Need support with design of a virtual testbed	Might not have the technical knowledge to contribute to the development of the testbed resources (UDI)
		High expectations on the testbed technology and quality
		High demands on test results and reporting
Corporate industry	Close to market	High demands on test results and reporting
	Business focus	High demands on testbed technology and quality
	Technologically skilled (can be)	Do not want to enclose their technology/future plans
	Have resources to pay for the tests	Might have resources to develop their own testbed
Testbeds (both national and international)	Technically skilled	Limited resources
	Can develop the testbed resources themselves	Do not focus on business
	Have indulgence with technical flaws since the federation is working with innovations that are continuously updated	
	Have the technical competence to actually contribute to the federation's development through user driven innovation	
	Are technically competent to understand the potential of the testbed federation	
	Have the technical skills to design their own virtual testbed	
	The testbed resources can be used as a sandbox for test of immature technology	
Other projects (both national and European)	Continuous development of the testbed resources	Limited time-frames (short-term solution)
	Use of the testbed resources in experimental settings	

	Have indulgence with technical flaws since the federation is working with innovations that are continuously updated	
	Have the technical competence to actually contribute to the federation's development through user driven innovation	
	Are technically competent to understand the potential of the testbed federation	
	Have the technical skills to design their own virtual testbed	
Individual users who wants to get acquainted to new technology	The testbed resources can be used as a sandbox for test of immature technology	Do not have any resources
	Focus on usage of the technology	Might not have the technological skills to be able to contribute to future internet technology issues

- ***Identification of customers needs:*** The potential of customers in the mobile application industry where discussed as a potential segment. The short time to market for new application based products and services imply both opportunities and challenges for the testbed services. It is an opportunity since companies need to perform tests very fast and may thus be open for using outside testbeds. They are through this more flexible and do not need to invest time and money in their own testbeds. However, it takes at this point in time a relatively long time for the testbed providers to adjust their tests to the needs of particular customers. They do not have an established line of business that could be used by many different customers.
- There are also differences between groups of customers regarding their need of particular tests. Some customers need tests that require a lot of resources while others only need to do a small test. The potential customers of the testbed federation services has expressed that they have needs of doing performance tests of ICT services and applications. The customers also have the need to carry out interoperability tests of services and to get a faster testing process. Another need is to have access to competent testing expertise. Hence, the customers have need of support to speed up their process and also to get access to competence. The customers have expressed the doing standard conformance tests and having access of competence regarding standards are of less interest. One aspect that is both needed and not needed is the possibility to have access to users in different countries. Some customers do not have a need for that while others do.

4.3.2 Customer personas:

In order to facilitate the process of identifying customers and to clarify different perspectives of the testbeds we have developed a few customer personas. These customer personas are often used as a design tool when it is important that the team as a whole understand customers needs and characteristics. As part of the process of determining the testbed federations potential customers, we have developed three customer personas based on the results from our data collections, these are researcher, SME, and large enterprises. The aim of these personas is to identify the goals, requirement, context and usage of the federation's resources. Important to note here is that the customer personas are archetypes of customers, not a specific real person.

4.3.2.1 Researcher (other projects)

The first customer persona we want to describe is the researcher. The researcher is a computer scientist with high level of expertise within the area of IT-system development. This researcher has got in contact with the federation through a European project in which one of the testbed providers in the

Panlab federation is one of the partners. In this new project, it has been decided that the researcher should use the federation's resources in the project when they develop future internet technology. Here, the researcher is motivated to use the testbed's resources by having the opportunity to test their technical system within limited and well defined technical boundaries, hence having control over what is happening with the system. The researcher also wants to use the federation's resources instead of developing their own. In addition, since the researchers are part of a research project, they are able to continuously monitor and control ongoing activities, thus it is possible to identify weaknesses with the developed system in the testbed. Due to the situation that the researchers are part of a project, they are willing to use the testbed even if it has some technical limitations if these do to interfere with their own system to be tested. The researcher is also willing to contribute to the development of the federation's resources based on their expertise and usage within the area. Hence, when the researchers have created a VCT and used it for their tests, they give input about their experiences from their usage of the federated testbed resources who then can take this input into consideration in future development.

4.3.2.2 SME

The second customer persona we want to describe is the SME. The SME is a small IT-company that wants to do a test of their newly developed VOIP application by using the testbed federation's resources before they introduce it on the open market. The contact person, who has been requested to contact the Panlab federation with the test, is responsible for quality assurance of their services and has found the Panlab federation through their website. Since this person does not have the technical knowledge to plan, execute and interpret test results the Panlab federation is contacted via the Panlab office and they plan all the stages of the test collaboratively. Since the SME has rather limited technical skills, limited budget and wants to get their application on the market soon, they decide that the test should be small but summarized and interpreted into a report. To perform the test, resources from two different testbed providers are used and afterwards, the results from the test is analysed and interpreted in a written report which is sent to the customer. For this customer, it is of utmost importance that interpretation of the results can be trusted since they do not have the right persons to value the results from the test of the application themselves. This customer give their input regarding the process so that the federation can further develop it.

4.3.2.3 Large Enterprises

The third customer persona is the large enterprise. This enterprise is motivated to use the Panlab federation's resources since they do not have all the resources available for service testing within their own organisation. This enterprise has found the federation through its website and designs their virtual testbed by themselves. They want to keep the tested technology, as well as their test results a secret, hence, they use resources from different testbeds and they request a high level of discretion from the testbed providers. Since the service the enterprise develops is vital for their future development and business they have decided to invest resources in the test and thus, they have high demands on the tests as well as the technology they use for the test. Being able to trust the results is very crucial for them. The results from this test cannot be read by anyone, they merely want a pile of paper that they can analyse themselves.

4.3.3 Customer relations

As soon as the customers have been identified, it is important that the federation starts to build relations with their customers. One aim with the federation is to conduct most of their businesses online. However, even though online business is conducted virtually, the Panlab federation's customers are still real people with whom it is important to build relationships with. For the federation, marketing the federation's offers on the Internet is a natural step. Here it is important to find relevant places to be visible at and also to decide areas worth exploring to boost the usage of the federation. The Internet holds no geographical barriers, hence, there is a great possibility to reach out to everybody who has access to the Web around the world. The federation can for example be marketed through the partners' websites, the federation's website, FIRE community (cordis) and via the ENoLL network.

When the customers have found the federation it is important to educate them while the offerings from the federation are marketed. The Internet customers firstly want to know what kind of testing resources that are best for them, hence, it is important that the federation makes it easy for the customers to understand what kind of resources that are available via the federation and which types of tests that are possible to do. Adding to that, it is important to pinpoint down the added value of testing their technology before they introduce it on the market. Why not give it to them while they're visiting the Panlab federation's webpage?

To encourage the customers to visit the federation's website it is important to recognize that the partners' individual relationships is the most important asset. It is also important to know what the customers want and how they can be communicated with. Email marketing is one such tool that can help to build stronger relationships with the customers and result in big cost savings. Important to note here is that to use this channel, it is important to have good relations with the customers, otherwise is might be considered as spam. Using email also put high demands on the message that is pushed to the customers. Today, many people have inboxes that are overfull, hence the message need to be short and appealing to the customers.

As in any relationship it is also important to listen to the customer, to understand what they want and need, and to let them know that their input is valuable for the federation. Hence, the federation needs to establish an authentic exchange by using tools such as online surveys, or other feedback channels such as a customer community, to stay in touch with their customers' needs and suggestions. Customers also value trust in their relationships. Earn trust and keep it by continuously working to maintain the integrity of the federation's customer relationships. Here, engaging newsletters, blogs or tweets to build familiarity and trust can be useful, also to become the first thing the customers think of when they think of testbeds.

The Panlab federation is planned to function as a third party who have some established relations with customers, hence, testbed providers that are part of the federation also get access to other partners networks and relations. The federation can also facilitate administration of customer relationships by providing a webpage and a standardized communication strategy that strengthens the brand as well as the offerings from the federation. Since all connected testbeds communicate in similar ways and with harmonised offers, the efficiency of the communication increases as well as the impact of the offers. One customer need that has been identified is to have access to competence within the test area, connecting several testbeds to each other and to use the collected knowledge this includes provides great possibilities to improve the quality of the offerings as well as the resources within the federation. Having access to the competences in the federation also decreases the customers' needs of having in-house competence themselves. The Panlab federation also contributes to developing and maintaining different types of customer relations due to its access to broad competences, which in turn increase flexibility in customer relations.

4.3.4 Customer channels

Concerning customer channels, the results reveal that a variety of distribution channels can be used to spread and exploit the federation's offerings. These channels can be clustered into three overarching approaches; Panlab office, Academy, and Personal Contacts.

In relation to the Panlab office, it has been found that the partners in the federation wanted to use the marketing and distribution channels that are decided and promoted from the Panlab office. They want to spread the results via this organisation's website and events, both on-line and physical.

The use of the academy as a distribution channel refers to ordinary academic channels such as publications in international research journal, presentations at research conferences and to attend exhibitions.

The third distribution channel is personal contacts. Here it has been suggested to contact their potential contacts via e-mails, to contact their current and former customers personally and to use the partners' organisation's distribution channels.

It is important to bring the federation's offerings to the right people and to reach the target audience. There are a lot of different distribution channels available on the internet today that could be utilized efficiently to the benefits of the federation's website. Everyone knows about the traditional online

distribution channels such as newsletters, and electronic press releases, but the federation could go one step further since it is the future Internet it is all about, hence the customers can be expected to be advanced users of the internet.

1. Social networks (Facebook, MySpace, LinkedIn)

The trend of the internet these days is social interaction, and the trend seems to be here to stay for a while. Using this as a distribution channel means to reach more people and increase the awareness of the federation's offers. The challenge with this is to use it in an appropriate manner. This is a rather immature channels which imply that a lot of experimentation might be needed to fully harvest its potential.

2. Social bookmarks (del.icio.us, Stumble Upon, Digg)

Social bookmarks enable customers and users to share, organise and store URLs of websites they like and/or find useful. And because social bookmarks are created by users who understand the content of the website they bookmark, it makes it easier for other users to find stuff related to an interest. Hence, the customers using the federation can also tip other potential users about the federation's resources.

3. Social media (YouTube, Flickr, Podcasts)

As with social networks and social bookmarks, social media has become increasingly popular among Internet users for the same reasons. Using a social media like YouTube or Flickr as a medium to promote the federation could bring a lot of traffics to the website which might influence the usage of the federation positively. The challenge here is to become visible in the vast flora of others contributions.

4. Blogs

Blogs are popular because they provide up-to-date information and enables readers to engage in discussions via comments. By using blog as a distribution channel, the federation can build a loyal readership and interact with the customer base. This approach requires resources and a commitment to update and communicate with the customers from the federation's point of view, hence, the Panlab Office might have this as a responsibility. Possible bloggers could be testbed providers who in their blogs describe their latest updates, challenges, tests etc to encourage other users to use their testbeds. These blogs could also describe how the testbed resources in the federation could be used and so forth.

5. Widgets and gadgets (Yahoo! widgets, iGoogle gadgets, Facebook APIs)

Widgets and gadgets deliver dynamic and updated content to the users at any time. They leverage the website's content to create new opportunities, extend users and strengthen the presence of the federation's brand, and for that very reason, widgets and gadgets have proven to be a very successful method of distribution.

6. Search engines

Many of the users on the internet today find websites through search engines. There is an established belief among many developers today that "if we build it, the customers will come", the truth is, the customers can only come when they know about it. Therefore, the power of search engine optimization (SEO) and search engine marketing (SEM) should be used to drive targeted and qualified traffic to the federation's website and improve visibility of their business.

The Panlab federation can offer a large number of services to their partner organisations such as for instance:

- Administration of customer channels
- Competence in handling customer channels
- Decreased risks for not having viable customer channels and not reaching customers.
- People employed in the organisation who have the competence to handle customer relationship
- Virtual machines
- The Teagle portal and associated repositories
- Publish and distribute research papers

In sum, there are many potential customers for the federated testbeds which all have their own pros and cons. The main issue here is to understand what can be expected with each customer segment and to handle that. When the customer segments have been decided, the next step is to consider how to build relations with each segment and how to communicate with them. One way to communicate with these customers are of course through the internet where the customers can be expected to find the federation. Here a combination of different channels is preferable to have a large impact. Related to that it is also important to remember that each channel requires different resources as well as different ways of communicating. Hence, the federation needs to determine which channels to start with and how these channels should be used.

4.4 Finance

The financial goal of the PII project and the development of a sustainable Panlab federation is to from a both short term perspective and long term perspective enable dealing with management of resources and develop activities and businesses that fit with to the current resources available and the future resources planned to acquire.

