Living Labs for Rural Development
Results from the C@R Integrated Project

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C@R Project website:
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Foreword

Innovation is a costly process. Indeed only one out of 3000 product ideas makes it on the market, meaning that there are hundreds of unsuccessful ICT products beyond every success. Even successful products may be far from being user friendly. Surveys show that 75% of all users find their ICT tools more stressing than relaxing. In such a context, user-centric validation can play an important role in speeding up effectively the innovation process through addressing the actual user needs.

Living Labs are open innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures. In recent years, Living Labs have become a powerful instrument for effectively involving the user at all stages of the research, development and innovation process, thereby contributing to European competitiveness and growth.

Several integrated projects from the Sixth Framework Programme have been developing and demonstrating interoperable collaboration environments supporting the user-driven open innovation process. Starting from Coordination and Support Actions under this Programme, the European Network of Living Labs (ENoLL) was launched in Helsinki at the end of 2006 under the Finnish Presidency. After these foundations of the Network were established, enthusiasm and motivation among the stakeholders has been growing.

With the continuous support of the respective European Presidencies, the network has surpassed the mark of 100 European Living Labs. Several of them are specifically active in the Integrated Project Collaboration@Rural whose contributions to the European Rural Information Society development and user-driven open innovation in Living Labs we warmly welcome, while looking forward to the results of the European Network of Living Labs "4th wave" of membership applications to be published during the Spanish Presidency, and potential contributions to be made to the Future Internet Public-Private Partnership in Europe.

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Contents

Chapter 1

Innovation Strategy for Rural Development Based on Living Labs for Human Empowerment

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1 Introduction

This book presents the main conclusions and results achieved during four years of work carried out by the C@R (Collaboration at Rural) consortium. The aim of the C@R project was to promote sustainable rural development through innovative ICT services enabling new forms of collaboration, and through a new approach of creating innovation ecosystems called “living labs” tailored to rural development needs. This approach was applied in various rural areas and was piloted in sectors such as fishery, agriculture, logistics, retail, public services, and government. C@R has established a multi-disciplinary consortium including experts in rural development, innovation and ICT to work together with stakeholders in the selected rural areas in tackling rural development challenges. Based on the living labs concept, strategies for rural innovation were developed aiming to overcome the structural and technological barriers preventing innovation, socio-economic development and equal access to the information society.

The mission of C@R originates from the fact that 90% of EU territory is categorized as rural; thus these areas potentially constitute a key opportunity for European new business creation and public-private partnerships for innovation and socio-economic development. Moreover, the characteristics and local conditions of rural environments make them an excellent opportunity for sustainable growth built upon ICT-based innovation. The current situation in rural areas is characterized by missing opportunities for employment and professional development, and by migration to cities due to a lack of investments, qualified jobs and absence of services. While the level of communication infrastructure and services operated in rural areas is often inadequate, many rural areas are slowly adopting ICT-based solutions. Sustainable rural development, including the support of entrepreneurial activities and provision of local services, requires an adequate level of infrastructure and solutions that are tailored to the specific characteristics of living and working in rural areas.

2 The Concept of Rural Living Labs

The first step of C@R has been to bring together public sector organizations, industrial software providers, telecom operators, SMEs (Small and Medium Enterprises), experts in ICT research, socio-economic analysts and potential end-users to form communities of stakeholders, elaborating the innovative concept of “Rural Living Labs”. This concept pursues the creation of ecosystems for user driven open innovation in rural areas. Through enabling new ways of collaboration within sectors, based on ICT solutions, this approach strengthens traditional entrepreneurial activities as well as societal services, and stimulates emerging business activities with the purpose of generating employment and income, reducing costs, improving work user-experience and, definitely, making these rural settings more attractive to business activities, venture capital and qualified professionals from elsewhere. The model of sustainable development applies also to the rural living labs concept itself. It implies that the initial efforts within C@R to launch the rural living labs and work on ICT-based innovations necessarily need to result into self-maintaining rural innovation ecosystems, attracting the attention of policy makers and business stakeholders who will in turn involve later public administrations and private partners.

The living lab concept as ”human-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts” originates from William J. Mitchell, who applied the concept to innovating spaces for living and working[1]. In Europe, the living labs concept as adopted during the EU Presidency in 2006 relates to early engagement of co-creating users in real-life experimentation, and also to open innovation thinking which addresses cooperation across the value chain [1]. Many projects and studies have elaborated a diversity of living labs based on different approaches to user engagement and to the process of experimentation and validation and in Europe a strong living lab

[1] MIT Media Lab and School of Architecture and City Planning. As an example see: http://architecture.mit.edu/house_n/placelab.html

movement has emerged[2]. In general, the living labs methodology includes a problem driven approach, based on short cycles of experimentation, and involving communities of stakeholders and end-users as early as possible. Relevant to C@R living labs are defined as emerging public private partnerships in which firms, public agencies, universities, institutes and people work together to create, prototype, validate and test new services, businesses, markets and technologies in real-life contexts. Such contexts could be cities, villages, virtual networks and also rural areas [2]. The regional and rural dimension of partnerships for open innovation could also strongly catalyze the creation of business networks, of relevance especially for SMEs [3].

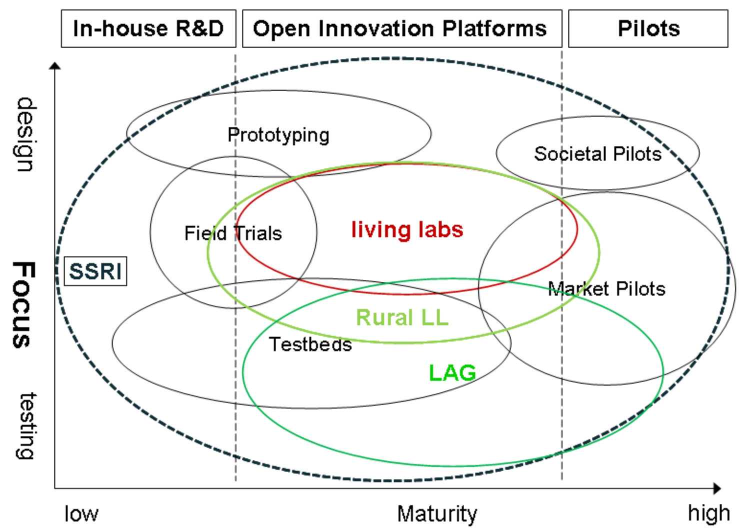

Fig. 1. Positioning of Rural Living Labs, Local Action Groups (LAG) and Social Spaces for Research and Innovation (SSRI)[3]. Figure adapted from [4].

The living labs concept should be distinguished from the testbed concept, which is a “standardized laboratory environment used for testing new technologies, products and services and protected from the hazards of testing in a live or production environment”[4]. Rather than testing technologies, Living labs aim to involve, experiment with and observe real users in real-life environments. However, the C@R project has demonstrated that in the practical settings of rural areas testing of communication technologies under difficult conditions is still crucial. Therefore combining and integrating different innovation methodologies among which living labs methods, testbed approaches and cyclic development is highly relevant as part of the rural innovation ecosystem. Fig. 1 compares living labs, test beds and other experimental approaches.

[2] European Network of Living Labs, see http://www.enoll.org/
[3] See http://www.researchspaces.eu

Most approaches do not consider the sustainability of the rural innovation ecosystem, the nature of innovation as socio-technical change, and the intertwinement of the innovation ecosystem and rural socio-economic development. A key contribution of the C@R project has been to explore and experiment a holistic concept of rural living labs that addresses these aspects.

In alignment to the European approaches to diversity and different speeds of integration, the C@R approach to rural living labs recognizes the different characteristics, requirements and goals in the various selected rural areas and countries as well as the highly different initial settings in terms of ICT infrastructure, existing IT solutions and stages of community building at the start of the project. In some settings we started from scratch, in others there was a more mature situation. Our methodology framework considers local community building as a basis for end-user engagement, getting key rural stakeholders involved and agreeing with them about the living labs strategy, establishing short experimentation, monitoring and evaluation cycles of solutions, and gradually building a policy framework to develop strategies for achieving policy impact at local, national and European levels. Key messages of a modernized ICT Rural Development Policy, such as "rural do not means agriculture only", "citizens or EU inhabitants cannot be divided in rural versus urban", "same services everywhere and every time" have been successfully promoted by the C@R consortium.

3 Key Outcomes of the C@R Project

The main objective of the C@R project has been to remove rural development barriers through adopting the Rural Living Labs approach in experimenting innovative collaborative working environments (CWEs) tailored to the local business and social conditions and needs. This ambitious goal has been addressed through the following objectives:

- To define, adopt and verify a common methodology framework for rural living labs innovation in the selected rural areas [5].
- To define, deploy and validate a common systems architecture and related technologies, enabling advanced collaborative working environments for experimentation in rural living labs settings [6].
- To assess existing rural innovation and development policies, and suggest future policies for systemic innovation in rural areas aiming to accelerate rural development.

Technical platform and systems architecture

The C@R technology platform supports remote synchronous and asynchronous cooperation of humans, machines and applications, allowing centralized as well as peer-to-peer communication models, and establishing a diversity of operation and exploitation models. Three models are considered for sustainable operation: (1) a self-managed collaborative working environment where stakeholders operate the IT platform; (2) a public collaborative working environment infrastructure managed by a third party as subcontracted by stakeholders or public administration; (3) the collaborative working environment as an advanced service offered by an Internet Service Provider or a third party provider.

From a technical perspective, the collaborative working environment solution proposed by C@R adopts an Open Service Oriented Architecture paradigm (OSOA) and utilizes a communication messages hub, named the C@R BUS, where all potential contributing components or CCS (Core Collaborative Services) are registered and made available for connection. The system provides upper layers above the BUS to provide aggregated components (Software Collaboration Tools) and common collaborative services exploitable in different scenarios named as "Orchestration Capabilities". In addition automatic processes for the system launch and self-configuration or self-healing tasks, named as "Instantiation Processes" are included. Based on this reference architecture the living labs implemented and deployed CWE instantiations adapted to local specificities The main conclusion concerning the proposed reference architecture and its validation in living labs is that the C@R collaborative working environments model successfully addresses the requirements of a variety of rural settings piggybacking on most advanced ICT research trends, satisfying also a range of possible exploitation models and allowing the integration of software components and systems from other players and ICT providers.

In order to establish a taskforce to align the C@R proposed architecture with other projects dealing with collaborative working environments and living labs, the "OCA Working Group" (Open Collaborative Architecture Working Group) was established in 2006. Whereas the OCA Working Group organized several meetings and workshop in relevant events, more efforts will be needed in the future in order to provide living labs across Europe a unifying technological platform. As a direct benefit from C@R involvement in the OCA Working Group, the C@R collaborative working environment architecture has been defined and validated considering a broader set of living labs scenarios and technology experts beyond the original project definition and available resources.

Rural living labs methodology implementation

The work on establishing the rural living labs included the preparation of technical infrastructure and platform deployment, the creation of local user communities and engaging them in the experimentation and evaluation process, the development and user-driven validation of collaborative applications, and the elaboration of business models for future sustainability. As mentioned above, across the living labs settings in our selected rural areas the point of departure was highly different as regards available infrastructure, knowledge and experience, objectives of rural stakeholders and their support to the living labs activities. It was offered a framework of methodologies that were contextualized according to the needs and objectives of every setting. A key methodology has been the socio-technical change approach of "action research" in combination with spiral development cycles. This approach is built on jointly identifying and analyzing innovation challenges and jointly engaging in problem solving, involving all actors and applied to the over-all innovation process. The living labs innovation process was driven by the selection, in every rural setting, of one or more rural innovation priorities around which the living lab innovation process was organised, supported by multi-disciplinary teams from within the C@R project (Table 1). Chapter 3 discusses the living labs methodology and its implementations in more detail, whereas chapter 4 elaborates on the technical foundations of C@R and chapters 5-10 present the results of living labs work. A detailed assessment of the results and impacts of the work on living labs innovation is provided in Chapter 11.