The offerings provided in the PII-federations are currently in early stages of their life cycles, thus the maturity is low and this implies difficulties in gaining access to resources and particularly financial resources in terms of revenue. An important problem frequently discussed among the PII key partners was the chicken hen problem of finance and gaining access to resources for enabling the development of sustainable testbed service businesses. Collaboration among key partners generates resources to be used in the project it for instance helps to decrease costs of human capital, costs of administration, costs of customer relations, costs of customer channels and provide a scale economy that in a long run perspective also may increase turnover for the key partners.

Sharing resources among partners were one possible way of financing the organization but the participants perceived that such a solution would increase the time to market for the testbed federation services and for the development of sustainable testbed businesses. Key partners were unsure of how to commercialise the offering without external finance at the same time as the future testbed-federation was expected to improve the potentials of gaining access to such external finance.

Pricing is a key issue related to the revenue management and it is also is a central part of the financial management in the PII federation, an activity that helps to allocate resources and that is far from easy to decide on (Diamantopoulos & Mathews, 1995; Fog, 1994; Fletcher and Russell-Jones, 1997). It is nevertheless well known that "*The way in which a firm prices its products or services holds the key to its success or failure"* (Cunningham and Hornby, 1993, p. 46). Many textbooks deal with the issue of pricing but then typically from a simplified point of view. Pricing is a challenge for development of sustainable testbed businesses with multiple and complex offerings where many key actors are involved in an international market. The key partners discussed the immature state of the testbed market and the lacking base of paying customers and how to identify potential customers that both are willing and able to pay for services for providing a revenue base.

Difficulties in completely self-financed sercice offerings in an immature market based on high technology embedded in high degrees of uncertainties was a core issue discussed in relation to the PII business model. Key partners experienced difficulties in defining and convincing customers of the value of the offerings provided through the testbed federation and this also received implication on the revenue streams. The immature market and inexplicit offerings receives consequences in that customers are not aware of how the testbed services can create and/or maintain values for their businesses and customers are through this not willing to pay for services. One of the partners stated; "*It is one thing to develop a testbed to be used for 100 000 dollars where customers pay 10 000 dollars for support and everything work as it should work*". The participants provided an example of a project for 2M Euro that not could identify customers willing to pay even 10 000 Euro for the services. The immature market implied that potential user could not yet see the potential of the exemplified project, even though 80-90% of the costs were covered, they were not inclined to finance 10% for extra costs, it was too much for them to invest. The example illustrates in accordance with the economic view on pricing in a situation where an efficient demand and supply system has yet not been developed and where no efficient price mechanism are implemented. The federation partners do no act

in a market with perfect competition, they are not price takers passively accepting prises set by impersonal markets and thus need to estimate and suggest own prices in front of potential customers (cf. Lipsey, Steiner & Purvis, 1990).

According to the accounting literature, accurate pricing needs to be based on real costs of offerings (Johnson & Kaplan, 1987; Drury, 1998) while this view is questioned in the marketing literature where price is seen as one part of the marketing mix that continuously need to be revised in accordance with changes in market conditions. It can be concluded that both the accounting view of cost based pricing and the marketing view on market based pricing are important to consider in pricing decisions. Currie (1995) for instance argue for that a first question to be asked is what "the market could bear" and this aims in a next step decide the framework for costs associated with the offering. The marketing literature emphasizes the need to consider business model components related to market and customers in the revenue and pricing decision. For instance market segmentation, differentiation in price, customer perceived values in pricing, the product life cycle pricing and competitor-oriented pricing need to be considered. Studies indicate that pricing is situational in nature and Diamantopoulos and Mathews (1995) suggest four critical contingency variables to be considered in pricing decisions, i.e. the nature of the products, the scope of and type of competitor, the market conditions e.g. in terms of market growth rate, and finally how competition influence the role of price. Pricing strategies are also further often considered in relation to quality in relation to price. In the case of PII, pricing in accordance to the marketing literature is difficult, if not impossible, due to the low maturity on the market for the complex offerings which PII aims to provide.

Costing systems may on the other hand help out in pricing decision making processes (Frenckner & Samuelson, 1989; Horngren, Foster & Datar, 1998). Costing in relation to pricing decision is often considered in relation to variable costs and full costing as departure for pricing decisions. From a short term perspective, variable costs are often recommended for starting the pricing decision while full costing is typically recommended in connection to long-term pricing decisions. Selection of time perspective also influence the decision on what to be considered as variable and fixed costs (see Ask & Ax, 1997).

It can be concluded that strategies of financial management e.g. in terms of revenue management and cost management are needed for taking the PII testbed services into the next step of commercialisation. There are for instance goals of start the exploitation of offerings, to start to make turnovers and also successively increase the amount of turnover. It is also a matter of cost management e.g. to further decrease the cost structure, balance the goals of expansion and cost structure.

The problem of revenue and pricing is closely related to the market maturity and expects to change in the future when the market become more mature and offerings are clarified. It is from a perspective of a testbed market important to develop a market with a variety of well defined offerings that in a long term may help to increase turnover in the international market for testbed services. A more mature market is expected to guide the pricing of offerings in the market and that the PII-testbed federation would through this come closer to the role of a price takers than what is the case today with the immature market situation. Increased maturity in the market also expects to increase revenue for early entry key actors / businesses in the national testbed market. An alternative discussed among the key partners for gaining access to future resources in a not so distant future is turning to new testbed projects for financing of the own testbed service and business development. This also expects to help out in an initial development of the new immature market.

Still, it can be concluded that pricing decision may be explored on and guided by mixing the three areas of literature, i.e. economics, accounting and marketing and all areas may provide different rules of thumbs that need to be considered in the pricing decisions despite the immaturity of the market situation facing PII. Pricing is a central activity related to the financial component and pricing is a function that often lacks professionalism when developing business models.

4.5 Organizational design and the Panlab office

The offering design requires a well defined organizational structure in order to deal with the high complexity.

Business models have become more complex with the emergence of new and affordable ICTs. Companies increasing the act in networks and offers complex value propositions through a multitude of distribution channels. For managers it is ever harder to keep track of how their companies will work and where profit is generated (Osterwalder & Pigneur, 2004).

The Panlab project involves identification of both an organization design testbed federation business model organization and business model design is about to be developed. Development of a Pan Lab federation office is an important step in the development of a sustainable testbed federation and is thus cautiously evaluated within the PII project. Different scenarios on the management of the Panlab office has been discussed and evaluated through out the project. Through this several possibilities was evaluated together with pros and cons. One early scenario was for instance built on that Eurescom acted as a spider in the web responsible for the coordination and administration of the Pan Lab office. Another scenario was that a number of business driven organizations among the key-stakeholders together organize and manage business generated through the Panlab office.

The business model organization refers to the development of a Panlab office. This office is characterized as fairly simple in nature, based on a few stable functions. The business model organization is supposed to be relatively stable in nature. The business model design is still flexible and unclear in nature, has not reached a higher level of maturity and is also expected to continuously change for a period of time. The whole Panlab business model is both related to a high degree of complexity and a high degree of uncertainty in several factors of both internal and external character. The comprehensive business model thus also implies difficulties in the disclosure of business model information relevant for external shareholders. The complexity and uncertainty make it difficult to provide external parties with a solid base of information; there is a high degree of information asymmetry between project partners and external partners. However, the compressive business model also implies difficulties for the internal parties in the communication of the business model content. It is difficult to develop a common frame of reference. A way for the Panlab federation to deal with this type of business model is to develop a business model characterized as 1) Simple and stable in organization and 2) Flexibility in design.

- A federation but with informal collaboration between parties

The different approaches lead to:

  - Different degree of management
  - Different revenue streams

- Fully automated or manual process, or a bit of both?
- Responsibility:
  - for test results when different resources are combined
  - for the selling of the federation resources
- The federation customer relationship process – from identifying and communicating with the customer to delivering the test results and evaluating its value

Organization:

Production process: The participants discussed the need of flexibility in the production line. It was here possible to identify targets where components easily could be rearranged, a base with potential of flexible adjustments. There could also be components where it would be possible to add additional functions ex sensors. This would provide an additional value. It is here important how long time it would take to make such adjustments of functions.

Production process: Connecting to the operational work and the business model organization: Should services be carried out automatically or manually (business model distribution channel – customer relationship).

Panlab federation office organization: We should not go to the discussion on a future organization; there are 9-10 organizations, e.g. Nokia and large and small companies. We need to define something… If there is an organization, one can decide to support it. There is a lot of work to create an organization.

4.6 Testbed Providers and End-Users Perspectives on Tests

In this section, a summary of the interviews that has been carried out with testbed providers are given. The aim of these studies was to gain knowledge about the testbed providers expectations on the federation from a socio-techno-economic perspective. Thereafter a summary of two end-user studies are presented. The aim of these studies was to learn about what motivates end-users to participate in innovation activities such as tests.

4.6.1 Testbed Providers Perspective on the Federation

As a means to identify the potentials and expectations with the PII federation we have conducted interviews with the project partners as reported on in section 4.2. The interviews reported on below were carried out in the middle of the project. The results from the interviews reveal that there were rather high expectations on what the federation could offer to their testbeds in the project. Here the interviewees had an expectation that they would actually earn some money from the testbeds by starting a European collaboration. The expectations on this collaboration were that it would give them an opportunity to save money by sharing costs for investments and resources. They could also get access to other testbeds resources which would make it easier for them to attract customers and also to enrich their customer offerings. By developing a single entrance point to Europe's leading testbeds and a broader geographical reach, the testbed providers could offer the federation as a service and hence strengthen their customer offerings. In this way, they had identified the possibility to obtain a share of revenues they had been part of bringing into the federation, by showing the customers to the resources the federation can offer. In addition, by joining forces the testbeds also expected the federation to help them keep track of future trends and the market which would reinforce their possibility to offer high-end technology testbeds to their customers. One identified value of the federation is the ability to perform large scale tests in different cultural settings and with different technical infrastructures. If the federation succeeds, it could contribute to increase investments among its partners which would lead to enhanced services and offerings. Being part of the PII federation can also be a value in itself for the testbed providers if the federation succeeds since they can offer a pile of testbeds and resources to a fare price (hopefully). Another expected value of the PII federation is that it will function as a way to attract customers that they would not have been able to attract otherwise.

However, offering an entrance point for potential testbed customers is not enough to ensure its success. It is also vital to build customer relations, trust and to have customer contacts. As one of the respondents expressed "Someone has to do the selling". To fulfil that goal, the Panlab Office has been developed which aims to handle customer contacts. This is a good first step, and it also requires staff that are engaged and committed to their task and people with a large personal network among potential customers. When it comes to collaborating in the PII federation, it is difficult to open up and reveal what kind of business model all the partners have in mind. In relation to economical aspects, competition is hampering the collaboration, while from the technical perspective competition is viewed as something positive that boosts the partners' development processes. Based on what the interviewees said, being a partner of the PII federation might not contribute to their organisation on short term, but seeing it in a longer perspective, it might.

The overarching view of the testbed users in this case is that they work in the telecom industry and they have a high level of technological maturity which is needed to be able to use the resources offered by the Panlab federation. In addition, the users need to be experienced in testing and be knowledgeable of testbed processes to fully explore the offered opportunities. In our interviews, testbeds are often viewed as a sand box where developers can try new technological solution without interfering with the system in use. Hence, the testbeds becomes a limited and secure place for experimenting with high-end innovations.

When it comes to the social aspect of the testbeds, especially focusing on user driven innovation, the results from the interviews reveal a somewhat scattered view. In the interviews, both the aspect of end-user driven innovation and testbed user driven innovation were discussed. How these different user groups can be involved in user driven innovation is fundamentally different in this context due to the complexity of the technology in focus

One observation from the interviews is that user involvement is considered to be a complex task in the Panlab federation context. It is uncertain how users could be involved, when they should be involved and who they could involve. The respondents also expressed a consideration on how to actually involve users in their processes. They thought that it was difficult and that a supportive infrastructure was needed, but one that they lack in today's system. It is also viewed as a huge challenge to know what the users actually want.

Based on the results from the interviews it is observable that user driven innovation from a customer perspective is something that the interviewees view as an important aspect, as shown in the expression from one of the respondents. He stated that "*I mean, the best way of keeping customers coming back to you is to listen to them".* The respondent thought that involving the testbed users in the development of their technological offering is a fruitful way to develop their testbed resources. For example, several of the interviewees stated that by analyzing what kind of support and resources the users ask for, the federation can adjust and develop their offered resources. One possible solution that came up during the interviews was the federation's opportunity to build up a community where it becomes possible to gather interest in continuously developing the federation's offerings. "*You got to make sure that what you are doing is to meet the users needs and if their needs shift, you will be able to shift with them",* as one of the respondents said. Hence, the interviews reveal that the testbed providers think that user driven innovation is an important factor and that it is important to include the users in the test process and the further development of the testbed federation offerings. However, in the discussions on how this could be realized, they do not have an implemented solution for that at the moment.