Table 1: Overview of C@R living labs settings

Rural area	**Use case as driver of the rural living lab innovation process**
Sekhukhune (South Africa)	Collaborative order placement, procurement, stock management, logistics
Frascati (Italy)	Business incubation support, precision farming
Åboland (Finland)	Virtual city council meetings, mobile direct sales in tourism
Soria (Spain)	Mycological licensing and verification
Homokhátság (Hungary)	Orders and offers matching, collaborative logistics
Czech Living Lab Wirelessinfo (Czech)	Collaborative spatial planning, Forest management, Incident prevention
Cudillero (Spain)	Fishery coordination (hake traceability), surveillance team coordination, ship communication

A few remarks may illustrate the role of the C@R project in laying the foundations for enhanced rural innovation ecosystems. In some cases like ArchipeLabo Living lab in the Åboland region, coordinated by Aalto University, the living lab work was supported by local authorities who participated in the project. This contributed to achieving a high level of political commitment. The living lab work has strongly contributed to establishing closer collaboration among regional actors with respect to next phase living labs innovation.

The Cudillero living lab was developed from scratch. For this reason, it became a perfect environment for developing and validating C@R collaborative work environment solutions in an early phase. Therefore it also ended in providing the most advanced and validated platform. The Cudillero innovation ecosystem has successfully involved universities (UPM, UPV/EHU), Telefónica and TRAGSA as well as end-users (fishers and fishery association) under the responsibility of the Fisheries DG, Government of the Principality of Asturias. Due to the successful development of the Cudillero living lab and the high level of policy support obtained from the Cudillero Council, a sustainable and coherent plan for the future could be developed where a Local Action Group will take over its evolution.

In Homokháti living lab led by the University of Szeged, as well as in the Czech living lab Wirelessinfo, rural development policy did not play a role on the foreground. Rather, these living labs focused on bringing together the local actors and users into a process of joint innovation. Homokháti living lab successfully implemented a user driven approach of experimenting and evaluating collaborative applications for agricultural management, working with farmers and the cooperative community. Czech living lab Wirelessinfo acts as a network of business, government and industry partners fostering open innovation in concrete projects. This also illustrates the need for approaches that address the local circumstances and conditions.

The Sekhukhune living lab in South-Africa, lead by SAP Research in collaboration with CSIR/Meraka and other local partners, has strongly focused on working with local micro-entrepreneurs. Its success in adopting and tailoring the living lab methodology to local circumstances and its successful implementation and evaluation of a modified C@R service oriented architecture demonstrates the promise of their approach, which is currently also widely transferred to other African countries.

The Frascati living lab coordinated by European Space Agency focused on business incubation in peri-urban areas, which brings on the foreground the relation and interaction between cities and rural areas. The Frascati living lab has succeeded in creating a breeding ground for business ideas development and testing, and has created an important partnership within the Lazio region and within Italy. Furthermore it has built specific project-based living lab settings around the topic of precision farming.

The Soria living lab experience was quite successful in the first stage of the project, contributing to C@R architecture validation on basis of the mycological services scenario. Since the beginning this living lab was the base of a Local Action Group called ADEMA as a supporting participant to C@R. However, Soria living lab suffered from external political contingencies: the application scenario developed in the project was not allowed to be further pursued in Soria living lab because this scenario had to cover a wider area. As a lesson learnt in C@R we conclude that it is necessary to evaluate living lab stakeholders' political interests in order to guarantee the viability and sustainability of the living lab.

Living Labs and rural policies development

C@R has also looked into the role of rural development policies, and how such policies could support living labs deployment targeting rural innovation and rural development (Chapter 12). The rural living labs concept includes interesting characteristics that potentially may enrich the existing set of instruments for rural and regional innovation. Right now at the beginning of 2010 there are 129 living labs brought together in the European Network of Living Labs and most probably there are many more to come. At the same time there are also more than 2000 Local Action Groups for rural development, most of them involved in ICT innovation. One strategy to strengthen rural development is to foster the convergence of living labs and local action groups, thus reinforcing their capabilities for innovation at the rural level. Some of the lessons learnt during the last years of working on C@R that could help implementing this strategy are the following:

- It is necessary to foster local innovation ecosystems where people needs are driving the research and development activities; this could be framed by those communities that will clearly benefit from new approaches to innovation as a social process (see section 4).
- In fostering these innovation ecosystems it must be considered five key pillars: society, market and industry, ICT, policies and infrastructures that should be well defined, balanced and mutually aligned.
- It is necessary to experiment and develop new forms of systemic innovation, which are sustainable and well balanced regarding a representative participation from the side of legal associations and public-private partnerships.
- Creating strong networks of stakeholders can increase and catalyze the benefits of living labs as regards rural innovation, ensuring the necessary critical mass for its sustainability while considering jointly the impacts of a globalizing economy and local daily life needs.

4 Rural Living Labs as Social Spaces for Research and Innovation

Within C@R we have elaborated the rural living labs concept as local innovation ecosystems, embedded in the rural environment, working with rural stakeholders and acting as mechanisms for socio-technical innovation and change. The pilots that have been launched and operated by C@R demonstrate that still work must be done to realize the promise of rural living labs. A main issue is to mobilize the rural constituencies including the citizens, and create engagement of all. A concept of Social Spaces for Research and Innovation[4] (SSRI) has emerged, which stresses the dimension of social innovation and local communities' engagement. The SSRI concept strongly relates to the living labs concept, and aims to accelerate the progress of those communities or areas willing to be the ones playing a leading role in their own future and willing to actively participate in the co-creation and design of innovative services and ways of cooperation, generating social welfare and wealth, avoiding at the same

[4] See http://www.researchspaces.eu

time exclusion, in particularly barriers due to handicapped, elderly population or territory singularities. Therefore the SSRI concept will play a relevant role in future national and European policy, highlighting the influence in new rural and regional development paradigms, healthcare, and the support for elderly and handicapped in an independent living.

The C@R project has observed that normally projects, Local Action Groups, living labs and a large number of municipalities and public entities interested on wealth creation improving the citizen's quality of life do not sufficiently exchange information and do not network adequately, thus lacking a common strategy to exploit synergies for achieving sustainability and societal impact. This goal indeed must be considered if active communities or "Social Spaces for Research and Innovation" are to be created. The real power of SSRI lies on its member's strengths and its cooperation capabilities in terms of knowledge exchange, joint design and planning of strategies and services oriented to achieve significant improvements, benefits and development of the inhabitants they represent. Public administrations therefore should promote the initial creation and cooperation among national and European SSRI, but also will play their own part in achieving the objectives of rural development.

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Chapter 2

Rural Development and Open Innovation: Challenges and Perspectives

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Abstract. This chapter provides an introduction to the concept of rural development in relation to strategies for open and collaborative innovation as undertaken within the C@R Integrated Project. Rural policy at the European level is discussed including various instruments related to innovation and development. The development of a strategy based on human-centric open innovation in rural living labs as proposed by the C@R project presents a new policy challenge aiming to open new opportunities for rural socio-economic development.

Keywords: Rural, rural development, policy, open innovation, collaborative research

1 Introduction: The Concept of Rural Development

This chapter provides an overview of the key phenomena related to rural development and open innovation. It describes a paradigm shift that supports wider adoption of the new approach of rural development, and discusses the key challenges. Later on, issues concerning management and stimulation of innovation in an open, networked environment are presented, together with a summary of future prospects for open innovation, especially in the context of development of rural areas and the work carried out in the C@R project.

A first challenge is the relative difficulty in defining what is "rural" from a multidisciplinary perspective. Actually, there is no single answer; the different views on what constitutes a rural area are often complementary, although sometimes they may be fundamental differences. Until late in the past century, physically differentiating rural from urban areas was relatively simple. Rural was considered everything that was outside the city limits, which moreover used to be quite differentiated (natural physical boundaries, symbolic gateways to the city, walled enclosures, etc). Both environments had well defined and complementary roles. Rural areas were the source of supply of raw materials, and urban areas were aimed to manufacturing and trade. From a development perspective, the definition is less evident. If we consider development in a rural context as a process of structural change of whole social, economic and ecological systems [1], like all other geographically defined areas, rural spaces have been affected by the advent and adoption of new technologies, processes and social dynamics. Recent studies of the UNU-WIDER programme on 'Spatial Disparities in Human Development' [2] have demonstrated how development tends to bring about distinct discernable spatial patterns, where certain areas of a country tend to have high concentrations of populations (urbanization) with significantly higher standard of living, while other rural regions of a country have lower standards of living, restricted access to services, with direct consequences on the quality of life of the inhabitants of the region. The technological advances of the industrial revolution had profound impacts on rural areas, changing not only traditional agricultural practices, but transforming every dimension of the rural landscape and its relation to the rest of the territory. In developed countries, with advanced land transport networks and modern information technologies and communications, remoteness and isolation, typical features of rural areas, is no longer a characterizing feature of the rural environment, crating strong interaction with urban areas. In [3] it is stated that rural and urban "constitute what is now considered as a continuous system or rural-urban continuum, in which there is no clear distinction between rural and urban, involving various levels of social and economic activity, reaching the highest point in the urban end and the lowest at the rural end. Going toward the urban end of continuum, human activity and production of manufactured objects predominate and intensify; toward rural end, ecological processes and natural resources predominate and intensify as well". In [4] it is stated that "evidently, the oldest division between town and country is erased before our eyes, and this fact is revealed as one of the most dramatic changes affecting our civilization… the merger between city and countryside is coming hastily".

In light of this changing rural world, the definition of rural areas in terms of population density, which distinguishes geographic areas below a certain threshold, has serious limitations for formulating and implementing development policies that can ensure economic, social and environmental sustainability. Besides a demographically-based definition, other criteria are necessary to characterize rural environments in terms of factors related to the development process. These include factors such as physiographic features, occupation and use of space, the organization of its inhabitants and ecological factors, which will provide a more effective typology of rural spaces in order to capture the enormous diversity and dynamic nature of the development of rural spaces and their inhabitants.

Although the current technological progress is allowing higher levels of territorial cohesion, there is still a large set of physical features that make it difficult for rural inhabitants to have progress levels similar to those of urban citizens. For example, the remoteness or even the isolation of those rural areas from metropolitan environments hinders the equality of opportunities among citizens, creating a risk of social and economic disparities, and seriously limiting the possibilities for growth and development.

One of the factors that have hindered the development process in rural areas is the lack of innovations that could significantly improve economic development prospects of rural areas. The capacity to innovate is considered one of the driving forces of economic growth and development. In today's globalized economy the capacity to innovate is seen as the most important single factor in fostering competitiveness of firms' and countries' economies by policy-makers and governments, see [5], [6], [7]. The conception of the innovation process has been evolving towards what is coined as "Open Innovation" [8] in terms of more complex socially distributed structures of knowledge production activities, which recognize the importance of the strong interplay between science, technology, society and policy [9]. This change has fostered a high degree of interdisciplinary networking and a growing diversity of knowledge generating organizational arrangements.

A key objective of the C@R project has been to develop an approach to innovation and rural development that would empower citizens and transform the rural environment into productive and prosperous centres of the knowledge society, based on the innovative use of knowledge and the physical, ecological and human assets of the rural environment. In this chapter we discuss the main challenges of undertaking such systemic innovation aiming to foster rural development.

2 Rural Development Policy at the European Level

We define "rural development policy" as the set of actions aimed at promoting a scenario of equal opportunities and bringing the welfare state closer to inhabitants of rural zones, working towards making it similar to that of citizens of metropolitan areas. In Europe, rural zones cover about 90% of territory, and more than 50% of the population is settled in such zones. Development in a rural context is defined as a process of structural change of whole social, economic and ecological systems [1]. It entails qualitative changes in economic sectors, cultural shifts; the emergence of new forms and reconfiguration of political and administrative structures, the advent and adoption of new technologies. Rural development constitutes a political area of vital importance, and strengthening rural development policy of the European Union has become one of its core priorities. Rural development policy in the European Union has evolved from focusing on structural problems of the agricultural sector to covering a wider rural context. These policies have evolved from a focus on supporting almost exclusively farming, encouraging physical investments to enhance competitiveness in the agriculture sector. Probably, the first time that a territorial element is introduced into the Common Agricultural Policy (CAP)[5] was in the seventies decade with the identification of the so-called "Less Favoured Areas". Support measures were introduced intended to stop the rural exodus with the objective of conservation and survival of less favoured rural areas.