Challenges that have been identified in our study can be viewed from different perspectives. The first perspective we want to highlight is the customer perspective (or social view), which has not been really in focus for this project. Taking this perspective means that it is vital to identify what the added value of the federation is, what is really being offered? In the interviews, one central aspect has been to identify what customer need the federation is answering to and how they plan to contribute to that need. The respondents state that they think it is really important to have close contact with their customers, but they are a bit unsure of how. One important aspect of having close customer relations is the innovation power that lies within it. This mean that communicating with the customers will make it possible for the testbed providers to identify gaps in their offerings which in turn offers a business opportunity for the. They can also identify what is not sought for and terminate that resource. Today, there are no mechanisms in the technical system that supports user interaction and feedback. For instance, if a customer has a need for a specific kind of resource they would like to use, that cannot be captured other than by personal contact these days. In addition, the technical tools available today do not support user driven innovation and end-user tests.

If we then consider the scenario that a customer actually use the federation, our interviews show that it is rather undefined what the actual output from the test will be. Here it is important to answer questions such as who has responsibility of what. For example, if a customer uses resources from 5 different testbeds, how will the test results be reported back to the customer? Will it be 5 piles of log files, or one test report? Who will have the responsibility to ensure that these resources can communicate with each other and hence guarantee that the results from the tests can be reliable? What if something goes wrong in that communication, who will have the responsibility towards the customer? Another aspect is the large companies that can pay for the tests, but wants guarantees that it functions. To be able to ensure a high quality product, it is therefore of vital importance that the people involved in the development of the resources within the federation can provide high-quality products and services.

Another possible scenario when it comes to responsibility can be if a customer is performing tests on secret technology. Who can then guarantee that the results will not be revealed to others and if they does, who will have the responsibility for that? The easy answer to this is the testbeds them selves or the Panlab office. Here, the interviewees did not have an answer, these are rather considerations that has come up. Taking the customer perspective also highlights the difficulty for some possible customers to really understand the resources that are offered and to understand how to combine them. This is an issue that has been discussed in the interviews where some of the respondents state that it will not be a problem to handle since the customers know what they want, while other are more unsure that they actually will understand it. Here one suggested that has come up in the interviews is to train

the customers in using the tools. This is also an activity that been carried out during the PII project. Another important aspect when it comes to understanding are explanations of the resources which can facilitate the customers usage and understanding of them.

A challenge highlighted in the interviews is how to build trust and collaboration to facilitate openness with business ideas, pricing and offerings. This is a crucial aspect of PII since most of the testbed providers do not know how to price their resource within the PII office and at the same time, it has been expressed that none of them wants to be first. This stressed the importance of communication among the testbed providers as well as the importance of facilitating a climate where people feel safe to expose their thoughts and ideas. If the communication and trust is not enhanced among the partners in the federation, the likelihood that the federation will become a success decreases.

To add to the complexity viewed from a social perspective, the involvement of end-users has been discussed as an important part, but an aspect that is regarded difficult. No one really knows how to involve them, nor do they have the required skills. As suggested by one of the interviewees, a partner outside the federation with that kind of knowledge would be useful at this stage. Another perspective is the usability, central for the users of e.g. the Teagle tool.

When it comes to pricing and how to get paid for the services the testbed providers offer to the PII office, the pricing model is somewhat unclear. The respondents do not know exactly how they will get paid, who determines the price and so forth. Customers possibility to compare different resources and prices with each other were highlighted since it is not facilitated at the current stage of the development.

Viewing the federation from a technical perspective the respondents state that the technology as such is not a problem, the integration will be functioning and so forth. However, one discussed issue is the situation that most of the resources offered in the federation are prototypes. This makes the system less reliable and stable and it will also be in constant development. This could both be seen as a strength where innovative resources are made available but it is also a constraint since the stability and trustworthiness of prototypes is expected to be rather low. The respondents has also emphasised the fact that the federation as well as the technology is very much at an immature stage which makes it difficult to have high expectations on impact. The technological maturity here puts delimitations on what to expect as well as what is possible. The interviewees have also stated that the technology that is developed within the PII is developed from a technical perspective, not from the users perspective. Here, some of the respondents said that the technical development would benefit from involving users earlier in the process since many innovations stem from users needs.

Also related to the technical perspective which influence the economical perspective is the fact that many of the testbeds provides similar resources to the federation. As such, this might not be a problem since it stimulates the competitiveness among the providers. But one important aspect here is that if many of the testbeds are offering the same, or similar, kinds of resources, what is then the added value for the testbed providers to join the federation (because it does not give them additional testing resources) or what is the added value for the customers to use the federation instead of going to one of the testbed providers directly? Another aspect that has been expressed by the respondents in relation to technology is the span that the federation aims to cover. It has been said that the federation includes to many things, hence, it becomes difficult to form a specific offer. This is not an issue from the architect point of view, but rather from the script view. How to describe a base station and an IMS software in a unique manner, in a comparable manner and in the same manner are issues identified that are not yet solved. It is also difficult to determine which information model and description model that should be applied to make coherent description of the resources. Besides that, the Teagle tool does not support automatic updates of the resources as it is designed today, hence the information about the resources needs to be filled in at several places as soon as a testbed provider updates their resources. The strategy now is to go for as open strategy as possible to not be constrained by corporate security framework and such things.

4.6.2 End-User Involvement in Tests

In this section a summary of the results from the end-user study carried out in February 2009 is given. This survey was answered by 198 users and the results from this survey showed that most of the users

(31 %) were in the age between 21-30 and 27 % were in the age of 31-40 years old. In this survey, 60% were men and 40% were female and most of them were employed. When being asked about their degree of education and its direction, most users, 54%, had a university degree and 41% had a technical direction of their education. 68 % are employed, 5 % have their own company, and 15 % are students.

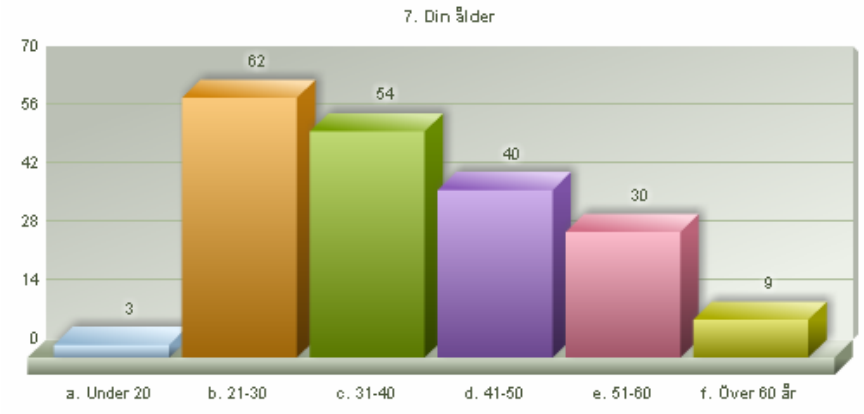


Figure 4 Results from the end-user study

When it comes to participating in the user activities at Botnia Living Lab, the results of the study show that 25 % of the users have participated in one or two activities, and 40% have been involved in more than three user involvement activities.

Among these users, approximately 95 % use their mobile phone and the Internet several times a day. The users have been members of the community for several years, but visit Botnia Living Labs webpage more seldom than each month and when they visit, they participate in user activities or read about on-going activities. Some of these users view themselves (45 %) as utility users of technology, meaning that when they realise that a product or service is useful and some people in their surrounding use it, they also start to use it. 4 % view themselves as innovators, meaning that they develop the application they need, 12 % can be identified as lead-users, which means that they usually recognise a need of product or service before they are available at the market and 28 % view themselves as technology enthusiasts. This means that they usually want to start to use a product or service as soon as it is available at the market.

These users willingness to participate in user involvement activities are determined by factors such as if they can win something, if the topic is of interest, if they get an ability to influence the technology development and the surrounding society and if they feel that their opinion is of importance. The answer distribution of the multiple answer question "Determining Factors for wanting to participate in tests" became as follows:

- To win something - 53 %
- An interesting technology – 81 %
- To be in control – 87 %
- Test in my hometown – Not at all determining
- I have influence on technology development – 51 %
- To contribute with ides to new technology – 53 %
- To learn about new technology – 65 %
- Contribute to a better society – 54 %
- To feel that my opinion is important – 52 %

When it comes to community engagement, most of these users are also active in other communities such as Facebook and Buzzador and they are motivated to be active in communities if these offer an opportunity because they offer:

- Personal growth

- Social network
- Give vent for their creativeness
- Share things with others
- People in their network has it
- Interest
- Gifts
- Enjoyment

When it comes to what the end-users use Internet for this study show that the users of Botnia Living Lab, in general, never use internet to develop their own applications or services, to write blogs, do schoolwork, play on-line games, up-load content, participate in discussion forums or for commenting others content or contributions. On the other hand, they often use internet to search for information, handle e-mails, read news, do bank errands, communicate with friends, and for taking part of what others have up-loaded.

4.6.3 Results from end-user study II

In this section we report on an end-user study carried out in May 2010. In this study we have used an on-line survey to collect data from the users. This survey was publicized by contacting a significant number (n2545) of users via e-mail. These users are gathered in a user database at Botnia Living Lab which has been built up since year 2003. The aim of this database is to create a gateway to users who are willing to take part of innovation activities on a voluntary basis. This particular study was introduced to the participants as a self-reporting opinion survey regarding *"Your participation in innovation activities"*. 270 users responded to the survey, which gave us a response rate of 10.6%. The aim of this study was to understand the characteristics of end-users that voluntarily contribute to open innovation communities and what motivates them. The results from this study is relevant for the Panlab federation if they aim to implement UDI and thus needs to understand what kind of users that would be of interest to put their effort on engaging and also to know what motivates these users so that suitable incentives can be implemented into the system.

Analysing the background data of the respondents we find that two-thirds are male and one third female. Despite this difference, the distribution in gender comes close to the common scale of 40/60 often seen as the threshold of gender equality. The age of the respondents ranges between 15–68 years old, with 29% of the respondents between 31–40 years old and 71% between the ages of 26–50. Half of the respondents have a university degree and almost 70% are employed.

Our data clearly show that the users of Botnia Living Lab have many common characteristics. They all have a high technological use level; 97%, use the Internet either 24/7 or several times a day; 83.5% are members of one or several social networks and more than 60% of them visit their networks several times a day or 24/7. The users' attitudes about technology also are confirmed by their choice of technology adoption type. None of the users sees themselves as *technology sceptics*; instead, the majority viewed themselves as either *technology enthusiasts* or *utility users*. There also is a high representation of people at university, with a university degree or employed. The main difference in the group is related to age and gender.

The picture becomes a bit more diverse when analysing what motivates the members of Botnia LL to participate in innovation projects. There are five motivational factors that are ranked as very important by more than half of the user group:

- learning something new
- testing innovative products and services
- curiosity
- winning something
- being entertained.

This means that the group as a whole is in consensus that these motivational factors are important; the divergence in their answers is rather about how important the factors are considered. The same trend can be seen among the other factors as well.

Learning something new is the strongest motivational factor within the group; it is seen as important to almost everybody, and very important to almost 70% of the users. Among the top six motivational factors, only one divides the group in two camps and this is related to the importance of being able to win something. While the majority of the users state that they are strongly motivated by the possibility to win something, more than 20% of the users also state that this is not at all important. As such, it represents one of the few motivational factors listed that more than 15% of the users considers as not at all important.

It also is interesting to see that two of the three motivational factors ranked as least important by the users relate to social factors: *getting to know new people* and *social belonged*. This is somewhat surprising considering the users' relatively high involvement in social networks. One possible explanation for this is that different types of communities satisfy different needs for the users. Hence, social networks are used mainly to satisfy socially related needs while Botnia Living Lab, as an open innovation community, satisfies needs related to learning, testing innovative products and services, and stimulating curiosity.

Since user communities and innovation communities have become a way for organisations to utilise external resources, they appear in many different contexts and form, and as such they differ in purpose, methods, user profile, etc. Developer communities such as Free/Libre and Open-Source Software communities (FLOSS) are characterised by young single male developers without children but with a university degree with a technical orientation (David & Shapiro 2008). They mainly are motivated by values such as: people should be free to software they use; I want to give back to the community, and I want to provide alternatives to proprietary software (ibid).

Developer communities for mobile applications, such as those hosted by Apple and Google, attract similar groups of people as FLOSS but the motivational drivers differ. For these developers, the size of the market, return on investments, low barriers and personal development are main motivational factors (Bergvall-Kåreborn *et al.* 2010). For these users, the brands of Apple and Google, and what they stand for, also are of vital importance. This indicates that there are major differences between categories of innovation communities, as well as within.

Dealing with motivational factors is not a straightforward process where one size fits all; instead, it is dependent on situational and personal factors. In research related to different personality types, it has been found that individual personality traits play a role in the use of interactive social media tools. Since a specific personality type leads to a diversity of usage, it can be expected that a specific technology adoption type might influence the motivational factors for users to contribute to innovation activities.

4.7 Benchmark of testbeds

4.7.1 General features of testbeds

An effective testbed should be used by both experts in the technology which it exposes and those who just want to integrate that technology with higher or lower levels in an application stack. It must be robust enough for reliable, reproducible tests by the first category of users as well as for durable prototypes needed to expose new functions to end users (http://www.ict-fire.eu). This part of the report will identify on-going projects and their potential users of the test-beds.

A project called FIREwork (http://www.ict-fire.eu) has identified a set of issues which must be dealt with by a single testbed or by a federation of testbeds in order to support real external users:

- "User facing clearinghouse "is the way a facility is discovered, how you can be authenticated as a user and how the access to the facility can be defined. This is not only a list of facilities it is also the ability to create an understanding in what way a facility may be used.
- "Terms & conditions" includes the cost to use a facility, the acceptable use policy, frequency and duration of use.

- "Security & Privacy" defines both the ability to protect the IPR of the experimenter and the facility provider. It also includes methods to protect privacy of a traffic data.
- "Operational & Research Monitoring" are the functions to start, stop and meter experiments and other operational aspects of experiment control.
- "Define, simulate and control experiments" is the process of creating and supporting the experimental development process.
- "User support to grow the market for test beds" is the process to make public what facilities are available and when, announce federated facilities and promote use of facilities for other user groups.
- "Deployment of resources" is the process of creating the virtual test bed for an experiment where both physical and software resources will be bound to an experiment.

Difference between academia and companies; the terms and conditions of usage are still complex issues.

4.7.2 Benchmarking an important activity

Benchmarking is an important activity for further understanding the Panlab testbed services in relation to other testbed services provided by competing and complementing international projects. Three Business models were presented and compared at one of the business model workshops held in the PII-project. The business models were 1) Orbit Lab, 2) The open cirus test bed and 3) ***Planet lab*** were presented and the workshop participant These three business models were different and also experienced to be successful. ***Orbit Lab*** includes a Wireless field trial network, their services are worldwide deployed and they offer evaluation of protocols and applications in real world settings. The open cirus test bed is connected to the HP Intel corporation and Yahoo Inc, July 2008, it includes more than 50 research projects, situations of real life, global internet environments. The goal is to provide the researchers an ability to test applications and measure – platforms. Planet Labs is a worldwide network of R&D institutes. Their business model is in short based on that each partner provides hardware and receives a specific time slice that can be used to test network applicant and protocols on the planet lab network. They have pure academic customers. The discussion on the benchmarking helped the key partners in the sense-making process of their own business model development e.g. in the identification of types of customers, i.e. customer personas.

The Panlab federation project with development of testbed services may also be related to non-European projects that have received great international attention. One such project is Geni and another such project is AsiaFi shortly presented below.

GENI

GENI (The Global Environment for Network Innovations) is being designed and prototyped in a series of quick, one-year ³spirals.² The GPO (GENI Project Office) issued its first solicitation in December 2007, six months after the office was created, seeking proposals for GENI Spiral 1 prototyping. The goal was to fund multiple competing projects in core areas such as resource discovery, control framework implementations, and wireless and optical networks. At that point the GENI design was still immature, and the GPO encouraged the science and engineering community to flesh it out. Now there are two nearly complete spirals, third one is kicking off. GENI projects are listed at www.geni.net.

AsiaFI

FIRE¹s main point of contact in Asia has been the umbrella organization AsiaFI, which can be considered its Asian equivalent. Asia Future Internet Forum (AsiaFI) was formed in 2007 to coordinate research and development on Future Internet among countries in Asia as well as with those on other continents. In order to coordinate efficiently, AsiaFI is involved in various activities, such as working groups on subjects ranging from Future Internet architecture to mobile and wireless networks, events including workshops and conferences, and educational courses such

Other testbed-projects

Examples of resource federation exist, such as **PlanetLab** Europe, which is based on a relatively mature technology, servers overseeing hundreds of medium performance clients spread around the world to provide a platform for experiments in distributed computing. It allows users of two separately managed distributed computing testbeds to have access to each other's facilities under academic fully open ground rules, constrained only by acceptable use policies.

PlanetLab is a global research network that supports the development of new network services. Since the beginning of 2003, more than 1,000 researchers at top academic institutions and industrial research labs have used PlanetLab to develop new technologies for distributed storage, network mapping, peer-to-peer systems, distributed hash tables, and query processing (http://www.planet-lab.org). There is a difference of approaches between SFA and TEFIS/PII/VITAL++. The latter have centralized the control of the resources, which they federate in a single clearinghouse. The Panlab approach with TEAGLE adopts a more centralized telecoms approach with a tight control and governance view of the world. In contrast to this approach, SFA defines independent clearinghouses, each of which can allocate and manage resources, and in which identity, authorization and privacy policies are carried out. It remains to be seen which approach lends itself to a greater flexibility and acceptance in the research community – only real experiments can shed light on this question! It is also possible that each model will suit different sets of users with different sets of requirements (http://www.ict-fire.eu).

OneLab testbed federation (European project): including PlanetLab Europe and the NITOS wireless testbed, is open to third-party platforms. The OneLab Consortium consists of 26 networking research teams from university and industrial laboratories. OneLab provides an open, general-purpose, shared experimental facility, both large-scale and sustainable, which allows European industry and academia to innovate today and assess the performance of their solutions. Developing and deploying reliable Internet services requires the ability to test new technologies in an environment that provides the same conditions found in the real-life Internet (www.onelab.eu).

NITOS: *Network Implementation Testbed using Open Source code*. Their testbed consists of wireless nodes based on open source software. NITlab participates in several major EU and national projects. There is a strong connection of NITOS with EU project OneLab, where NITOS participates in the federation among several main experimental facilities in Europe. NITOS is also part of EU project Opnex where it is a basis for an experimental framework for optimizing performance of wireless networks (http://nitlab.inf.uth.gr). There is no information of potential users in this project.

ETOMIC: is a subproject of the EVERGROW (Integrated Project in the EU Information Society Technologies, Future and Emerging Technologies programme). They build a measurement infrastructure in Europe that provides a high resolution, spatially extended dynamic picture of fast changes in the network traffic. http://www.etomic.org. There is no information of users in this project.

The **WISEBED** project is a joint effort of nine academic and research institutes across Europe. It is funded by the European Commission under the Information Communication Technologies programme part of the Seventh Framework. The aim of this project is to provide a multi-level infrastructure of interconnected testbeds of large scale wireless sensor networks for research purposes, integrating the aspects of hardware, software, algorithms, and data (www.wisebed.eu). No real use tests have been conducted yet.

FEDERICA is a European project to implement an experimental network infrastructure for trialling new networking technologies. This infrastructure is intended to be agnostic as to the type of protocols, services and applications that may be trialled, whilst allowing disruptive experiments to be undertaken. The aim is to develop mechanisms that will allow such experiments to be run over existing production networks without adverse effect. The target users of the infrastructure are the researchers and the activities engaged in research on networking. User groups will include EC projects, research groups in universities or research centres, equipment manufacturers and telecommunications research labs or even individuals (e.g. PhD students). Users of the FEDERICA infrastructure will be distinguished between 'contributors' (i.e. being able to modify -in a controlled way- their allocated virtual slice properties, configuration, software) and 'consumers' (i.e. those who

are simply using a FEDERICA slice or layer to do higher layer or application layer testing) (www.fp7-federica.eu).

ECODE performs research on cognitive routing. The goal of the ECODE project is to develop, implement, and validate experimentally a cognitive routing system that can meet the challenges experienced by the Internet in terms of manageability and security, availability and accountability, as well as routing system scalability and quality. By combining both networking and machine learning research fields, the resulting cognitive routing system fundamentally revisits the capabilities of the Internet networking layer so as to address these challenges altogether (http://www.ecode-project.eu). There is no information about users of this testbed.

N4C does experimentation on delay tolerant networking applied in rural areas of Sweden and Slovenia. The goal is both to experiment with the applications and the delay tolerant networking technology. The experiments are based on developed technology within the project and commercially available technology. N4C aims to use existing, novel technologies in these remote areas by creating an 'opportunistic networking architecture' (ONA) to exploit these communication opportunities and to set up two test beds in Swedish Lapland and Kocevje region of the Slovenian mountain. Application tests are carried out on: Reindeer (animal tracking), Hikers (a pod cast application), and Meteorological data. The tryout of their application in a real setting is a major goal of the project (http://www.n4c.eu).

RESUMENET proposes a new architectural approach to Internet resilience that is multilevel, systemic, and systematic. At the same time, interoperability with legacy network components is maximized. The testing environment is directed towards wireless networks. The ResumeNet Consortium includes 9 partner institutions (http://www.resumenet.eu). There is no information of potential users of this testbed.

PERIMETER's main objective is to establish a new paradigm for user-centricity in advanced networking architectures. In contrast with network-centric approaches, user-centric strategies could achieve seamless mobility driven by actual user needs rather than simply business considerations. Putting the users at the centre rather than the operator enables them to finely control their identity, preferences and credentials. Potential users are everyone who uses the Internet or a mobile phone is a target user for PERIMETER. The availability of a user-centric network architecture will revolutionize mobile communications. PERIMETER is to a large extent a project concerning usability aspects (www.ict-perimeter.eu).

SMART-Net (Smart Antenna Multi Mode wireless mesh network) project is based on a simulation-based test-bed. The motivation behind SMART-Net is to overcome the limitations of conventional Broadband Wireless Access systems, in which all communications are required to pass through one costly central base station. Therefore, the project proposes a novel system architecture enabling next generation of Wireless Mesh Networks which will support new applications by the Internet, innovative service packages delivery offered by telecom operators and advanced communication solutions for public safety and homeland security. It is not clear from the available documentation if Smart-Net is providing their experimental facility to external users.

VITAL++ major objective is to combine and experiment with IMS-like control plane functionality and P2P technology. VITAL++ is putting together a pan-European testbed comprised of existing geographically distributed test sites integrated by IMS technology. This will be tested by reference content applications and services that use P2P technology as a means for their distribution and achieving satisfactory QoS levels through network resource optimisation algorithms rather than non-scalable QoS reservation operations. VITAL++ mainly aspires at defining and illustrating a new communication paradigm that will demonstrate how content-based applications and services, highly heterogeneous in terms of user functions and distributed in the network, can be enrolled in the frame designated by the operations of traditional telecommunication networks and thus be widely available to the users with proper QoS, security and adequate privacy. Potential users of this testbed are from the industrial sectors like operators, content providers and content distribution platform providers or a combination thereof. This also includes their users (customer base) to deliver similar multimedia services beyond conventional means. Academia also may use VITAL++ facilities in order to test and compare new P2P algorithms and schedulers for content delivery (www.ict-vitalpp.upatras.gr).

Nanodatacenters proposes a solution to data hosting and delivery. The Nanodatacenters project takes a orthogonal approach through what is called "nano" data centres, which are deployed in boxes at the edge of the network (i.e. in home gateways, set-top-boxes, etc.) and accessed using a new peer-to-peer communication infrastructure. Nanodatacenters develops communication architecture with security and incentive mechanisms. The Nanodatacenters project is to a high degree an architecture project and less an experimental environment. It is difficult to envisage profitable usage of the FIRE facilities as an experimental resource since the architecture involving mainly local connectivity and the most important problems in the project are architectural issues as security and business aspects (as e.g. do I want to let someone else use my electricity). Possibly PlanetLab could be used in some of the experiments (http://www.nanodatacenters.eu). NanoDatacenters have not presented their experimental environment and is mainly an architecture project.

OPNEX, Optimization Driven Multihop Network Design and Experimentation, delivers the first approach of principle to the design of architectures and protocols for multi-hop wireless networks. Systems and optimization theory is used as the foundation for algorithms that provably achieve full transport capacity of wireless systems. Subsequently, a plan for converting the algorithms termed in abstract network models to protocols and architectures in practical wireless systems is given. Finally a validation methodology through experimental protocol evaluation in real network test-beds is proposed. OPNEX has no published deliverables and cannot be fully analyzed (www.opnex.eu). There is no information of potential users of this testbed.

CONECT will deliver a holistic network design approach aiming at enhancement of the performance of wireless networks by unlocking the hidden potential of the broadcast wireless medium. The fundamental idea is to remove the boundaries among received signals, such that they are not classified as desired or interfering ones. Contrary to existing approaches, different received signals are allowed to mix, superimpose themselves on each other, and interact. This key observation unlocks the potential to exploit the open broadcast wireless medium. Nodes located within the broadcast range of a transmitter are no longer passive listeners trying to distinguish the signal intended for them. Instead, they cooperate among themselves in order to realize efficient and reliable information forwarding by essentially pooling the overheard information.