Of particular interest is LEADER ("Liaisons Entre Actions de Development Rural"), a piloting and experimental program launched in 1991. This program constituted a new instrument financed by Structural Funds and built on direct subsidies to rural territories aimed at improving living conditions of those territories. The program also constituted a methodological approach based on active involvement of rural population to empower their own resources by the definition and management of their own development projects using a bottom-up approach. Subsequently, Agenda 2000, (Action program to strengthen Community policies and giving the European Union a new financial framework for 2000-2006 with a view to enlargement)[6], was a turning point in European rural development policy. Rural development policy was established as second pillar of the CAP, accompanying the trade policy that remained as first pillar. Lately, in June 2003, a reform of the CAP was attended, in which the complementarily of both pillars mentioned before was emphasized. New concepts were introduced, as decoupling, cross compliance and modulation, implying a transfer of funds from the first to the second pillar of the CAP. This reinforced the public support to the environmental function and rural development in agriculture, beyond the original function of agricultural production.

After the first LEADER I program (1991-1993), LEADER II was implemented (1994-1999) and later LEADER+ (2000-2006). The successful results of these programs were reflected and introduced in public policies of the member states. The LEADER approach was designed to help rural actors improve the long-term potential of their local areas. It was aimed at encouraging the implementation of integrated, high-quality and original

[5] Common Agricultural Policy, http://ec.europa.eu/agriculture/capreform/index_en.htm

[6] See: http://ec.europa.eu/agenda2000/index_en.htm

strategies for sustainable development for local areas draw-up and implemented by broad-based local partnerships, called Local Action Groups (LAGs). In the current budget period 2007-2013, the Council Regulation (EC) nº 1698/2005 remains in force [10]. Sustainable development of rural areas is reinforced, based on achieving three key objectives: 1. Increasing the competitiveness of the agricultural and forestry sector; 2. Enhancing the environment and countryside through support for land management and 3. Enhancing the quality of life in rural areas and promoting diversification of economic activities (Fig. 1).

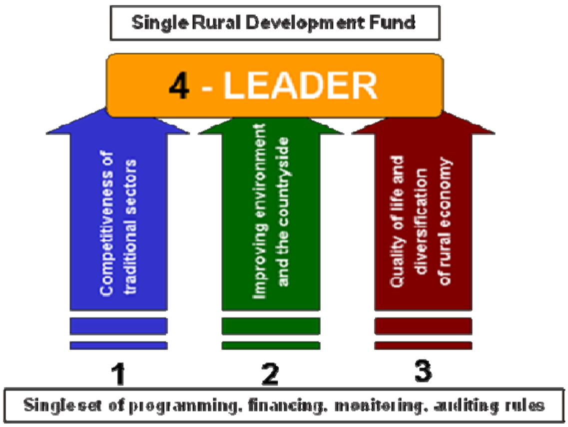

Fig. 1 Rural Development Policy of the EU 2007-2013

Rural development programs include a thematic axis for each key objective. The three thematic axes are complemented by a methodological axis dedicated to the LEADER approach. A minimum funding is imposed for each axis in order to ensure a balance in the program. There are, for each thematic axis, a set of available measurements on which each Member State chooses those that it considers more relevant. In addition to the thematic axes, two important aspects are highlighted. On one hand, a new financial instrument is articulated, the European Agricultural Fund for Rural Development (EAFRD), in order to simplify the programming and funding system. On the other hand, the LEADER model is to be continued and consolidated at EU level by integrating what used to be a Community Initiative in the previous programming periods as an obligatory element into the rural development programs to be implemented by the Member States during 2007-2013.

From the perspective of the C@R project development, the LEADER model and the concept of Local Action Groups in the current rural development policies is of high relevance. Local Action Groups constitute an important platform representing the rural constituency to adopt models of user-driven open innovation. LEADER is methodologically focused on "how" to act and not so much on "what has to be done". Certain features like its territorial approach, the bottom-up approach, the promotion of innovation, the networking and cooperation and its territorial structuring through Local Action Groups, constitute a promising basis on which to articulate the concept of rural living labs as developed in the C@R project.

3 Current Issues in Rural Development Policy

As expressed in the Green Paper on the Territorial Cohesion [11], competitiveness and prosperity depend on the capacity on the people and businesses to make the best use of available territorial assets. In a global and interrelated world economy, however, competitiveness also depends on building links with other territories to ensure that common assets are being used in a coordinated and sustainable way. Cooperation that fosters the flow of technology and ideas, as well as goods, services and capital is becoming an ever more vital aspect of territorial (and rural) development, and a key factor underpinning the long-term and sustainable growth performance of the EU as a whole. Likewise, in 2005, the European Commission re-launched the Lisbon strategy for the European Union (EU).The strategy seeks to tackle the EU's urgent need for higher economic growth and job creation and greater competitiveness in world markets. It is a major EU policy priority. The Lisbon strategy aims to provide people with a better standard of living in an environmentally and socially sustainable way. The Lisbon strategy focuses, among other things, on improving education and training, research and development and the promotion of innovation and sustainability. These are exactly the results which can be delivered by rural development.

The guiding principles for the contribution of the CAP to the Lisbon strategy were set by the European Council in Gothenburg (2001) and confirmed in the Lisbon strategy conclusions in Thessaloniki (2003): strong economic performance that goes hand-in-hand with the sustainable use of natural resources. These principles have shaped recent CAP reforms.

In all Member States, rural development can help promote competitiveness in the agricultural and food processing sectors. As quoted from the last European Commissioner for Agriculture and Rural Development, Mariann Fischer Boel, "We now have to turn rural development into a central element of the Lisbon process. This means investment in the future, creating new employment possibilities and rural diversification". Table 1 below shows some connections between the objectives of the Lisbon Strategy and those of rural development in Europe.

Table 1. Relations between Lisbon Strategy and Rural Development policy objectives

		EC STRATEGY FOR RURAL DEVELOPMENT			
		Improving the competitiveness of the agricultural and forestry sector	Improving the environment and the countryside	Improving quality of life in rural areas and encouraging diversification of the rural economy	Building local capacity for employment and diversification (LEADER)
LISBON AGENDA	Competitive and dynamic economy: innovation	- Modernisation of agriculture - Facilitating innovation	- Encourage environmental / economic win-win initiatives	- Raise economic activity and employment rates - Develop micro-business and crafts	- Promote cooperation and innovation
	Knowledge-based economy	- Encourage ICT take-up		- Encourage ICT take-up - Upgrade of technology infrastructures	
	Sustainable economic development	- Foster dynamic entrepreneurship	- Promoting environmental services - Combating climate change	- Provide use of renewable energies - Tourism development -Upgrade local infrastructure	- Build local partnership - Promote PPP
	Social cohesion		- Promote territorial balance	- Encourage entry of women in labour market - Training young people for local economy diversification	- Improving local governance

Nevertheless, as is actually increasingly confirmed, the separation between rural and urban zones is blurred. Rural and urban areas no longer are separated from each other, but are territories whose viability depends on cooperation between institutions and on the synergy between its various social and economic groups. It will be the only way to ensure the cohesion required to avoid the risk of exclusion in a global context increasingly demanding and competitive.

Finally, it is noteworthy that at the moment we are witnessing a sharp global economic crisis that forces us to reconsider our production model. Economic indicators such as Gross Development Product (GDP) were never designed to be comprehensive measures of well-being. Complementary indicators are needed that are as clear and appealing as GDP but more inclusive of other dimensions of progress, in particular environmental and social aspects. We need adequate indicators to address global challenges such as climate change, poverty, resource depletion and health. In November 2007, the European Commission, European Parliament, Club of Rome, OECD and WWF hosted the high-level conference "Beyond GDP"[7] with the objectives of clarifying which indicators are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate.

It might be expected that, as a result of this debate and reflection, many of the values that today are apparent in our rural zones will be incorporated into a new vision of progress and development. Therefore it might be expected a much more relevant role of rural development in a context of open and collaborative innovation in rural areas, benefiting its socio-economic development in a context of globalisation of work and business.

[7] http://www.beyond-gdp.eu

4 Rural Development Challenges: A Role for Living Labs

In a context of rural development, innovation should be understood as a process which not only concerns technological and organisational advances but has a much wider relevance and impact. From an economic perspective we may think of innovation in farming, fishery processes and local government, but these innovations also imply changes in the way people are working together. Innovation in rural areas focuses on renewal of the rural economic as well as social and cultural environment and eventually aims at increasing the welfare of rural citizens. Such innovations imply changes in behaviour, lifestyle and collaboration which sometimes conflicts with established structures, processes and behaviours people are used to. In this sense innovation processes should be considered as cultural and socio-technical change processes in which social and psychological factors are playing an important role.

Within the context of the C@R project, focus has been on innovations of a socio-technical nature, emerging both from opportunities provided by advanced information and communication technologies and from the needs and objectives of rural environments. As regards the process of innovation, the point of departure was constituted by the concept of human-centric open innovation in “rural living labs”. This concept aligns well with modern thinking concerning innovation systems and innovation policies. The impact of innovation policies and programmes towards attaining sustainable development can be seen as a constant interplay among several driving forces, such as technological innovations, population and migration trends, macro-transformations of production-consumption systems, energy use, land-use changes and spatial disparities in development patterns between rural and urban environments, changing political structures, as well as trade patterns [1], [2].

The concept of “innovation systems” has become widely used in current innovation policy literature to describe the need for a much wider perspective on relevant policies and programmes to stimulate the innovation process in a more inclusive way. The World Bank [12] defines innovation systems as a network of organizations focused on bringing new processes and new forms of organization into social and economic use, together with the institutions and policies that affect their behaviour and performance. In this context innovation is not seen only as technological changes or products, but as the process through which knowledge is generated, linked through networks of organizations and applied in social and economic activities [13], [14]. The living labs programme of the European Commission represents one of the most ground-breaking initiatives to bring about innovations of social and economic significance, improvements in technical and managerial issues, institutional and policy aspects.

The rural development process is highly influenced by the institutional context. By institutions we mean the mechanisms and instruments that create and regulate the normative environment in which social and economic agents interact [15]. The institutional framework includes the set of rules and instruments for their application, and also the ethical, cultural and legal norms that help to frame the behaviour of social and economic agents [16]. This institutional environment is one of the determining factors that governs the innovation process, the effective dissemination of new technologies and also contributes to determine who benefits from innovation, and the eventual social and environmental impacts of the innovation-driven development process. Elements of the institutional framework include rules about property rights, antitrust regulations, human resources development, and provision of infrastructure. These elements generate the environment in which social and economic agents interact. But these interactions (socio-economic networks) are the result of complex behaviours of organizations, corporations, social agents that seek to influence policy-makers and political processes, following individual or common interests that can secure benefits from innovations in the market place.

Innovation generally tends to be associated with large conglomerates of science and technology institutions and corporations with vast resources and knowledge, largely driven by private sector interests. Recent developments in innovation focus on open and user-based innovation, such as the living labs initiative of the European Union. The rural living labs launched by the C@R project have become a promising platform for involving the rural citizens in early stages of the research, development and innovation process, and the approach constitutes a strategy for how rural communities may contribute to European competitiveness and growth.

In developing a methodological framework for establishing C@R living labs and assessing their impact on rural development it became apparent that several key elements play a fundamental role in community-based innovation, including society, markets, infrastructure, technology and policy. The C@R approach to living labs innovation therefore focuses on an innovation-based approach to development with an explicit geographic reference aiming specifically at improving the well-being of the citizens of rural communities. A key element to consider in addressing the sustainability of living labs innovation environments is the need to consider the social dimension of adapting living labs innovation results and approaches to the social realities of local communities, which requires addressing the dimensions of participation and governance, and new social and institutional arrangements among stakeholders and actors tailored to the rural development context.

Already 25 years ago it was stated that "innovation is work rather than genius... and very much a matter of discipline" [17]. Since then the thesis has proven true many times. It appears that without an effective approach for stimulating and managing innovation processes, it is next to impossible to sustain continuous developments and improvements. And it is even truer for open innovation environments than for closed ones. The former create additional, new challenges that the traditional approaches did not have. For innovation in rural areas, for example to benefit the fishery industry or farmers, this means winning the trust of people and creating local communities of interested citizens and stakeholders to engage them in the innovation process. In avoiding the failures of adopting of in itself innovative technologies and processes, such innovations no longer should be produced behind closed doors of university labs or company R&D departments. They need to be focused on and within the community or society, and early engagement of citizens and small companies as users must ensure sustainability in terms of benefits for a locality or a rural environment. Innovation processes thus become much more participative, iterative and experiment-based and part of daily life [18]. All these phenomena demand a change in the existing set of instruments and policies for innovation and rural development used so far.

A role for rural living labs

The C@R living labs methodological framework of building human-centric open innovation ecosystems has been implemented in various rural settings. Its results aim to constitute recommendations for policy-makers at the European Commission level as well as at the regional and national level on the process of promoting living labs as engines of innovation driven rural development. Also, these results constitute recommendations for policy to support the scaling-up (systemic use and sustainability) of C@R living labs innovation ecosystems in order to really have an impact on the well-being (livelihoods) of rural populations.

So far we introduced several aspects that link technological innovation and social change with relation to rural development. The discussion now goes on to deal with the issue of managing an open networked environment when innovation and rural development are combined. The assumption in aligning rural restructuring and innovation is that rural areas can rise to serve as testing ground towards developing a distinct human-centric methodology and in the process benefit from the results for a new generation of 2.0 services and new entrepreneurial opportunities. In other words, the C@R project attempted to show that activities around innovation in rural living labs assume a vital part of the process of rural restructuring in the light of the challenges of information society and networked economy.

Rural economic recovery or development processes may increasingly be facilitated through open and collaborative innovation approaches as a mechanism to create a place for rural areas in the 2.0 economy. The issue that we are addressing is to what extent rural living labs as mechanisms for open and collaborative innovation may constitute a new approach to rural innovation and development that may yield successful innovative outcomes in response to overall technological and socio-economic changes.

To explore the benefits of collaborative and human-centric approaches to innovation it is necessary to adopt multi-disciplinary and participative methodologies. Therefore it is important – for example in innovations targeting agriculture management or fishery supply chains - to link the technical process of software development to the social activity of engaging citizens as end-users and to identifying rural development needs emerging from citizens engagement. It is important also to include rural policy into the innovation process, as policy innovation must be part of the socio-technical innovation. Importantly, the focus is on ways to enhance innovation processes in rural areas towards developing viable economic and social rural environments.

In policy making, rural living labs need to be considered as services or facilities that, while aiming at playing a role in the rural innovation system, have rural development in focus. The overall objective of the rural living labs is to provide a facility for human-centric co-creation to foster and improve the economic, social and environmental development of rural areas. Rural living labs constitute collections of resources or "assets" – e.g. infrastructures, methodologies, user communities and existing rural and regional business networks – which are geared toward the overall objective of utilizing technology for rural development. As the Living Lab approach favours partnerships and collaboration in its ways of working we need to look at what types of collaboration needs facilitation in which rural areas. The types of rural areas and the respective different approaches to rural living labs tie to governance and link technology use, and its extended value network, with rural policies.

Examples of the relevance and power of the rural living labs concept are elaborated in the following chapters. However, it can be stated that the C@R project has achieved important results in terms of innovation culture, entrepreneurship and business creation, adoption of open innovation principles, as well as new organizational models and participation of local communities.

5 Conclusions

In today's globalized economy, rural areas are generally considered as environments in crisis. It is clear that one negative consequence of the global economy and ongoing developments in terms of ageing population and migration is the low value assigned to rural traditional activities of rural citizens seen as food providers and reserves of the environment in Europe. However there is clear evidence that rural areas possess enormous potential, capacities and resources in terms of their citizens and territories if we are able to find new business models and public-private partnership strategies that could certainly help in overcoming the current economic crisis. Rural development is about raising the living standards for rural populations with particular attention to the sustainable use of natural resources, the environment and the cultural heritage.

The challenge we face is to articulate methodological frameworks for innovation that allow technology, new or already existing, to be co-created through processes of citizen engagement. We are witnessing economic, social and technological changes that are shaping a new rural development paradigm in which the principles of cohesion, interrelationship and complementarily of both territories, rural and urban, are shown as an opportunity in the twenty-first century.

In this sense C@R has made a significant contribution to the development and validation of a methodological framework for living labs innovation, including "action research" approaches for collaborative innovation, and cyclic development strategies for innovation, grounded on architectures and tools for collaborative working and business. In an ongoing process of development and validation, these methodologies were specifically adapted to rural development needs. The methodological framework developed in C@R represents a viable platform for rural open innovation, implemented through the living labs concept. C@R has initiated a convergence process between rural living labs, Local Action Groups and what could be called Social Spaces for Research and Innovation focusing more specifically on rural community development and social innovation. The approach of C@R has set the stage for intensified user-driven future research and innovation activities benefiting rural areas. The development and implementation of the C@R project has itself been a learning experience in that it allowed us to enhance our insight that in the complex dynamic world we live in, as a result of social, geographical and technological developments and interactions.

Understanding the complex development process of which rural living labs are a part of is one of the key elements for monitoring progress and scaling-up the results, which requires an interdisciplinary approach such as the one developed in C@R to ensure flexible and adaptable innovation strategies that address the diverse dimensions of the livelihoods of rural communities.

Policies and programmes that support rural development have had relatively little impact in rural populations of Europe. For example, rural people have abandoned many apparently promising approaches, owing to the limited access to ICT technologies, lack of an integrated approach to improving rural livelihoods, and insufficient support from key groups and institutions. Promoting the uptake of C@R results, innovations and methodologies by mainstreaming them into local development programmes, education and media systems will require a strong policy effort. In Europe, many rural development initiatives remain on a small scale. Scaling-up C@R results, including promoting local innovation ecosystems, can be a valuable and cost-effective policy strategy to achieve wide scale improvement of wellbeing in rural communities.

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Chapter 3

Living Labs for Enhancing Innovation and Rural Development: Methodology and Implementation

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Abstract. This chapter describes, analyses and evaluates the methodologies that have been used within the C@R Integrated Project for launching and developing seven rural living labs innovation environments. After introducing the living lab experimentation environments, we describe the methodological framework developed in C@R. It is distinguished between strategic methodologies to establish and shape the living labs, and operational methodologies to run living lab innovation projects as experimentation and evaluation cycles. We discuss and assess how the living lab methodological framework has been implemented in the living labs and which lessons can be learned. Finally on the basis of a socio-technical change perspective we provide a wider outlook into the role of living labs as instruments and strategies for innovation and discuss implications for policy.

Keywords: Living lab, methodology, innovation system, rural development

1 Introduction

The C@R project has established seven living labs in rural areas to create and experiment advanced collaborative work and business environments aimed to increase the attractiveness of rural areas and strengthen rural socio-economic development. The living labs approach also served to enhance the existing, mostly weak and vulnerable, rural innovation systems. Key issues covered in this chapter are the following:

- The initial rural innovation settings, as the basis for elaborating our living labs innovation strategies and methodologies.
- The methodological framework and specific key methodologies we have used, as grounded in and appropriate to these rural contexts. Among these are early user-stakeholder engagement, cyclic and spiral development, and action research.
- The critically important process of preparing, launching and developing the living labs as a phased development process. In our approach, the rural living lab as an innovation environment co-evolves with the innovation-driven processes of platform deployment, applications development and prototyping, and the usage and tailoring the collaborative applications in practice.
- Results, experiences and assessments in developing and applying the rural living labs methodologies, achieved during a three-year process of building and operating the living lab innovation environments.

The C@R living labs vision and methodology takes its departure in an understanding of local conditions and characteristics of the existing rural innovation system. Whereas emphasis of C@R always has been on the wider socio-economic context of rural development, the living labs work has concentrated on the rural innovation environments and the role of ICT-based innovations in sectors that were found of crucial importance for the rural economic and social environment.

C@R innovations are not about mass products and services but about innovating the SME-related work and business environment. To that end the C@R project has developed and experimented a collaborative platform for enhancing working and living in rural areas. These areas are characterized by problematic conditions such as lacking infrastructure, poor socio-economic conditions and weak innovation culture. C@R's goal was to promote new forms of business for small entrepreneurs, but also to stimulate innovation in small communities. The living lab approach has been chosen to establish open and user driven innovation environments and mobilize rural stakeholders, including small entrepreneurs, business associations and policy makers, in such local innovation communities.

Six rural living lab environments in Europe and one in South-Africa have been launched to establish and experiment collaborative platforms, applications and processes enhancing SME-related work and business collaboration in specific sectors. The living labs are: Cudillero and Soria (both in Spain), Åboland (Finland), Frascati (Italy), Homokhátság (Hungary), Wirelessinfo (Czech Republic) and Sekhukhune (South Africa). In all living labs, our focus was on innovating current processes of doing business or public service provision, based on functionalities in collaborative work and business environments adapted to the local context and needs. An overview of innovations and functionalities explored in the living labs is presented in Table 1. C@R living labs addressed both technical innovations - collaborative platform, middleware services, collaborative business and work applications - and changes in the socio-economic domain, such as new ways of collaboration and communication, innovation partnership models, and new ways of innovation. In this paper, after a short introduction to the platform work, we focus on our experiences in building up the rural living labs and on effectiveness of the rural living labs innovation approach as a strategy for entrepreneurial innovation and social change. This is facilitated by the fact that we monitored, from the early beginning of the project, the organization, process and impacts of building the rural living labs as unfolding in cycles. We summarize the results achieved so far and also present some lessons learned. In doing so we aim to focus the role of living labs in rural and regional policies regarding innovation and development.

Table 1: C@R process innovations and Collaborative Working Environment functionalities

Rural living lab	Process innovations (value chain level)	Example Functionalities of CWEs
Sekhukhune (South Africa)	Collaborative order placement, procurement, stock management, logistics	Mobile messaging, GIS procurement, order bundling, Catalogue management
Frascati (Italy)	Business incubation support, winery management	Shared workspace, Community Blog, Single Sign On
Åboland (Finland)	Virtual city council meetings, mobile direct sales in the tourism sector	Conferencing, eVoting, Calendaring
Soria (Spain)	Mycological licensing and verification	Mobile messaging, mobile GIS
Homokhátság (Hungary)	Orders and offers matching (agriculture), collaborative logistics	Collaborative workflow management, predictions modelling
Czech Living Lab Wirelessinfo Czech Republic)	Collaborative spatial planning, Forest management, Incident prevention	Collaborative decision support and planning, Map management, Conferencing
Cudillero (Spain)	Fishery coordination (hake traceability) surveillance team coordination, ship communication	Mobile messaging, presence awareness, context management

This chapter presents and evaluates the key elements of the methodological approach and evaluates the application of the methodology. Whereas chapters 4 (reference architecture) and 5-10 (living labs results) present the technical results of the C@R project such as the systems architecture, collaborative platform, services and applications, and chapter 11 the impacts of the living lab results on innovation capability and on the rural socio-economic system, this chapter focus on living lab methodology and lessons learned. We conclude with a discussion related to the business, societal and policy implications of the rural living labs as instruments for innovation, particularly focusing on SME innovation.

2 The Rural Living Lab Concept Emerging in C@R

The rural living lab concept within C@R is built upon two cornerstones: the technical platform architecture, and the living lab innovation process. The C@R collaborative platform approach provides a technological infrastructure for the living labs to reuse and share software components and services. The platform is based on an open service-oriented architecture approach and allows the orchestration and instantiation of collaborative functions, based on a service or resource broker, for specification, development and implementation of collaborative services, tools and applications [1]. The layered architecture design realizes decoupled components to deal with different levels of functionalities. Collaborative core services (CCS) are implemented as reusable software components encapsulating specific core functionalities. Software collaboration tools (SCT) define a more aggregate but still generic functionality which is to be integrated in multiple collaborative applications experimented in the various living labs. SCTs are using orchestration capabilities (OC) which comprise high-level CWE functionalities such as distributed workspaces and context awareness. At end user level, Collaborative Applications, drawing from the underlying architecture defined components, are supporting a variety of users‘ collaborative situations. Although not realized to the full extent, this architecture concept provides an outlook towards a situation where living labs across Europe easily share methods and software components, and even user communities.