CONVERGENCE: The Internet is evolving into an Internet of services, an Internet of media, an Internet of people and an Internet of 'things' rather than the classical 'network of hosts',. This leads to a shift from 'host-centric' to 'content-centric' and 'data-centric' networking. Against this background, Convergence proposes to enhance the Internet with a novel, content-centric, publish/subscribe service model, based on the Versatile Digital Item (VDI): a common container for all kind of digital content, derived from the MPEG21 standard. CONVERGENCE targets professional and non-commercial providers and consumers of digital content, allowing them to publish, control, search for, and use content, independently of the structure or geographical location of the content. Users will be able to define their own policies for using, authenticating, protecting and revoking VDIs. The functionality provided by VDIs supports new models of use and new business models, difficult or impossible to implement on the current Internet architecture (http://www.ict-convergence.eu).

EULER: The main objective of the EULER exploratory research project is to investigate new routing paradigms so as to design, develop, and validate an experimentally distributed and dynamic routing scheme suitable for the Internet and its evolution. The driving idea of this research project is to make use of the structural and statistical properties of the Internet topology as well as the stability and convergence properties of the Internet policy in order to specialize the design of a distributed routing scheme known to perform efficiently under dynamic network and policy conditions when these properties are met. The project will develop appropriate tools to evaluate the performance of the proposed routing schemes on large-scale topologies (order of 10k nodes). Prototype of the routing protocols as well as their functional validation and performance benchmarking on the iLAB experimental facility and/or virtual experimental facilities such as PlanetLab/OneLab will allow validating under realistic conditions the overall behaviour of the proposed routing schemes (http://www.euler-fire-project.eu).

HOBNET is oriented towards smart buildings. Key objectives of HOBNET are to create:

- A scalable all IPv6/6LoWPAN network architecture to support Future Internet services and applications, particularly for the smart/green building domain.
- A coherent set of novel models and high quality algorithmic solutions that have been implemented, tested and validated along with high-level technical recommendations for smart building scenarios
- An interface layer between the building management system and FIRE experimentation platforms to be used for the rapid development and the evaluation of building management applications
- Contribution to 6lowApp and its standardization towards a new embedded application protocol for building automation

The experimentation is expected to run on FIRE facilities. However, the use of facilities as Wisebed and PlanetLab are unclear. The main objective of HOBNET is to ease and maximize the use of FIRE platforms by multidisciplinary developers of Future Internet applications focused on automation and energy efficiency for smart/green buildings (http://www.hobnet-project.eu).

The **LAWA** project on Longitudinal Analytics of Web Archive data will build an Internet-based experimental test bed for large-scale data analytics. Its focus is on developing a sustainable infrastructure, scalable methods, and easily usable software tools for aggregating, querying, and analyzing heterogeneous data at Internet scale. Particular emphasis will be given to longitudinal data analysis along a timeline of Web data that has been trawled over an extended period. The project's long-term objective is to develop methodology for knowledge discovery: collecting, organizing, searching, exploring, and ranking facts from structured, semi-structured, and textual information sources. The project has an approach towards this goal combines concepts, models, and algorithms from several fields, including database systems, information retrieval, statistical learning, and data mining (http://www.lawa-project.eu).

NOVI (Networking innovations Over Virtualized Infrastructures) research concentrates on methods, algorithms and information systems that will enable users to compose and manage isolated slices, baskets of virtual resources and services provided by diverse yet federated Future Internet (FI) platforms. NOVI will also enrich the FIRE facility with federated models and methods enabling comprehensive and reproducible experiments. NOVI plans to create federation between PLE, FEDERICA and GEANT as a main target and extend the virtualization to both facilities. NOVI will concentrate on methods, information systems and algorithms that will enable users with composite isolated slices, baskets of resources and services provided by federated infrastructures (http://www.fp7-novi.eu).

The **SCAMPI** project envisions a future environment where users will carry personal mobile devices such as cameras, smart phones and PDAs, with a number of resources (several wireless interfaces, a lot of memory, powerful CPUs, components able to generate multimedia content). The resulting networking environment, viewed as a whole, will therefore feature a multitude of heterogeneous resources. The goal of Scampi is to enable each user to benefit not only from the resources available on their own device, but also to opportunistically exploit the other resources of the environment, including those on other users' devices, with confidence and security. Scampi will thus enable users to utilize the functionality of the different resources available in the network, so that users enjoy more than what is solely available on their own device (http://cordis.europa.eu).

Spitfire works towards the realization of a stronger connection between the natural and the digital worlds. It will investigate unified concepts, methods, and software infrastructures that allow the efficient development of robust applications that span and integrate the Internet and the embedded world. Due to the enabling technologies provided by Spitfire, IoT-related technology could permeate private households and enterprises in a way not seen to date. The goal of this project is hence to investigate unified concepts, methods, and software infrastructures that facilitate the efficient development of applications that span and integrate the Internet and the embedded world. The key metric of success for the project is the effort required for development of robust, interoperable, and scalable applications in the Internet of Things (IoT) (http://www.spitfire-project.eu).

In sum, some of the testbeds have identified potential users, but since the projects are all focusing on quite immature technologies and are in the beginning of the pre-commercialization phase, there are few external customers. Only the project of OneLab/PlanetLab/NITOS and FEDERICa has projects outside the FIRE constellation.

5 Final conclusions

Panlab/PII is still discussing how to create a business offer for users outside the PII consortium. Federica has a set of users, but will not be able to accept much larger experimental community since the experimental resources are quite limited. FEDERICA has developed acceptable use polices and user documentation. It is found that PlanetLab is widely used in many projects outside FIRE and FEDERICA has most of its users outside FIRE.

There is an evident overlap in testing facilities in Europe and since many of the research projects use experimental facilities available with partners. The users are mostly within the academia. In order to create greater use of experimental facilities, projects must plan to use facilities already at project definition phases. The use of FEDERICA as a federated test bed in experiments performed e.g. in PERIMETER and PII shows a need for support of heterogeneous federation. This need is also emphasized by the work in integrating the OPNET simulation environment to the physical equipment in the experiments performed by SMART-Net (http://www.ict-fire.eu).

A business developer with marketing education and experienced involved in several similar projects as the PII- project stated that there were no other similar project that have been developed as far as the PII-project. This person did not know about any project that had started to work on business model design and organization like this project and concluded based on that the success of the project. This person also pointed on the matter that the process of implement the Panlab business model organization design takes time. The implementation of such a complex organization is estimated to take at least 2-3 years. The time for the organization to become self-financed may hereafter be compared to the development in new companies where break even often is reached no further than in additionally five years after implementation (references).

The development of the Panlab testbed federation is foremost technology driven. There is however other projects that have been more focused on the customers needs from the very beginning. An example of this is the Project N4C where two testbeds connected to animal tracking, capturing of environmental and energy data as well as Hikers PDA, are developed in cooperation with users. The user driven project thus also has a clear target market from the very beginning of the project. We identify based on this a further need by the Panlab testbeds to plan for involvement of users and potential customers in the future work with the development of a European testbed federation. There are also partners in the Panlab project with needed competences e.g. the Finish and Swedish partners.

5.1 SWOT analysis

The present section includes a presentation of the state of the art in the Panlab federation project and also identification of Strengths, Weaknesses, Potentials and Threats.

Who (Potential Customers / Users)	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
Testbed Provider E.g. Octopus, Fraunhofer		Limited financial resources	Market access – increasing market	Financial resources
Panlab project	A mutual distribution channel to a variety of customers and users	Every case has its own business model Get the technology functioning	Consultancy Development Testing	Financial resources Collaboration – limited exchange Trust among partners
Academic community	Access to new ideas for research community	Little monetary resources No commercial interests	Test of research and new technology Let them play with it for free	Financial resources
Large companies, ex Ericsson	Got resources Can keep their reasons for testing secret	Test their own services and applications	Benchmarking Potential new partners	Competitors IT and security
SMEs		Little monetary resources	Invite them to test the technology within the project timeframe Potential new partners or customers	Monetary resources
EC as an organisation	Network Funding Competence	A work programme to follow	Promote new research and ideas	

Who (Potential Customers / Users)	Strengths	Weaknesses	Opportunities	Threats
Panlab Office, federations Coordinate federation activities	Experiences Marketing Instrument Deployment of technology Legal issues Differentiate between initiatives Connected to research Cost reduction, shared costs Upgrade services Open for different actors	Immature concept Unclear offer Undefined activities Confusing initially to connect technologies Building on a specific model Different language and concept definitions Broad solution demands more functionality	Large demand of a federated service	Trust among customers
Technology Providers, ex Cisco	Install releases of new technologies			Trust Need of new equipment due to short development time
Other European projects		No 'real' customers		
National programs	Support the build-up of testbeds	No global collaborations	Reach a national market	
Local Living Labs			Could serve as local administrators Local service providers	
End-Users	Experimental resource			

What (the offer)	Strengths	Weaknesses	Opportunities	Threats
ICT service and application testing, a variety of tests, functional validation, performance testing, standard	Better Faster Influence customer	Facilities to available yet Unclear if users or customers are interested in this kind of service	Interoperability of services Demand will increase Increase if using external	Peoples unwillingness to change behaviour Agreements The hype of future Internet

What (the offer)	Strengths	Weaknesses	Opportunities	Threats
conformance, interoperability tests	infrastructure Experiences Service Quality Large panel of technology Include facilities into a more sophisticated scenario Availability of testing tools Access to IMS Interoperability of performance testing Reality check of others ideas Access to hardware that is not on the market	Poor economic climate Competition from other testbeds Monopolisation of resources Need to adapt providers processes	facilities Provide wider global access Security tests Consultation Quality of service tests Deliver value Personal contact important Create a core team of experts of different themes	fades (service request decreases) Not enough money Prices linger Unable to deliver what is required technically IPR Financing unclear Securing privacy issues combined with security Support in native language if local support is done Set up legal an agreement to start tests Combining different countries require different legal, business and technical arrangements Three of more parties almost impossible to make arrangements Not enough developers interested Competitors do not want to share or use third party infrastructure Offerings via Panlab or via cluster is difficult to say Government policy changes Copycats

What (the offer)	Strengths	Weaknesses	Opportunities	Threats
				Getting access to people with the right competence
Get access to users in different countries Faster testing SME can involve users		Bigger companies can do this Not a clear business model No actual user How to engage users unclear Money flow undefined		
Large in-house expertise Experience and knowledge of standards			Build close and long-term relations with customers Open up access to networks	Security Using in-house expertise Working too close with one customer

How (process for offerings)	Strength	Weakness	Opportunities	Threats
Outsourcing of single components	Automatic deployment of the testing session	Service Quality Experience		Cannot compete on price
Payment via fees to the Panlab office		Fees for users and providers Added value unclear Human resources available		
External providers		Get paid	Identify sponsors Incentives for the providers	
Consulting fees Testing fees Courses Project brands			Access to requested competence	

Why (what is the added value)	**Strength**	**Weakness**	**Opportunities**	**Threats**
Added value for universities and research institutes				Unclear
Initial offering on the platform				Unclear
What should be the selling point to gathered to attract a critical mass of people				Unclear

5.2 A societal perspective

The following section includes a presentation of expected societal benefits and challenges from the development of the Panlab federation.

5.2.1 Benefits

Expected benefits / values	Panlab contribution	Societal effects
Development of a common infrastructure that will enable future values	Development of a dynamic, flexible, efficiency and efficacy, professionalism, platform, market window infrastructure Sustainable business and resources through the Panlab federation infrastructure.	Wealth Increase turnover Decrease costs
Development of an international market for testbed services	Increase content and quality of value added offerings	Long term effects on wealth at an aggregated societal level: EC-level. Increase turnover in the international market for testbed services Increase revenue for key actors / businesses in the testbed market
Employment opportunities in the region	Maintain current number of employees in the region Increase number of employees in the region	
Employment opportunities in the federation office.	Maintain current number of employees in the testbed sector Increase number of employees in the testbed sector	
Decreased risks for not having enough with core resources such as human, social and financial capital for developing and exploiting testbed services and continuously technology development and sustainable businesses…	Contribute to the development of a testbed market together with other key project in the testbed area.	

Challenges in the forthcoming work

- Closer Cooperation in Testbed services / Overcoming barriers to the market:
- Identifying technology gaps:
- Working together as a sector: collaboration between projects
- Testing the technology:
- Gain leadership in key technological areas
- Creating job opportunities e.g. Finland, France etc…
- Improve conditions for investment in research:

- Research careers, fiscal incentives, relations between public research and industry
- Enhance EU attractiveness for R&D activity in testbed service field; (e.g. Japan, Canada)

We address major technological and societal problems using complementary expertise from distributed actors across disciplinary and organisational borders. In that context, the emergent nature of collaborative arrangements characterised by interactions across disciplinary and other boundaries should also be emphasised as most supportive for creativity and innovation.

Due to the strategic orientation towards socio -economic objectives and real world applications in the broadest sense, the consideration of a bro ad range of criteria surpassing the domain of natural and engineering sciences becomes important, as well as impacts or implications, public awareness and concern, but also accountability are playing a strong role.

Sometimes, this situation has lead to tensions in evaluation and selection processes and procedures, where values and criteria of traditional scientific peer review following disciplinary excellence may "clash" with the requirements of modified peer review following an approach involving also criteria and values from other than the natural and engineering sciences' perspectives according to an advanced concept of technology.

Micro-economic perspective:

- economic efficiency (cost -effectiveness),
- profitability, optimising profit,
- company growth, safeguarding the company,
- affordability,
- market assessment, market development drivers, constraints and viability, its actors (users, providers, developers) and their positioning in the market,
- job creation;

Macro-economic perspective:

- Prosperity, wealth,
- competitiveness (sustainable and competitive growth),
- market assessment,
- market development drivers, constraints and viability, its actors (users, providers, developers) and their positioning in the market,
- employment,
- fulfilment of demand: consumer needs and quality of services;

Benefits on an individual / organizational level

- Working together, collaborating in testbed service development is a challenging task and also a educational work that stimulate individuals in the project. People meet for accomplish the project but also to contribute to work with each other. There must be incitement on individual level to make the work more attractive.
- Knowledge and innovation for growth (org)

Business framework development:

- Making testbed services more efficient.
- Monitoring the testbed services.
- Bringing the industry together.
- Making the testbed service industry more attractive for investors.
- Large-scale implementation of testbed services in Europe.
- Helping testbed service networks to be more flexible.
- New ideas can be contributed from a much larger range of parties and from different perspectives than what might be contributed internally.

- Business and financial risk can be mitigated by the participation of one or more third parties and greater market scale can be achieved by joining forces.
- Speed to market may be accelerated by particular contributions made by other partners or contributors in the ecosystem.

There are also direct risk sharing values identified such as risk sharing in development of infrastructure, risk sharing regarding identification of customers, risk sharing regarding development of value proposition and also risk sharing in terms of financial risks.

6 Towards a sustainable testbed federation - Implications and conclusions

Internet of today constitutes a vital part of the global society and also the world economy. The internet of the future providing full service broadband connections, anywhere at any time also imply high international potentials for exploitation of communication and businesses. The ICT sector enable strategic innovators to reach beyond the well known and taken for granted and for doing this and for taking advantages of the potentials of exploit opportunities there is a need for new technology infrastructure, technological solutions and also new services As stated by Markides. and Anderson (2006) "*ICTs continue on their path of seemingly ever increasing improvement, we believe that more and more industries will be disrupted by the power of ICT-enabled strategic innovation"*. The PII project is a project in the forefront of the ICT and testbed innovation system, a project that will contribution to the development of technology infrastructure and also knowledge for exploitation of future potentials for reaching the goal of a establishing sustainable businesses (http://www.unfpa.org; http://news.mongabay.com) A group of seven regional clusters, leading in European testbed service utilities have come together to decrease socio-techno-economic barriers for exploitation of European testbed services. However, the testbed services are parts of an environment characterised by new high technological innovations, high uncertainty and also high complexity and these circumstances need to be dealt with in the business model development. Below we explore on implications and conclusions for the ongoing moves towards a sustainable testbed federation.

6.1 Implications and conclusions on business model development

We argue in line with Hedman and Kalling (2001) that *"It is important that even if the business model cannot always be used to calculate exactly the net present monetary value of an ICT, the model provides the conceptual parameters to consider for anyone interested in understanding the factors that lie between ICT and strategy improvements."*

The innovation context of the PII federation can be described as "open", that is the key partners cooperate in an innovation network in order to together develop a platform for future businesses with a focus on creating a mutual business around testbed technology. The innovation process for the federation can be characterized as being technology-driven with a main focus on technical competencies where the actors has successfully been involved in the pre-commercialization phase of developing test-beds possibilities. Also, the focus has been on core activities related to infrastructure and technology development with the aim to provide facilities for experimentation within the area of ICT. However, in order to reach the next phase of creating a business platform - the commercialization phase - other types of competences are needed that can assist in developing the technology base into specified potential offerings that can later be transformed into services targeting specific markets and customers. Further, in the commercialization phase, other activities become vital, e.g. building customer relationships and developing suitable distribution channels.

We can also conclude that values and norms play a central role for the development and exploitation of new technology and the development of business models in collaborative innovative project such as the PII project. The norms and values in the project is by nature influenced by the main purpose of the project, i.e. the development of a technological infrastructure. This also imply that allocation of resources, competences in the project, directions of activities and also expected and established values drives to project in the direction towards the main purpose. The project through this receives a clear focus on what to do and how to do things. However, these norms and values also call for risks for neglecting vital aspects of other than technical nature, i,e, the economic and social aspects. Norms and values related to the economic aspects are for instance aimed to assure for actions and resources allocated towards development of a sustainable self-financed federation and also creation and capturing of values through the development of customer offerings and use of the testbed facilities. The economic norms and value also call for a need to understand the is also a need Regarding social aspects such as commitment to the project, trust in the project, sense-making processes and mutual understanding among the stakeholders are vital factors influencing the outcome. Low general

commitments among participants may lead to the slowing down of the process, lack in trust may lead to lack in exchange of e.g. knowledge, resources and business among partners.

In order to reach the commercialization phase, the PII federation key partners now need to organize their efforts (resources and activities) to develop and design a mutual future business model for the PII federation. However, there are certain steps that must be considered in designing such a business model (cf. Osterwalder & Pigneur, 2010). The PII federation and its key partners have started the process of business model development by mobilizing, discussing motivation behind participating in the project, developing a common language and understanding of business model elements related to testbeds of telecommunication and information technology. In this stage of business model design, different types of knowledge and information are important. Since the mutual PII federation project is technology-driven, knowledge and information about the specific technology are well established within the PII federation and its partners. The technology is developed within well-established research organizations and institutes. In the commercialization phase, other types of knowledge and information need to be developed and collected so that a business model can be designed. For instance, information about customers and offerings are required. Both external as well as internal activities need to be re-organized and developed. For instance, an external activity that is central in the commercialization phase is building channels to potential customers, e.g. PII federation should develop their existing web-portal so that customers easily can view what the offering consist of from PII federation. PII federation has an interactive tool that visualizes the infrastructure of the technology and how different testbeds can be utilized and linked to each other. This interactive tool can be further developed to a marketing channel to potential customers by visualizing specific potential offerings of experimentations and possible test categories. This implies that a potential market window is already set for future testbed businesses.

The next step in developing a mutual business model design, the partners must generate and test viable business model options and select the best suited for their market segments. This step consists of transforming the information concerning the testbed technology and information of needs different customers (within the academia, SME etc) can have on the different testbeds offerings. The PII federation has started this step by identifying customers within the academia and other research projects. Since the technology related to the testbeds are immature and features still under development, one category of customers within academia can assists in the user-driven phase of the development process.

Since the technical complexity of the technology being offered to the PII federation customers and their users is rather high; it is difficult for end-users to actually contribute with innovative ideas in this context. This leads to a situation where end-users have high technical competence, or the tasks where the end-users are involved should be focused on tasks with relatively low technical complexity.

In the commercialization phase, business elements (factors) adjusted to specific market segment and customers are designed and described. These elements are: value proposition (VP), customer segment (CS), distribution channels (CH), customer relationships (CR), key resources (KR), key activities (KA), key partnerships (KP), revenue streams (R$) and cost structure (C$). Linked to these blocks, specific questions need to be answered in the business model development process. PII federation's business model has a business model focusing on customers within the academia (customer segment). This business model is under development and has a well-defined infrastructure consisting of key partners within the federation, key resources (technological competence) and key activities (technology innovation). Resources that can be developed in the business model design are within user-driven innovation and business competences. These resources are of importance in order to build suitable relationships and channels to other types of customer and increase the business potential in the future.

When the different offerings are described within the different categories (information technology and telecommunication), relationships to other potential customers can be built and suitable distribution channels identified.

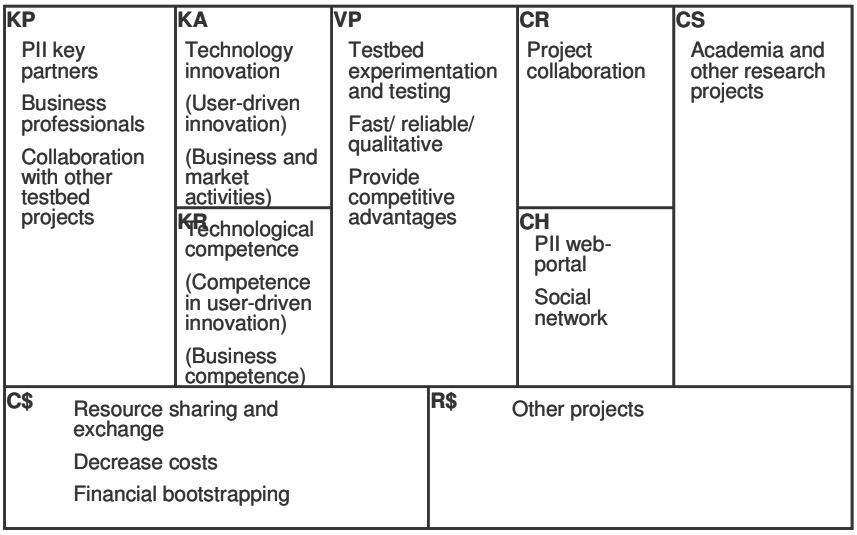


Figure 5 Example of Business Model for the Panlab federation

The last steps of business model design are implementation of the business model prototype in the field and management of the business model that is to adapt and modify the business model prototype in response to market reaction. Further, management structures need to be set up and to continuously monitor, evaluate and adapt the business model. PII federation is not ready for these steps today due to their focus have been on technology development.

The project started with relatively open and often technology-related views and ideas and the business framework in the PII project may be described as having a technology-push rather than a demand-pull approach. An important challenge to work with an overcome in this stage of the development of a sustainable testbed federation and to enable large-scale implementation of testbed services in Europe is to take the first steps towards exploitation of business potentials based on the testbed service offerings. When the field evolves from technology-oriented problem solving to business application commercialization a more specific business development agenda should be proposed. When the basic technology has been developed, next step is to adjust the R&D required to adapt these new technologies to the demands of these segments. Further, in order to be attractive we suggest development of a roadmap on the direction of the future work connected to the corner stones in the business model framework. We argue for a need to further develop the business model framework for the Panlab federation for both improving internal communication in the future Panlab federation but also for improving/developing a solid base for external communication with current and potential key stakeholders outside the testbed federation. (See e.g. Shafer *et a.l* 2005).

In connection to offering...*"… firms can become too complex by attempting to serve an excessively broad strategic scope with an excessively broad activity configuration*". If the PII federation have defined the scopes of business very broad e.g. in terms of "information and communication technology" they may "*be unable to provide a ''common thread'' that is ''a relationship between present and future product markets which would enable outsiders to perceive where the firm is heading*'' (Ansoff, 1968, p. 105). Further, ''thrive by aggressively diversifying often become too complex, fragmented and thinly spread to be effective'' (Miller, 1992, p. 28; Almeida & Fernandob, 2008).

6.2 Phases in the process of exploitation of services and businesses

We will here continue to explore on the PII-work processes and maturity phases of the testbed market in relation to the financial base. Figure 5 illustrates different phases in technology and business exploitation. The testbed market is characterised as immature and as to be in an early phase, and the testbed services in the PII project is struggling in the forefront of the fuzzy front end of innovation (Kurkkio, 2010; Andersson, 2010).

Reaching from the fuzzy front end to the Functional / commercialisation phase take at least (in the best case) five years. The development of a testbed federation is in many aspects similar to the creation

process of new ventures. "*The early process of ideas development is in many respects technique driven, where the technical skills of the founders are decisive for the generation of new ideas*. (Klofsten, 2005) The socio-techno-economic analyses also indicate the main part of discussions performed in the project to a high extent consider the mere technical aspects of the project." *It is also of interest to note: "To have an idea appears to be a random process and to begin development work is quickly done, but behind these two processes are years of research and other mental work that makes a discovery possible*". (Klofsten, 2005). The technology constitutes the platform of the project and it is of high importance to focus on such aspects. However, the business aspect is also highly relevant for possibilities of bringing the testbed services to the market.

The testbed services associated with the PII project is at present moving from Phase 2 to Phase 3 where distinct actions are needed to take place. Real customers need to be finds for development of attractive services that fill a function and help customer to develop their competitive advantages. The PII-webpage needs to be further developed and also show that "happy" customers are reached and that attractive offerings are available. Offerings can in this phase be directly designed and adjusted to the particular customers needs. Individual prices may be set depending on the nature of the particular "order" and this price could be set together with the particular partners involved in the specific "order". Businesses need not to be open for all partners. A service fee for covering costs connected to the needs PII-office need to be decided on. This may be a temporary fee used in the present Phase 3 and may be revised in Phase 4. The work in Phase 3 is critical for reaching the goals in the PII-project and is taking place during fall 2010. A first preliminary business model is in this phase designed and organized.