2.1 The Rural Living Lab Concept

Point of departure in C@R to elaborate a rural living labs methodology is provided in [2]: living labs are understood as innovation environments where stakeholders form a partnership of enterprises, users, public agencies and research organizations. This way the living lab concept is linked to open innovation [3]. In a living lab, cooperation is established for creating, prototyping and using new products and services in real-life environments. Users are not seen as object of innovation and as customer but as early stage contributors and innovators (see also [4]). Thus we might view living labs as concrete implementations of user driven open innovation environments [5]. These concepts need translation into practice, and practical living labs experience needs wide dissemination. In [6] it is observed a remarkable lack of in-depth descriptions and discussions of living lab processes and of innovative methods of end-user involvement. The C@R project aims to fulfill the need for elaborated living lab methodology and practical experience and evaluation.

Living lab environments in C@R are part of the rural innovation infrastructure. Living labs are facilities including technical resources for software development and testing, and methods and techniques to generate product and service ideas, arrange user interaction, measure user experience and so forth. This "resource" view implies a Living lab as bringing together various types of assets such as people (users, designers and other stakeholders), innovation opportunities, enabling technologies and know-how (e.g. computing technologies, software infrastructure), and, in a broad sense, collaboration infrastructures, facilitating innovation.

The living lab concept in C@R goes beyond a collection of living lab resources. It also includes a set of processes or, referring to the value chain concept of Michael Porter [6], „value activities" including the linkages between living lab partners to share research and innovation infrastructures, technologies and tools. A "process view" on living labs adds to the resource view the particular activities and methods to prepare, organise and run the pilot preparation, design and development including technical testing, user experimentation and evaluation. To become sustainable, a living lab will need to add processes for partnership development and maintenance, planning and project management, client relations and business development (Fig. 1).

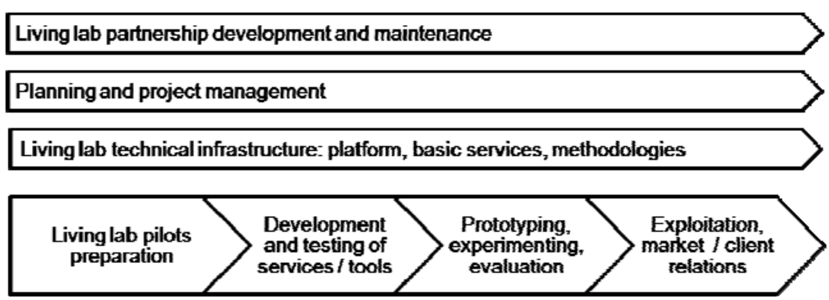

Figure 1: Living lab as innovation projects organization ("value system")

This way we emphasize the living lab as project organization which is capable to initiate, run and complete living lab innovation projects. This perspective on living labs is facilitated by the use of ICTs such as collaboration tools enabling distributed project management and community building, service oriented architectures to build modular systems from components, sensor networks to capture user experience. Even more important is the role of collaboration agreements to establish the living lab organization among the key rural stakeholders.

2.2 Towards a Practical Rural Living Labs Approach

Cornerstone of C@R living lab methodology is continuous development, prototyping, user experimentation and evaluation of innovative collaboration systems and new ways of collaborative working. Our aim was to link and integrate innovative technical work and user-driven innovation process, embedded in local innovation and rural development contexts. Our approach was two-level: (1) organising the development and experimentation of software systems in cycles (mostly three-monthly), and (2) within these cycles applying an action research approach at the "micro-level" of interactions between designers, users, researchers and other stakeholders. From the early beginning and grounded in local community building we built up a series of experimentations and evaluations, monitored over time and organised in three-monthly cycles. This approach has worked remarkably well in organising the living lab project teams and in achieving concrete results and also provided a good basis for end-user driven software development processes.

Establishing an environment of user-led co-creation currently cannot go that far as to let users develop specific architecture components. These components even should be hidden for the users. However, our aim is to maximize user engagement on all levels. We therefore must identify the "artefacts" that possibly can be influenced and shaped by the users, on basis of a process of interaction, exchange and dialogue between developers and users, and also researchers and other stakeholders. Such artifacts include simple scenarios for work and business enhancements, evaluations and ideas for improvements of current collaboration processes, elements of collaborative workplace reference architecture, initial application designs and mock ups, and more developed prototypes. A next element of end-user shaping and appropriation is in actually using and experimenting the application prototypes in near-real or real-life settings, providing explicit or implicit feedback and guidelines.

Therefore, an important challenge in designing living lab projects is to create the conditions and frameworks for such "action research" interactions, e.g. by establishing a local user–stakeholder community and arranging agreements among all actors to participate to the process, and given such frameworks to arrange and manage the concrete innovation project as a process of user-influenced experimentation and evaluation covering the complex, cyclic and interacting processes of conceptualizing, designing, developing, testing, using and validating the innovations.

2.3 Positioning Living Labs in a Science Context

Living labs innovation can be positioned in a wider scientific context of innovation frameworks, in order to build the bridge towards innovation theories on the one hand, and to rural and regional innovation policies on the other. Several theoretical frameworks and their relevance to C@R are summarized in Table 2.

Table 2: Theoretical frameworks and their relevance for C@R

Theoretical frameworks	Relevance for C@R Rural Living Labs
Mutual shaping, Sense making [10, 11]	Technologies are outcomes of social action, creating new structures. Focus on appropriation process of technologies and on mutual shaping of technologies and practices, as well as tailoring and adaptation
Actor Network Theory [12]	Understanding the existence and sustainability of actor networks; the role of core networks (forum)
Action Research [13]; for C@R: [9]	Cycles of (joint) diagnosis, action planning, implementation, evaluation and learning. Fits very well the living labs approach of open user driven innovation
Information systems / Decision support systems design [14, 15]	Emphasis on user involvement and evolutionary, participative nature of design. Information systems design and development as organisational process. Implementation as organisational process (organisational learning).
Soft Systems theory [16]	Modelling of organisational innovation processes and support in change management
National Innovation Systems [6]	Focuses on the role of sector networking, home base advantages. Living labs as rural innovation ecosystem, basis for rural development interventions. Policies are part of the innovation system
Work systems [17]	Work systems as key concept to understand, analyse and transform systems in organisations
Socio-technical systems [18]	Living lab as socio-technical system allows to focus on actors, technologies, tasks and structures and their interactions, and on CWE and business information systems change as underlying the innovation
Agile development of software systems	Living lab work in C@R calls for integration of action research and agile development approaches (in particular the SCRUM approach).

C@R has gained considerable experience in working on practical rural living labs innovation methodologies. There is a need to understand living labs innovation in the context of modern innovation and social science theories. The mutual shaping and sense making framework emphasizes the adoption and appropriation process of technologies in practice, and mutual shaping of technologies and practices. Actor Network Theory brings under the attention the sustainability and vulnerability of networks. Emerging from Information Systems, the Decision support systems concept started to emphasize the organizational context of information systems innovations as well as the participative nature of development and implementation through user involvement. The Innovation Systems framework takes another level of analysis to focus on bottlenecks in the innovation system. The work systems concept and the view of socio-technical systems change invites us to address living labs innovation as an evolving socio-technical system, and the living lab interventions as a mechanism for creating change. At the level of design and development methodologies, agile development and related approaches such as spiral development put emphasis to the iterative, dynamically evolving development of software systems. Linking such approaches to user engagement is an important topic. In our view these frameworks contribute to the vision of living labs as social-technical systems of innovation and to the practical role of living lab interventions in stimulating innovation and change.

3 Implementing Rural Living Lab Methodologies

According to the dual view on rural living lab both as rural innovation environment and organizer of innovation projects, we categorize living labs strategies and methodologies according to these perspectives. We distinguish between:

- **Strategic level methodologies** to establish and shape rural living labs innovation environments. The character of this type of methodology is to enable steering of living lab evolutionary development. Methodologies include preparing and building the living lab innovation environment e.g. through local community building and partnership agreements, and the living lab "business model" focusing on longer term sustainability.
- **Operational level methodologies** for the living lab to run innovation projects and organize experimentation and evaluation cycles. These include methodologies for organizing the development, prototyping, experimentation and evaluation process and run specific living lab innovation projects. Also included are specific methods and techniques, for example to brainstorm early innovation ideas, construct scenarios and use cases, engage in joint problem solving, structure the micro-interactions between users and developers, and measure and observe user experience and user behavior.

In [3, 4, 5] we discussed such strategic and operational level living lab methodologies and presented early results. The evolution and adaptation of these methodologies has been part of the rural living lab process itself. This fact is also determined by a particular characteristic of the C@R living labs: the living labs are working on one single, albeit very complex, innovation during the full project period: innovation of a collaborative work environment for the purpose of enhancing a particular socio-economic sector. Our living lab approach has been pragmatic to tailoring the approach to the specific rural situation in order to achieve a real socio-economic impact. Local situation determinants include the level of infrastructure and technologies, the existence of an innovation-friendly culture, and the innovation and business opportunities of interest for the particular rural area. Moreover, local characteristics include the stakeholder interests which are related to the plans and ambitions of policy makers, business associations and user organizations. Our early phase actions were aimed to ensure that these local conditions were addressed properly.

It should be taken into account that besides the fact that our rural areas were very different in terms of business cases and stakeholders, most were characterized by poor economic conditions, lacking infrastructure, ageing population and low level of innovation culture. Therefore a mix of strategies, tailored to local conditions, has been chosen to launch, develop and operate the living labs. The methodological approach did not exist already right from the start. Rather, the approach was co-evolving with the innovation activities in C@R and has been strongly influenced by the many practical problems that had to be resolved in getting the living labs work off the ground. In the following sections we shortly discuss the methods used.

3.1 Strategic Level Methodologies

At the strategy level we focused on (1) phasing of living lab launch and development, (2) building local communities for stakeholder support, and (3) agreeing on a collaboration model or business model governing the partnership. Table 3 summarizes how these strategies have been employed in C@R.

Table 3: Strategies for establishing the living lab innovation environment in the rural context

Strategies for living lab creation and operation	Implementation and evaluation of the strategies in C@R
Phasing of living Lab launch and development; co-evolution	Has been adopted as general approach in all living labs. Approach must be adapted to local rural contexts and needs. Should be combined with developing living lab strategy for development.
Building local communities to establish a stakeholder support base and involve users	Has been implemented in several living labs as platform for discussion, exchange and strategy (Frascati, Åboland, Cudillero). Frascati living lab has developed a workspace and portal supporting the innovation community. It appears that communities need clear goals to act as steering mechanism.
Agreeing on collaboration and partnerships; exploring business models for sustainability and venturing	Agreements definition has been explored in a few living labs and to a limited extent. Most of the living labs have worked on formulating business models for future sustainability but still need a way to go.

Phasing of the living lab development; co-evolution. It must be recognized that the rural living labs evolve over time, building up resources and processes until its objectives have been achieved as an innovation infrastructure serving the needs of the rural environment cases. As experience grows and living lab projects deliver results, living labs become more mature over time in terms of their methodological and technical infrastructure. For example, with respect to user engagement less mature living labs show end-users participating only in limited-scale experimentations or even only in providing feedback to user interfaces. In a more mature phase the living lab may allow users to co-create innovative solutions.

When the C@R project started in 2006, living labs as such were not in place. Resources and processes were only partially available. The living lab resources and processes actually have co-evolved with the progressing innovation process (the collaborative working environment). In this context, there was consensus that the phasing of living lab development would take place in four major stages, even if all living lab local situations are different (Fig. 2):

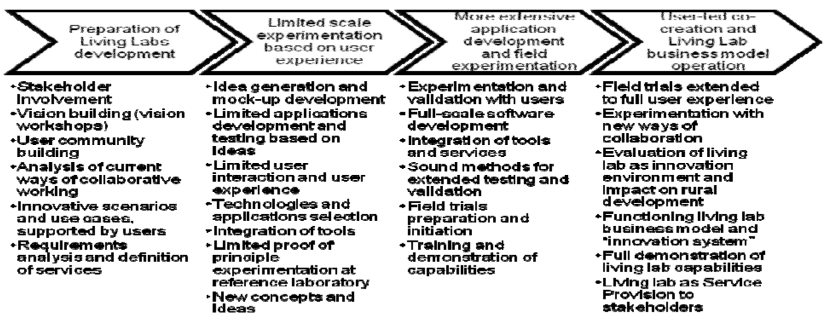

Figure 2: Phases of living labs deployment [5]

- Preparation of living lab development: setting in place the conditions for final success of the living lab, such as establishing commitment of key stakeholders and embedding the living lab in rural policies. Key activities are joint vision building, discussion of local innovation opportunities and possibly working on a business model enabling longer term cooperation between stakeholders.
- Limited scale experimentation: demonstrating effect of innovations on work and business practice is necessary to convince skeptics or followers. Limited-scale experimentation on technical and business process innovations and sharing critical information to initial users may be appropriate to create an initial user community.
- Extensive application development and field experimentation. In a later phase of development, and as soon as initial examples can be shown and early adopters are able to adopt business process innovations, the

conditions are improving for transition towards more extensive development, experimentation and user involvement activities.
- User-led co-creative innovation. The phase of co-creation of innovative software applications is end result of living labs development, not the beginning. At this stage there is a more extensive user community willing to actively be involved. A business model governing the operation of the Living lab as innovation environment is in place.