The Panlab federation is at the end of the PII-project standing in-between Phase 3 and 4 are thus also standing in front of the classical 2:nd financial gap, called the second death valley. (Panlab succeeded to pass the first financial gap, death valley, with use of financial bootstrapping through FP6 funding. This gap refers to the first three phases.) The Panlab-federation situation is very much in line with the situation for the particular organizational/business phase, a well known pattern in the literature.

The federation is at the end of the PII-project standing in front of a situation with a highly restricted customer base, high uncertainties connected to the revenue model and also limited businesses; the federation is still not self-financed. Adding to this, Phase 4 is a capital (resource) intensive phase that includes activities such as development of market strategies, broader market actions for accomplishing growth, and also design and organization of a full Panlab federation business model.

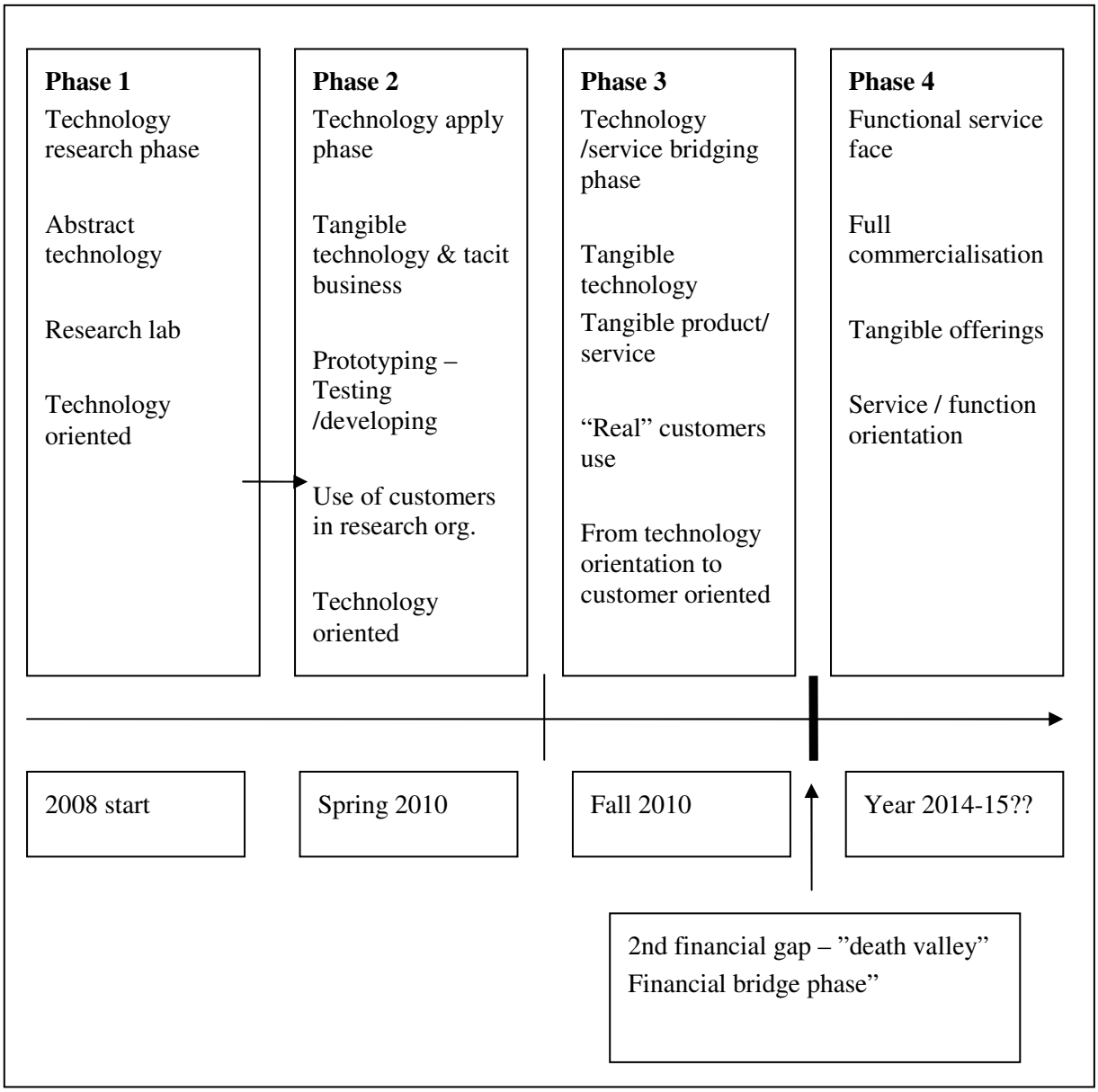


Figure 6 Different phases in technology and business exploitation

Regarding the future generation of internal financial means, there is currently no developed market for testbed services, the market is under development. Customers are generally not yet willing to pay for services. There is however a large number of European projects with available funding for testing services. These projects may serve as an initial customer base and may be seen as the initial market for the federation services. Regarding the financial situation a financial plan need to be prepared for showing how the federation plan to deal with the financial gap and assure for sustainability.

Establishment of an internal capital base large enough to help the federation through the financial gap takes time, time that not is available for federation. The lack in internally generated means instead imply a severe need of external finance. Potential sources of external finance may for instance be bank loans, external venture capital and financial grants/subsidiaries from different types of governmental financiers such as EC-finance. Banks are by nature highly risk avert and are to a high extent prohibited to entry into uncertain and risky projects in early phases, such as is the case with the PII-federation. The recent financial crises have also even more increased the un-willingness to take such high risks. Bank loans may however be part of the financial strategy in the mid of phase 4. Regarding venture capital, commercial venture capitalist firms have high demand on return on investments and are not willing to take high risks. They may however have a limited amount of finance to spend on high risk portfolio investments. Generally, such financial means are at this point in time hard to get and also

connected to need of a large investment in preparation of convincing business and market plans. This kind of external finance may thus also be preferred in later phases for instance in combination with the bank finance. There are a few venture capital funds investing in *infrastructure* and it might be worth to further check what kind of project they invest in. There is also a third type of venture capital firms of *governmental character*. These venture capital firms are supposed to take higher risks and it may therefore be of interest to take a deeper look at this type of financiers. Regarding governmental subsidiaries, applications for carry out Phase 4 may be written.

Equity versus debt is an issue to consider when establishing a financial plan. Equity may for instance imply loosing of control to the new equity holders. The *cost of capital* is another issue to consider when deciding on the mix of internal and external capital.

The financial plan includes two main parts:

1. To plan for the acute dealing with the financial gap and take actions to access bridge finance – to even be able to start the work in Phase 4.
2. To plan for the continuous financial situation in relation to development of the business model throughout Phase 4. This plan is also needed for convincing financiers to invest in bridge finance. In general, a mix of financial sources with both internal and external financial means need to be planned for and connected to sub-phases of Phase 4. For instance 4:1, 4:2 etc…

Financiers investing in risky businesses typical strive for decreasing the own financial risks and a way to deal with this is to include different types of financiers into the Panlab federation financial plan. It is also important to have plans for how to work with the return on their investments.

6.3 Implications and conclusions from the user perspective

The focus from the PII project is to develop rather complex technology to support remote testing of new technology and application within the ICT sector. One aim of the project is to implement a user driven innovation approach and this could be accomplished in two ways, one as an approach for the continuous development of the federation's offerings, that is as an organisational strategy, and the other approach to UDI is to offer it as a service to their customers. In the following, the conclusions that are related to offering UDI as a service offered by the federation is given based on the findings in the socio-techno-economic analysis. The technology that is tested in the testbeds have a rather high complexity, it can be networks and protocols which the end-users have little interest and knowledge about. Therefore, it is difficult for end-users to actually contribute with innovative ideas in this context. The end-users can usually contribute with ideas related to services and applications, where they can relate to a particular use situation. This leads to a situation where end-users need to have high technical competence, or the tasks where the end-users are involved should have a relatively low technical complexity to ensure that their efforts gives value to the testbed customers. The end-users can also be expected to contribute to technology development and innovation when the level of technological maturity is rather low. Based on that, the possibility that the users could actually contribute to developing the tested technology is high. Usually, what is being tested are innovations and thus the maturity level is low. However, it is still important to keep in mind that the end-users need rather high level of technical competence to be able to contribute within this context.

Involving end-users is seen as a complex and important task among the testbed providers; hence they need to be supported with this task to facilitate user driven innovation. To involve users a suitable technical infrastructure is needed which is not available today.

When end-users should be involved in testing activities they also need to be motivated to participate. In this study we have found that end-users are motivated by a possibility to:

- learn something new
- test innovative products and services
- curiosity
- win something
- be entertained

Hence, when testing activities with end-users are planned, these factors are important to keep in mind while designing and carrying out the test.

Looking at UDI from a federation strategic perspective this study shows that there are great potentials by implementing this in the federation. One aspect is related to user satisfaction. Relating user satisfaction to the federation it seems reasonable that the users involved here are the customers of the federation, or its potential customers, not the end-users of the services. We base this conclusion on the fact that end-users in general have little to contribute with when the technologies are vary complex since most people do not have the technical knowledge to be able to contribute on that level. However, those involved in developing future internet technologies such as the potential customers have the necessary competence and insights to have valuable input to the development of the resources offered within the federation. Also, the maturity of the technology being offered via the federation is rather immature which would stimulate the customers of the testbed to actively contribute to its further development. Hence, the federation needs to implement channels and structures to handle customers' feedback and suggestions. Finally, the barriers to innovation such as the design of the both the federation and its tools as well as the patents and IP rights are important to handle user involvement in the federation.

6.4 Collaborations towards exploitation of innovation

As shown in the benchmarking analysis, the testbed-technology is immature and there is no many actual customers at this date. However, other research projects, like Tefis, are today using the technology (Teagle) and are valuable users of the testbeds and can come with valuable feedback of the offerings. Also, the collaboration within Panlab federation shows that it is a lot of potential of future success. Because PII has won the Future Internet Forum (FIF) award for the best initiative that is currently running and nearing completion.

FIRE increases the global collaboration between relevant stakeholders, promotes experimentally-driven approach in future internet research and intensifies the usage experimental facilities, ultimately speeding up the development process of new systems and services.

Various European and international initiatives of interest to FIRE, i.e. either with which FIRE shall interact, or to monitor in case there is something of interest to FIRE. [Ref: http://www.ict-fire.eu/home/fire-related-initiatives.html]. For further readings on socio-techno-economic trends linked to the future internet see e.g. the report Towards a Future Internet – interrelation between technological, Social and Economic Trends, DG Information Society and Media, Nov 2010].

References

[1] Andersson, S. 2010. The Fuzzy front end of produt innovation processes, The influence of Uncertainty, Equivocality and Dissonance in social processes of evolving product concepts, Dissertation Accounting and Control, Luleå university of technology, ISSN: 1402-1544, ISBN: 978-7439-172-5.

[2] Bergvall-Kåreborn, B., Björn, M., Chincholle, D., Hägglund, C., Larsson, S., & Nyberg, M. 2010. The Pioneers of Mobile Application Development - A Silhouette of Android and Iphone Developers. Paper read at Proceeding of the ISPIM conference, 6-9th of June, at Bilbao, Spain.

[3] Bergvall-Kåreborn B., & A. Ståhlbröst, "Participatory Design - One Step Back or Two Steps Forward," in *PDC 2008 Experiences and Challenges*, J. Simonsen, T. Robertson, and D. Hakken, Bloomington, Indiana, USA, 2008, pp. 102-111.

[4] Bergvall-Kåreborn B. and A. Ståhlbröst, "Living Lab - an Open and Citizen-Centric Approach for Innovation," *International Journal of Innovation and Regional Development,* vol. 1, pp. 356-370, 2009.

[5] Bessant, J., & Tidd, J. 2007.. *Innovation and Entrepreneurship*. Chichester: John Wiley & Sons.

[6] Braun, V., & Herstatt, C. 2008. Freedom-Fighters: How Incumbent Corporations are Attempting to Control User-Innovation. *International Journal of Innovation Management* 12 (3):543-572.

[7] Butscher, S. & Laker, M. 2000. Market-driven product development, *Marketing Management*, vol.9, no.2, pp.48-53.

[8] Calderini, M. & Cantamessa, M. 1997. Innovation paths in product development: An empirical research. *International Journal of Production Economics*, 51(1-2), 1-17.

[9] Campbell, A.J. & Cooper, R.G. 1999. Do customer partnerships improve new product success rates?, *Industrial Marketing Management*, vol.28, pp.507-519.

[10] Chesbrough, H. 2003. The Era of Open Innovation. *MIT Sloan Management Review* 44 (3):35-42.

[11] Chesbrough, H. 2006. Open Innovation; A New Paradigm for Understanding Industrial Innovation. In *Open Innovation: Researching a New Paradigm*, edited by H. Chesbrough, W. Vanhaverbeke and J. West. Oxford: Oxford University Press.

[12] Chesbrough, H., & Appleyard, M. 2007. Open Innovation and Strategy. *California Management Review* 50 (1):57-76.