Recognizing the principle of phased development, accepting the limitations of earlier phases, and working towards a tailored implementation has proven to be a strong general approach and basis for steering. The phasing relates to more specific methods within each of these phases to facilitate the actual innovation process at project level. For example, during the preparation phase emphasis is on creating a local support base and on identification of user needs. After this phase emphasis shifts towards experiment organisation and joint evaluation (see below). Given the diversity of local conditions we should be careful in offering too rigid approaches to phasing and structuring. Rather, we should pay attention to developing a dedicated living lab strategy, in line with rural partnership agreements, which is open for regular adaptation, for each of the living labs.

Local stakeholder communities. Building local communities to establish a stakeholder base and facilitate involvement of the main actor groups is an important strategy to create local commitment. We find some good examples of community building in the living labs of Frascati, Åboland, Cudillero, Homokháti, where we also observe that community building needs time to develop and develops in different forms. Communities also need concrete goals, in order to be effective as a basis for living lab steering, and possibly as a source for user involvement in the living lab experimentation. Community building has not succeeded in all living labs as sometimes other instruments appeared to be more realistic and beneficial, such as stakeholder and user workshops, user focus groups and bilateral interviews. The ideal situation of early, co-creative user engagement has not been established as it took time to establish communities and getting users and other actors involved. One approach to avoid this situation could have been to establish collaborative agreements with key rural stakeholders before starting the project.

Collaboration agreements and "business model". Simple forms of open innovation agreements were observed to emerge in several living labs although mostly in informal form e.g. collaboration plans and agreements in the Åboland, Cudillero and Frascati living labs. The Czech Wirelessinfo living lab has taken another approach which is to build a consortium of partners to work together on joint projects. The business models issue is strongly related to the issue of future sustainability of the living lab. We have worked with the rural living labs to explore potential 'business models' in order to ensure opportunities for longer term sustainability, identifying potential 'living lab services' and their value proposition. Whereas the initial collaboration agreement constitutes the early phase of the living lab which is often co-funded by government subsidies, future sustainability is determined by a valid service offering, and access to diverse funding sources and customer groups. Most of the living labs still need a way to go to develop concrete sustainability strategies.

Table 4: Methodologies for living lab operation

Methodologies for living lab operations	Implementation and evaluation of the methodologies in C@R
Cyclic development	Establishing 3-monthly cycles of innovation and evaluation. This approach has been one of the key success factors of living labs work
Action research	The action research approach has been applied in several living labs. It matches the problem oriented and collaborative nature of the living labs work.
Multi-disciplinary development groups	Has been a very important achievement to create multi-disciplinary teams of engineers and living lab organisers including social scientists. Could be further improved.
User and actor engagement	Different levels of user engagement have been achieved across the living labs, sometimes in pro-active mode and sometimes more feedback oriented. Distinction between strategic users and end-users proved to be useful.
Agile development and user experimentation	Attempts to integrate agile development and action research have been conducted in a few living labs e.g. Sekhukhune, Homokháti
Networking synergies creation	Has been exploited to a limited extent. The collaborative platform is not yet in the stage of enabling cross-living lab reuse and sharing of services. Some bilateral service development and reuse activities can be identified (Sekhukhune – Homokhátság living labs, Frascati – Czech living labs; Åboland – Cudillero living labs). However the continuous exchanges of living lab approaches and results contributed to awareness and results.
Monitoring and assessment	The cycle-based monitoring framework was very helpful in keeping the overview, gathering authentic living lab and user data, and making living labs aware of processes and results
Specific methods and techniques	Requirements identification, use case development, Scenario building have been applied in most living labs.

3.2 Methodologies for Living Lab Operations

The main operational level methodologies include 1) cyclic development, 2) action research style experimenting, 3) creation of interdisciplinary groups, 4) user engagement, 5) agile development, 6) creation of network synergies, and 7) monitoring and assessment. Besides, we have applied more specific methods and techniques to support the innovation process. Table 4 provides a summary of experiences in implementing the methodologies. It should be recognized that the local conditions in living labs are different and thus local solutions must be found that address these conditions.

Cyclic development. Once the innovation environment (resources, processes) is established, innovation activities start iteratively guided by interventions including prototype development and field experimentations. Living lab style innovation starts with creating user scenarios and limited experimentation on simple use cases in order to achieve quick results and being able to learn jointly and effectively. Interventions consist of the identification of user needs and problems to be solved, the formulation of hypotheses for its solution, planning and implementing the development innovations, and joint experiencing, learning and evaluation of solutions achieved. Joint experiencing also drives the further living lab evolution in terms of resources and processes. Recognizing this cyclic nature of innovation in the living labs, we have implemented a two-level approach. First we have implemented a three-monthly frequency in organizing and reporting about innovations. Second, we promoted a cyclic approach to innovation based on continuing activities of preparation, prototyping, user experimenting and evaluation.

Action research. As living labs innovation assumes a process of interaction among all stakeholders including developers and end-users, and as such processes imply an iterative and joint problem discovery and solving process, we stressed the relation of living labs approaches to action research. Additionally, living labs should be considered as a social-technical system of innovation, allowing to address the practical role of living lab interventions in stimulating innovation and change.

Action research methodology seems to be perfectly suited to carry out joint research, experimentation, evaluation and validation activities in our context of open innovation living labs. Following [14], Action Research is a collaborative activity among individuals working with others in teams or communities of practice searching for solutions to everyday, real problems. It allows practitioners to address those concerns that are closest to them, ones over which they can exhibit some influence and make change. The ideal domain of Action Research is characterized by a community where: the researcher is actively involved, with expected benefit for research and organization; the knowledge obtained can be immediately applied, based on a clear conceptual framework; and the research is a (typically cyclical) process linking theory and practice.

Using principles of action research, which is based on joint problem discovery and solution and also addresses the issues of organizational change ([14]), we have started a series of experiments and evaluations. These were organised in three-monthly cycles and monitored and evaluated over time in order to assess living lab impacts and evaluate the methodology (Fig. 3). This approach has worked reasonably well in achieving concrete results and also provided a good basis for end-user driven software development processes and connecting with the nowadays common iterative, spiral software development approaches.

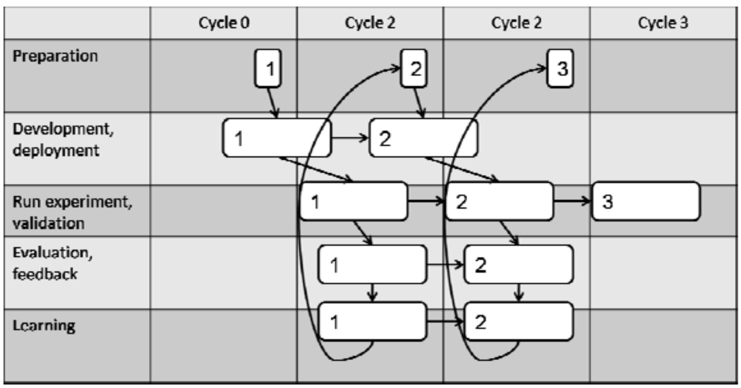

Fig. 3: Implementing cyclic development through action research

Vertical groups and matrix management. The cyclic development iterations have been supported by interdisciplinary task-forces, called vertical groups. These task-forces originally were set-up because of the need to integrate and align different work activities within C@R, aligning different aspects of the collaborative platform, the core services, the tools and applications, and user experimentation. They have been composed mainly of technical experts experienced in service oriented architecture and collaborative working environments and have succeeded in exchanging knowledge and methods across the living labs groups as well. Several vertical groups have been established: the Spanish Vertical Group (related to Soria and Cudillero living labs), the Sekhukhune-Homokhati-Åboland Vertical Group and the Czech-Italian Vertical Group. These vertical groups have had specific objectives related to supporting the technological needs of the living labs, and specifically for developing the collaborative applications. Nevertheless, all vertical groups share the objective of defining an architectural approach to create advanced collaborative environments based on the composition of already existing basic collaboration services. In order to achieve this aim, each vertical group has been centered in different approaches and architecture implementation parts, so they are collaborating to achieve the architecture related goal. As an example, the Spanish vertical group has defined a framework to instantiate software collaboration tools specified in BPEL and managed the processes related to the orchestration and choreography of the basic collaboration services that compose a specific software collaboration tool. The Sekhukhune-Homokhati-Aboland vertical group has defined an approach for high-level modeling of software collaboration tools using Business Process Models Graphical notations that would be able to be translated as BPEL scripts. All vertical groups exchanged regularly.

User engagement. As the living lab concept is strongly related to user driven innovation, we must shortly evaluate the quality of user involvement in C@R. Although the level of user-involvement within the vertical groups has been fairly limited, in several living labs the vertical group acted as a "core" around which user communities gradually could develop.

Practical constraints hinder to engage the end-users in a continuous and participative process of innovation. A reasonable successful strategy has been to distinguish between different levels of users, involving not only end-users but also local stakeholders such as business associations and policy makers who could be considered as the "owners" of living labs innovation models. Building up a local community in which these parties are being represented and are able to interact seems to be an important success factor in living labs of Frascati, Cudillero and Homokhátság. Other strategies that have been explored are:

- Targeting key users and key user groups and their interests (Åboland)
- Identify early movers and get them into the role of trusted influencers (Homokháti, Åboland)
- Create a strong local stakeholder base (Cudillero, Åboland)
- Practice what you preach; use modern collaboration tools yourself to set examples for others to follow (Frascati)
- Demonstrate the clear benefits of innovations with respect to existing ways of working (Homokháti, Åboland, Sekhukhune).

Some of the problems experienced in enhancing the engagement of users are due to situational bottlenecks, such as stakeholders assuming the role of end-users. In living labs such as Czech, Soria and Cudillero, also to some extent Homokháti, it is difficult to work with end-users directly because stakeholders assume a role of "representing the end-users". On the other hand, end-users – e.g. in Cudillero - are not so motivated to work in experimenting collaboration tool prototypes as their priority is daily business and for them time is money. A key motivator to enhance user involvement is to focus on collaborative applications that create immediate value for end-users.

Definitely, dedicated expertise and skills are necessary to organise and manage the user involvement process, e.g. in launching and facilitating user communities and in bringing structure and continuity in user-developer interactions, which not always can be provided by European projects as emphasis on technology innovation is dominant. It has been a challenge within C@R to implement a systematic monitoring and observation approach to acquire "authentic" living lab data, such as how people are experiencing the experimentations, from the different living labs environments, and future projects could benefit by including socio-technical systems expertise.

Agile development and user experimentation. The cyclic nature of the Action Research approach offers opportunities to efficiently realize end-user driven development of software platforms and applications for collaborative working environments. Within C@R an Open Service Oriented Architecture (OSOA) framework has been chosen and was adapted to the rural context. The initial architectural framework is adapted incrementally according to the learning in the individual cycles of prototypical implementation. Agile development methodologies proved to be successful in standard software development. One of the keys of success to providing effective software platforms and applications to living lab end-users has been to marry agile development and the cyclic approach of action research. One prominent example of agile development methods, used in the Sekhukhune living lab, is SCRUM. Such agile software development methodologies implement the cyclic iterations that result into solutions based on user and system requirements. The setup of living lab experimentation allows for similar approaches as it provides the environment for continuous requirements list refinements based on explicit learning acquired in cycles of prototypical implementation that reflect action research principles (Table 5).