[13] Chesbrough, H. 2007 Why companies should have open business models, MIT Sloan Management Review, vol.48, no.2, 22-28.

[14] Chesbrough, H. & Rosenbloom, R.S. 2002. 'The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spin-off Companies' *Industrial and Corporate Change*, Vol. 11, No. 3, pp. 529-555. Osterwalder, A. and Pigneur, Y. (2004) 'An Ontology for e-Business Models', In W. Currie (Ed.) *Value Creation from E-Business Models*, Oxford: Butterworth-Heinermann.

[15] Christensen J., Olesen, M., & Kjaer, J. 2005. The industrial dynamics of open innovation – Evidence from the transformation of consumer electronics, *Research Policy*, vol.34, 1533-1549.

[16] Cohen, W. & Levinthal, D. 1990. Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, vol.35, 128-152.

[17] Cooper, R.G. 1999. The invisible success factors in product innovation. *Journal of Product Innovation Management*, 16, 115-133.

[18] Chronéer, D. & Bergquist, B I: 2011. Complexity of R&D projects in process industry : a Swedish study. / Project Management Journal.

[19] Chronéer, D., Johansson, J. & Perzon, H. 2009. Value creation in learning : experiences and outcomes from engineering education, in European continuing engineering education : Conceptualizing the lesson learned*, Lappalainen P. (Ed.), Espoo, pp.91-100*.

[20] Chronéer, D.; Bergvall-Kåreborn, B.; Ek Styvén, M. ; Engström, A.; Johansson, J. ; Malmström, M. 2009. Born global in a heartbeat. / Proceedings of the XX ISPIM Conference, Vienna, Austria, 21-24 June. Lappeenranta University of Technology Press, 10 s.

[21] Chronéer, D.; Mirijamdotter, A. 2009 Systems thinking benefits in supply change management : an illustration of the viable systems model in a supply chain. / International Journal of Intelligent Systems Technologies and Applications; vol. 6, nr. 3/4, s. 227-248

[22] Chronéer, D. 2006. A change in supply chain information for Swedish process industries and its consequence on a changed development focus. / International Journal of Integrated Supply Management. vol. 2, nr. 1-2, s. 149-167

[23] Chronéer, D.; Laurell-Stenlund, K. 2006; Determinants of an effective product development process : towards a conceptual framework for process industry. / International Journal of Innovation Management vol. 10, nr. 3, s. 237-269

[24] David, P.A., & Shapiro, J. 2008. Community-Based Production of Open-Source Software: What do We Know About the Developers Who Participate? *Information Economics and Policy* 20 (4):364-398.

[25] Davis, S. 2006. How to Make Open Innovation Work in Your Company. *Visions Magazine* December.

[26] Dell'Era, C., Marchesi, A. and Verganti, R. 2010. Mastering technologies in design-driven innovation, Research Technology Management, Vol. 53 No. 2, 12-23

[27] Desouza, K., C., Awazu, Y., Jha, S., Dombrowski, C., Papagari, S., Baloh, P., & Kim, J. 2008. Customer-Driven Innovation - To be a marketplace leader, let your customers drive *Research Technology Managment* 5 (3): 35-44.

[28] Di Gangi P. M., and M. Wasko, 2009 "Steal my idea! Organizational adoption of user innovations from a user innovation community: A case study of Dell IdeaStorm," *Decision Support Systems,* vol. 48, 303-312.

[29] Dodgson, M. 2000. *The management of technological innovation: An international and strategic approach*. New York: Oxford University Press.

[30] Dubosson-Torbay M., A. Osterwalder, and Y. Pigneur, 2002 "E-Business Model Design, Classification, and Measurements," *Thunderbird International Business Review,* vol. 44, pp. 5-23.

[31] Eason, K. 1987. Information Technology and Organisational Change. London: Taylor and Francis.

[32] Franke, N. 2009. How can users' creativity be implemented in new products and services? Innovation in Mind. Lund. 16-17 September 2009

[33] Gruner, K.E. and Homburg, C. 2000, Does customer interaction enhance new product success?, *Journal of Business Research*, vol.49, 1-14.

[34] Harmsen, H., Grunert, K.G. & Declerck, F. 2000. Why did we make that cheese? An empirical based framework for understanding what drives innovation activity. *R&D Management,* 30(2), 151-166.

[35] Hyysalo S., "Some Problems in the Traditional Approaches to Predicting the Use of a Technology-driven Invention," *Innovation: The European Journal of Social Sciences,* vol. 16, pp. 118-137, 2003.

[36] Johansson, J. 2007. 'Sell-Side Analysts' Creation of Value - Key Roles and Relational Capital', Journal of HRCA, Vol 11, No 1.

[37] Johansson, J. & Kurkkio, M., 2007. "Relationships causing conflicting evaluations - Managing and creating values in collaborative projects", Nordic Academy of Management, August, Bergen.

[38] Johansson, J. & Malmström M, 2007. "Finance and competence - two sides of the innovation coin: Strategic growth in innovative technology ventures", Nordic Academy of Management, August, Bergen.

[39] Johansson, J., Lundberg, H., Malmström M, 2007. "Capital structure in innovative high growth firms", 2nd Conference on Nordic Innovation Research, 3-4 December, Luleå.

[40] Klofsten M. 2005. New Venture Ideas: An Analysis of their Origin and Early Development, Technology Analysis & Strategic Management, Vol. 17, No. 1, 105–119.

[41] Kok, R.A., Hillebrand, B., & Biemans, W.G. 2003 What makes product development market oriented? Towards a conceptual framework. *International Journal of Innovation Management*, 7(2), 137-162.

[42] Kristensson, P., Magnusson P. & Matthing, J. 2002. Users as a hidden resource for creativity: Findings from an experimental study on user involvement, *Creativity and Innovation Management*, vol.11, no.1, 55-61.

[43] Kurkkio, M. 2010. Managiong the fuzzy front end of product and process development - Case studies of process firms, Dissertation Accounting and control, Luleå university of technology, ISSN: 1402-1544, ISBN 978-91-7439-195-4.

[44] Kärkkäinen, H., Piippo, P., & Tuominen, M. 2001. Ten tools for customer-driven development in industrial companies, *International Journal of Production Economics*, vol.69, 161-176.

[45] Love, J. & Roper, S. 1999 The determinants of innovation: R&D, technology transfer and networking effects. *Review of Industrial Organization*, 15(1), 43-64.

[46] Lüthje, C. 2004. Characteristics of innovating users in a consumer goods field: An empirical study of sport-related product consumers. *Technovation* 24 (9):683-695.

[47] Lüthje, C., Herstatt, C., & von Hippel, E. 2005. User-Innovators and "local" information: The case of mountain biking. *Research Policy* 34:951-965.

[48] Malmström, M., Ersson, M., Westerberg, M. 1999. Financial Bootstrapping – Alternative sources of financing.' Accepted and presented paper at the 15th Nordic Business conference (18-21 Augusti) Helsinki, Finland.

[49] Malmström, M. 2007. 'Competence Acquisition and Competitive Advantages. An Empirical Study of Small Firms.' Luleå 2007:01.

[50] Malmström, M. 2002 'Acquiring Competence to Create and Sustain Competitive Advantages: A Study of Four Small High Technology Firms.' Luleå 2002:28.

[51] Malmström, M., Wincent, J., Johansson, J. (Forthcoming) 'Generic competence acquisition strategies in smaller firms: A transaction cost perspective upon how they orientate themselves and the sequential performance implications.' *Journal of Engineering and Technology Management.*

[52] Malmström, M. & Wincent, 2011. Modeling competence acquisition in small firms. International Journal of Entrepreneurship and Innovation Management. ;

[53] Mullins, J., & Komisar, R. 2009. Getting to plan B: Breaking through to a better business model, Harvard Business press. Boston, Massachusetts.

[54] Morris, M., Schindehutte, M. & Allen, J. 2005. 'The entrepreneur's business model: toward a unified perspective.' *Journal of Business Research*, Vol. 58, No. 6, 726-735.

[55] Nedimovic V. "The trends of open innovation in services," European Commission/Information Society and Media Directorate General, 2009.http://ec.europa.eu/information_society

[56] Nyberg, A.-K. 2008. Att studera digitala artefakter i människors vardagsliv, Institution for Informatics, Umeå University, Umeå.

[57] Osterwalder, A., Pigneur, Y. & Tucci, C.L. 2005. 'Clarifying Business Models: Origins, Present, and Future of the Concept' *Communications of the Association for Information Systems*, Vol. 16, 1-25.

[58] Raasch, C; Herstatt, C; Lock, P. 2008. The dynamics of user innovation: Drivers and impediments of innovation activities, *International Journal of Innovation Management*, vol. 12, no.3, 377-398

[59] Roberts, M. 1999. Integrating customer needs into product development. From stage-gate to market-based innovation. *Chemical Week*, 161(11), s8.

[60] Rogers, M. 2004 Networks, firm size and innovation. *Small Business Economics*, 22(2), 141-153.

[61] Salavou, H. 2004. The concept of innovativeness: should we need to focus. *European Journal of Innovation Management*, 7(1), 33-44.

[62] Selwyn, N. 2003. Apart from Technology: Understanding People's Non-Use of Information and Communication Technologies in Everyday Life. *Technology in Society* 25 (1):99-116.

[63] Sharp, H., Rogers, Y., & Preece, J. 2007. *Interaction Design: beyond human-computer interaction*. 2nd ed. Chichester: John Wiley & Sons Ltd.

[64] Ståhlbröst, A., & Bergvall-Kåreborn, B. Fortcoming. Exploring Users Motivation in Innovation Communities. *International Journal of Entrepreneurship and Innovation Management*.

[65] Ståhlbröst, A., Bergvall-Kåreborn, B., & Holst, M. 2009. Understanding Innovation Communities Users - Their Usage and Nature. K. R. E. Huizingh, S. Conn, M. Torkkeli and I. Bitran. The XX International Society for Professional Innovation Management (ISPIM) Conference. Vienna, Austria. 21-24 June, 2009

[66] Tatikonda, M.V. & Stock, G.N. 2003. Product technology transfer in the upstream supply chain. *The Journal of Product Innovation Management*, 20(6), 444-467.

[67] Thomke, S. & von Hippel, E. 2002. Customers as innovators: A new way to create value, *Harvard Business Review*, April, 74-81.

[68] Turban, E., & King, D. 2003. *Introduction to E-Commerce*. Upper Saddle River, New Jersey: Prentice Hall.

[69] Utterback, J. 1996. *Mastering the dynamics of innovation.* Harvard Business School Press, Boston.

[70] Vanhaverbeke, W., Van de Vrande, V. and Chesbrough, H. 2008. Understanding the advantages of open innovation practices in corporate venturing in terms of real options. Creativity and Innovation Management, Vol. 17, No. 4, pp.251-258.

[71] Van der Panne, G., Van Beers, C. & Kleinknecht, A. 2003. Success and failure of innovation: A literature review. *International Journal of Innovation Management*, 7(3), 309-338.

[72] Vanhaverbeke, W., Van de Vrande, V., & Chesbrough, H. 2008. Understanding the Advantages of Open Innovation Practices in Corporate Venturing in Terms of Real Options. *Creativity and Innovation Management* 17 (4):251-258.

[73] von Hippel, E. 1986. Lead Users: A Source of Novel Product Concepts. *Management Science* 32 (7):791-805.

[74] von Hippel, E. 2001. Innovation by User Communities - Learning from Open-Source Software. *MIT Sloan Management Review* Summer 2001:82-86.

[75] von Hippel, E. 2001. Perspective: User Toolkit for Innovation. *The Journal of Product Innovation Management* 18:247-257.

[76] von Hippel, E. 2001 Learning from open source software, *MIT Sloan Management Review*, Summer, pp.82-86.

[77] von Hippel E. "Economics of product development by users: The impact of `sticky' local information," in *Management Science*. vol. 44: INFORMS: Institute for Operations Research, 1998, pp. 629-644.

Internet

http://cordis.europa.eu

http://www.ecode-project.eu/

http://www.etomic.org/

http://www.euler-fire-project.eu/

http://www.fp7-federica.eu/

http://www.fp7-novi.eu

http://www.hobnet-project.eu
http://www.ict-fire.eu/home/fire-projects.html
http://www.ict-convergence.eu
http://www.ict-perimeter.eu
http://www.ict-vitalpp.upatras.gr
http://www.lawa-project.eu
http://www.planet-lab.org/
http://www.nanodatacenters.eu/
http://news.mongabay.com/2008/0227-population.html
http://www.n4c.eu/index.php
http://nitlab.inf.uth.gr
http://www.onelab.eu
http://www.opnex.eu
http://www.proprofs.com/quiz-school/story.php?title=which-user-driven-innovation-approach-fits-your-testbed
http://www.resumenet.eu
http://www.spitfire-project.eu
http://www.surveymonkey.com/s/B9N3XV5
http://www.unfpa.org/pds/urbanization.htm
http://www.wisebed.eu