Creating network synergies. The networking and exchange across living labs has appeared as a decisive factor. Although not enforced and not exploited to the maximum, we more and more looked at the C@R project not as a collection of seven living labs but as one connected living lab, experimenting platform and application innovations in seven different settings. In these settings, different issues are experimented for example different collaboration tools, work processes and local constituencies. Across these settings it is shared a common platform architecture vision, experimentation methodologies, monitoring and evaluation approaches and also the living lab results, in order to provide, besides a technical platform, also a "social" platform within to stimulate mutual understanding, collaboration and learning.

Table 5: Software development and architecture design integration into action research

Phase	**Principles**
Diagnosing	Participatory identification of pain points with end users that enable co-innovators to get a full understanding of where the user comes from. Early detection of overlapping pain points and the immediate translation into potential technical synergies are vital for the design of reusable services and service orchestration mechanisms that suit the needs of different living labs in different context.
Action planning	The diagnosing seamlessly enters into a phase of use case design, Business Process Modelling and process reengineering. The integrated view gathered from end user participation ends up in the definition of an engineering target point that also takes the local context of the individual Living Lab into account. Early cycles of the project lifetime reflect a rather high level business process design that gets more and more detailed in subsequent cycles. As a next step to conceptualize the implementation of OSOA (Web) Services are designed and mapped onto the architectural layers (core service layer, orchestration and application layer).
Action taking	Software development cycles (sprints) realize rapid prototypes of different maturity depending on the level of detail of use case specification. Early cycles are characterized by simple mock ups and simulated Human Computer Interaction that are not implementing the principles of OSOA. Later cycles introduce incremental changes on User Interfaces and backend functionality compliant to open standards that enables simplified accessibility.
Evaluation	Applied end user feedback collection enables co-innovators to learn lessons for future product backlogs. Many different ways of feedback mechanisms are being used like observations, surveys, interviewing, test case execution etc. At the same time the design principles of the architecture framework are validated (e.g. open standards, service reusability) are applied.
Learning	Outcomes of the evaluation phase serve as input for the next development cycle (product backlog). Such input affects the use case redesign, service specification, Business Process Models etc. In a sense the spiral of incremental improvements eventually leads to the best fit of solution closest to the engineering target point.

Monitoring and assessment. Within the C@R we implemented a monitoring and assessment framework which allows us to keep track of essential events, processes, decisions and activities. The monitoring framework uses the main categories of action research and looks at strategic and operational issues. This has enhanced our understanding of how living labs environments shape the innovation process. At the same time it has informed the living lab organizers about the state of affairs, problems, bottlenecks in their living lab to enable continuous learning.

Specific methods and tools. These fulfill a precise purpose to support specific parts of the innovation process. Examples are requirements identification, idea and scenario generation, use case development, running user workshops or focus groups, organizing field trials, establishing user-developer interaction, and usability research.

Final remarks. Despite the variety of living lab business domains ranging from fishery, retail, tourism to agriculture the C@R project strongly focuses on mechanisms to share services and tools between the living labs. In order to enable such networking synergies, organizational and technical setups have been tailored. Application development in the living labs was implemented through the 3-monthly cycles that include all phases of the action research approach. In some cases (in particular in Sekhukhune living lab) agile development methodologies like SCRUM have been applied to support the cyclic progressing. The vertical group project structure and matrix organization to share information, methodologies, knowledge and experiences across the living labs – avoiding rigid enforcement and empowering initiatives in the living labs - enables optimized cooperation between technical staff and business domain experts. We applied certain governance rules on the vertical group level, e.g. to support a common approach in terms of architecture validation activities, and established horizontal coordination through conferences and reporting.

The over-all C@R living lab methodology offers clear advantage in sensing potential synergies across such overlapping use cases that also reflect extensive end user drive and interaction. Whilst end users often express clear needs in specific use case areas local living labs interventions often still miss innovations that leverage further end user impact. A common approach in terms of methodologies and application design offers ways of fruitful co-innovation amongst the living labs leading to supplementing innovations that can further be validated with end users (push-pull interaction).

4 Rural Living Labs Growing Towards Maturity

The most visible achievements of the C@R rural living lab approach include innovations in the collaborative working environments and business processes of its participants. These will be covered in next chapters. Less visible achievements include the establishment and operation of the rural living labs facility as an ecosystem for innovation projects, aiming for impact on the rural innovation system and ultimately boosting rural socio-economic development. This section summarizes experiences in applying the methodologies in the living labs settings and analyses how they contributed to achieving the over-all C@R goals. Table 6 summarizes the contributions of the methodologies to objectives of C@R regarding 1) stimulation of rural development, 2) efficient and effective innovation, and 3) creating value for users.

Table 6: Living labs methodologies contributing to C@R objectives

	Rural development	Efficient and effective innovation	User value creation
Frascati Living Lab	Agreements among stakeholders are a basis for collaboration in Lazio region	Technical platform for projects collaboration Arrangements for open innovation	Limited user engagement and involvement
Sekhukhune Living Lab	Agreements among stakeholders as basis for collaboration for the scenarios considered in C@R	Evolution of the living lab innovation infrastructure from initial agreements and preparation to user-led co-creation and wide scale roll-out	Effective User engagement and involvement Effective application of user driven open innovation principles
Homákháti Living Lab	Community building on basis of trust Willingness to invest (Szeged university)	Living lab technical infrastructure evolved based on demand	Effective, practical approach to user engagement realised based on mixed methods
Czech Living Lab Wirelessinfo	Joint research and development consortium. Open innovation environment. Partial involvement of experts within the project consortia.	Technical infrastructure and consortium resources as one of the resources for future living lab work.	No clear living lab projects but joint research and development projects
Cudillero Living Lab	Agreements among stakeholders as basis for collaboration	Elements of a technical platform (under construction) Arrangements for open innovation	Elements of living lab project methodology Effective user engagement and involvement
Åboland Living Lab	Agreements among stakeholders as basis for collaboration	Elements of a technical platform for user driven innovation Several regional arrangements for open innovation	Elements of living lab project methodology User participation in applications development

Frascati Living Lab has established several elements for a future living lab innovation environment and project methodology. Its living lab activities, driven by the objective to exploit space technologies, started in creating a regional community of stakeholders focusing on joint discussion of innovative ideas and enabled by a common workspace. The clearest elements of the Frascati approach are visible at the community level where existing forms of collaboration have been strengthened to benefit the Lazio innovation system and bring together elements of what could become a Frascati Living Lab Innovation environment for the future. Looking at the living lab projects level, it has been quite difficult to create and motivate user groups and creating user-developer interactions in the process of developing and validating applications. User involvement has been limited mostly to idea generation and scenario development. The intention of Frascati Living Lab to use a cyclic development approach has partly been realized. The Frascati environment is not yet a living lab in its known sense as it has not yet reached the phase of being able to generate and implement living labs projects using living lab methodologies and involving end-users on an extensive scale. However it has succeeded in establishing a regional collaboration environment ("breeding ground"), pushing for business incubation. Next steps may include a clear living lab strategy, commitment of regional players, and increasing capability to attract and motivate user communities.

Sekhukhune Living Lab has implemented in a practical manner many of the methodologies offered in the project. Based on the agile and spiral development approach several action research activities have been applied. Various agreements among participants through an extended negotiation process have been established, issues and challenges have been diagnosed interpreting and collecting data based on the material obtained during end user interviews; improvements have been identified during the cyclic process of innovation. A number of specific engagements with members of the end user community in the Sekhukhune Living Lab took place. End user engagement activities carried out in Sekhukhune Living Lab included use case requirements capturing via interviews and pilot site investigation; process validation workshops; user interface validation workshops; value proposition meetings; planning meetings; regular telephonic communications with Infopreneurs and supplier representatives; and live operation feedback channels for all value chain stakeholders. The roll-out preparation activities for the collaborative procurement scenario included extensive training efforts to both the end user communities of the Infopreneurs and the participating Spaza shops. Conclusion is that several elements for a future living lab environment have been established. The Sekhukhune living lab has implemented a single innovation project based on open en user driven innovation principles. Current work is on creating a sustainable basis for the living lab activities. The existing partnership (SAP, Meraka) provides a sound basis for follow-up activities and more systematic building up of living lab facilities.

Homokháti Living Lab followed a practical approach as a combination of different methods was used to create a cyclic and user driven innovation environment: brainstorm sessions, focus groups, use case development, prototyping and testing. Stakeholders and end-users e.g. farmers and "local champions" who were respected members of local communities participated to different steps such as the development and refining of use cases. User groups involved in definition and validation were relatively small, consisting of directly interested participants, who do not have much time so their involvement was managed in a careful way, letting them interact with working prototypes. The user interactions were monitored and for all projects (applications) examples are available of "authentic user data". The first step in the living lab development process has been to establish a local stakeholder community and relatively much time was devoted to build a trusted environment to enhance commitment. The Homokháti Living Lab has been able to organize a user community around the living lab project to enhance the Agricultural Collaborative Working Environment. Winning the trust of stakeholders, and engaging "local champions" to take a leading role, were important strategies. Traditional approaches have been used to engage users in working with the developers, but they resulted in applications that have been integrated into the users' working environment. The living lab is currently exploring new business models that should establish the sustainability and viability of the living lab as an ecosystem and facility.

Czech Living Lab Wirelessinfo has the character of a joint research projects environment more than acting as a user driven open innovation environment. There has been no structured process of user engagement and co-creation in the sense of the living lab methodology adopted in C@R, except the involvement and collaboration of the commissioning organizations who often are representing users. One element that could further evolve as a characteristic of living lab work is open innovation. The consortium structure allows to attract partners as appropriate for the project's objective. This way it forms a breeding ground of projects. In the sense of user involvement, the Czech Living Lab is different from other living labs as it operates more as an environment for joint research and development, working on the basis of commissioned projects, rather than as a user driven living lab environment. A recommendation for the future is to enhance the character of the living lab as user driven environment and start working with end user communities.

Cudillero Living Lab presents a practical example of using living lab methodology. Based on the spiral development approach several action research activities have been applied. Building up and involvement of the users community has been one of the critical success factors. Fishers from the fishermen association indicated publicly several times that this was the first time that they could guide and participate actively in the creation of a technological solution for their daily work. Several specific activities for user involvement were carried out, such as: use case requirements capturing via interviews and pilot site investigation; user interface validation workshops; value proposition meetings; planning meetings; and regular telephonic communications. Cudillero fishermen assume directly the leadership being part of Cudillero Local Action Group and setting the strategic plan for Cudillero Rural Living Lab through this group. This assures the sustainability of Cudillero Living Lab as sustainable innovation organization. The project created an interesting stakeholder community engaged in the innovation process, with impacts beyond the C@R lifetime and impact on rural policy. Important elements for a future living lab innovation environment and methodology have been established.

Åboland Living Lab has used a cyclic development methodology (FormIT) and this approach has partly been realized. The user groups involved were limited. As a conclusion of user engagement activity in Åboland Living Lab, it can be stated that benefits for users are social and professional, as well as economic mostly in the long run, so many of the cannot be quantified at this moment. Connecting users with their community, including customers and competitors, is an important value sought by all types of users. So, in this sense, Åboland Living Lab tried to engage all types of users. The observation has been in the living lab application work that heavy users of the system realize the greatest benefits. Heavily engaged users constituted the core of an online community that provided important benefits to the less involved users. However, the challenge for the stakeholders in charge of municipal and regional development tasks is to create flexible responses through policy and funding allocation. Elements for a living lab innovation environment and project methodology have been established. The Åboland Living Lab has been working to create a sustainable innovation facility, but results have been restricted to the implementation of two scenarios with good examples of end-user engagement especially in the initial phase. A more clear and committed living lab strategy and increasing the capability to attract user communities will be necessary to exploit the results achieved so far.

5 Discussion and Conclusions

The perspective of how we see the role of living labs in rural areas has widened while working on C@R. First, the rural living lab was interpreted as an innovation environment, bringing together resources and organizational capabilities. It has the capability to act as such when it is established as an organisational system through which innovation projects are developed and implemented ("innovation engine"). Previous sections show that some of the living labs in C@R are moving towards that goal. The rural living lab concept also embodies a strategy for change and development: a mechanism to build communities and enable collaboration among stakeholders to influence and enhance rural development, mostly through enhancing the rural system of innovation, as it affects all determinants of the system of innovation (Fig. 4).

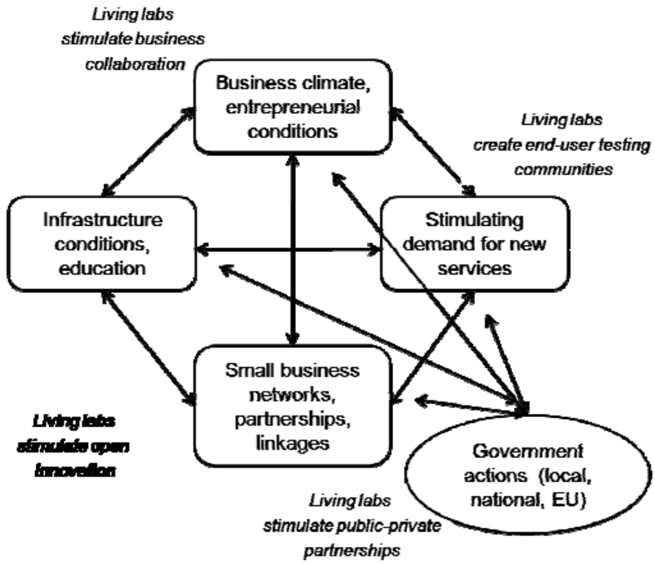

Fig. 4: Living labs enhancing the rural innovation system (adapted from [7])

More easily than traditional approaches, the living lab concept, building on community empowerment, has the potential to stimulate business-government collaboration for innovation, and creating end-user communities to test and co-create services and stimulate the demand for such innovative services. For rural innovation, traditional science and technology oriented policies seem to be inadequate. The capacity to absorb change and innovation matters, as well as empowerment of local communities and micro-entrepreneurs. Emphasis should be on pro-actively learning and change by setting examples and creating new practices. Partnerships and coalitions at rural level should include the relevant actors and organizations. Development policies are part of the innovation: the living labs provide an arena for exchange of visions and experiment on policies as well.

Rural living labs can be interpreted as mechanisms for socio-technical change in rural areas. A rural living lab is more than an innovation project, although a living lab will result into such projects; a rural living lab constitutes an innovation ecosystem. At the same time, living lab approaches enrich the set of instruments for rural and regional development policies e.g. those focusing on broadband deployment or on wireless network infrastructures. The living lab concept adds an emphasis on service innovation ecosystems. At the same time, rural and regional policies will strengthen the effectiveness and impact of living labs approaches, as they may promote new ways of collaboration and networking at the rural level, and new funding frameworks. Rural development policies and rural living labs are mutually enforcing.

Rural living labs as experimentation environments based on dialogue are mechanisms to discover and bridge gaps and to create change. In order to clarify the role of rural living labs as innovation mechanisms, a socio-technical systems view on information systems change may provide a useful framework. One such framework distinguishes between "building system" and "work system" and describes the dynamics of these systems in terms of interactions between actors, objectives, technologies and structures [19]. In applying this view we distinguish between three interacting systems that comprise the view of living labs as part of socio-technical change in rural areas (Fig. 5):

- The collaborative work environment as a system. In experimenting and using CWE innovations in a living lab setting, this system is in transformation.
- The living lab innovation system. This comprises the methodologies for systems development and implementation, applications development and testing, and the over-all organisation of the living lab process in terms of phasing and cyclic development.
- The organisational and rural environment. This environmental system represents the role of external stakeholders and policy representatives.

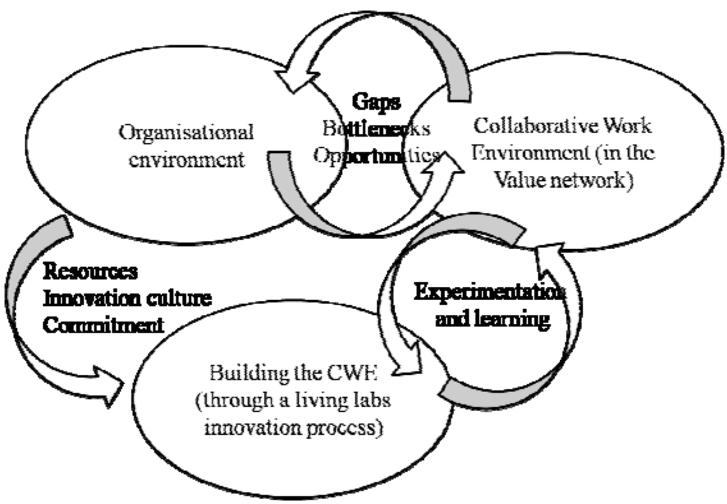

Figure 5: The living lab as socio-technical system of learning and adaptation

This view invites us to balance and align the C@R work and business environment settings with the system of innovating and experimenting new work environments, and with the dynamically changing characteristics of the rural socio-economic and policy environment. The three systems could potentially reinforce each other to support the development of a broad, self-sustainable innovation facility. A careful co-development and alignment of the work environment, the living lab system and the rural development system seems mandatory for rural living labs to fulfil their mission as successful self-sustainable innovation facilities benefiting the rural area. In fact, the concept of rural living labs extends to cover the three systems mentioned and its main mission seen from a strategic perspective is to balance and align.

At the level of aligning living labs facilities and innovation in the work environment, we found action research a highly relevant approach. Implementation of action research approach contributes to a systematic and collaborative approach to experimentation, evaluation and learning. Action research also enables to strengthen the aspect of socio-technical interaction, change and learning, and to realize the involvement of the researchers along with other stakeholders in the process of innovation and change. Essential for success is to ensure that the different activities in the (cyclic) process of experimentation and evaluation are being properly addressed and monitored.

A crucial step in applying action research principles to living labs innovation consists of shaping the innovation setting, composed of all communities, end-users and stakeholders that are involved in the innovation process. This means tailoring to the social and political context, the local aims and interests, the available infrastructure, and willingness of local partners to work together. Due attention must be paid to the process of building local partnerships and commitment, to preparing the basic foundations in terms of infrastructure and attitude, and starting with limited experimenting on simple use cases in order to be able to learn more effectively. Once the innovation setting is viable, the innovation activities can be managed by means of iterative cycles of interventions, experimentations and joint learning. This implies that a rural living lab is evolving over time, inviting for continuous feedback and enhancements until its full promise has been achieved. Relevant feedback will be achieved only if an effective and active user's involvement is achieved. The "user" of the living lab consists of a wide spectre of stakeholders, not only end-users but – especially in rural development contexts - also businesses and representatives of local communities and agencies.

Over-all, the results presented in earlier sections demonstrate the potential of the living lab concept in terms of business and rural development impact. It also demonstrates the effort required to make the concept work, in terms of preparation, collaboration and organisation, and the need to align the implementation to local circumstances. Although C@R hasn't exploited the possibilities to the maximum – we stressed the importance of pre-project preparation in establishing local public-private partnerships that could drive innovation processes and could ensure local uptake -, we feel that living labs could play a strong role in reinforcing rural development policies.

Whereas rural living labs are mechanisms for redefining and reconstructing rural activities – economic and social – they are also instruments for innovation policies or they may enrich existing policies. A clear example is regional broadband innovation policies where living labs could fulfill a natural role. On the other hand, policy development should be part of the living lab as policies are also subject to development and change and are being shaped in a context of actors and objectives. In this sense living lab innovation, resulting in enhanced CWEs and their use, comprises a socio-technical system including all actors and establishing dialogue. The process of initiating and building a living lab could also be termed a socio-technical system, as different processes and actors play their role in making crucial decisions laying the foundations. A third system is the rural development system, where again different actors and objectives can be identified. We feel that managing and actively shaping the interactions and exchanges between the three "socio-technical" systems will be critical for success of living labs.

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Chapter 4

Reference Architecture for Collaborative Working Environments in Rural Areas

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Abstract. A platform for advanced Collaborative Working Environments (CWEs) has been designed that follows the principles of an Open Service Oriented Architecture (OSOA). The multilayer architecture design realizes decoupled building blocks to deal with different aggregation levels of business functionality, namely Collaborative Core Services, Software Collaboration Tools, Orchestration Capabilities and Living Lab Applications. Additional to these layers a Control BUS has been conceptualized and implemented in order to centrally deal with component registration and brokerage enabling component reusability across living lab borders. The architecture design provides a reference framework for the individual rural living lab flavored implementations that reflect local specifics of the overall concept as a result of the contextual "engineering target point".

Keywords: OSOA, Living Lab Application, Software Collaboration Tools, Collaborative Core Services, Orchestration Capabilities, Control Bus, Collaborative Working Environments

1 Introduction

Users of Collaborative Working Environments (CWEs) in rural areas are confronted with a wide range of challenges and pain points. Application areas and industrial sectors represented in remote areas include distant education, agriculture, healthcare, transportation etc. to name a few. Within C@R, six rural living labs are operated dealing with fishery, farming, small and micro enterprise incubation, tourism and retail.

In order to come up with relevant software solutions based on an appropriate architecture design, living lab methodologies to collect end user feedback on pain points, needs and challenges have been applied to the extent possible. With regards to co-creation capabilities of end users one has to have in mind that dedicated input for the design of software architectures is very limited in particular in rural areas. The approach followed in C@R tried to overcome these end user input limitations by mapping raised use case requirements onto the underlying technology platform. Such a platform on the one hand need to be dedicated enough to accommodate commonalities within a range of rural living labs and flexible enough to serve individual needs of certain sectors, cultural backgrounds, ICT infrastructures etc. During the lifetime of the project it became evident that a reference architecture for rural CWEs has certain limitations in terms of reusable concepts due to the variety of use cases and professions being present in remote areas. Nevertheless C@R found out overlaps between architectural needs if not between all living labs at least between some of them. These overlaps drove the architectural design and the flavored implementations of according platforms operated in the individual living labs.

2 CWEs in Rural Areas - Architectural Requirements

The variety of slightly different implementations of the same concepts shows the adjustability of the C@R OSOA (Open Service Oriented Architecture) [1, 2] and the ability to fit into completely different scenarios and use cases that originated from dedicated requirements. Regardless of the variety of served use cases the overall design of the C@R CWE platform is driven by the following generic factors:

- Providing easy to use, end to end simplified, locally relevant solutions. End-Users must be able to identify applications and tools as important for their daily life. Usage appropriate for rural conditions together with low burden of maintenance and operation make the provided solutions acceptable and successful. At the same time training efforts are kept to a minimum.
- Embedded solutions comprising informal and formal aspects of collaboration. Collaboration tools must support formal business transactions and workflows that enable rural people to participate in a

global economy in a standardized way. At the same time informal ways of collaboration are predestined to overcome social exclusion and to provide most valuable knowledge sharing.
- Highest flexibility to adapt and customize solutions to the context of local living labs. Following a Service Oriented Architecture approach will enable reusability of services and components in different contexts. Orchestration capabilities to rearrange and rapidly adapt to changing business requirements will not only cope with continuous innovation but drive it.
- Openness including compliance to Open Standards. Open standards ensure the interoperability and reusability of components and services between heterogeneous platforms. Operating System and data base independency also favors the usage of Free and Open Source Software. As many use cases require mobile devices on end user side multimodality support independent of the client is essential. Small footprints on client side ease the deployment and maintenance of rolled out solutions.
- Supporting a variety of infrastructures. Whereas the living labs in Åboland and Hungary are very good examples that broadband network connections can be established in a ubiquitous way in rural areas, other living lab regions suffer from lack of communication infrastructure (Cudillero), low bandwidth (Soria, South Africa) electric power failures (South Africa) or lack of available hardware (Soria, South Africa). Offline and low bandwidth support is of great value in such regions.
- Integration. Seamless cross-collaboration and integration with existing legacy systems need to be ensured.
- Lowered Total Cost of Ownership (TCO). Limited investment capabilities of rural players require a low TCO. Minimal system operation, service & support and maintenance requirements ensure the affordability of solutions. Appropriate licensing and payment models have to be developed in order to accommodate the limited buying power of rural end users (in particular in emerging economies).
- Security. Distributed systems serving multiple stakeholders that use a variety of different client technologies require security infrastructures that provide authentication and authorization of users, as well as mechanisms for the secure exchange of data.

Despite the common C@R OSOA concept there is a variety of different implementations in the individual living labs but still are able to interoperate and reuse and thus to profit from each other. This is the major advantage of the C@R OSOA architecture approach.

3 Reference Architecture Design

3.1 Open Service Oriented Architecture Approach

Service Oriented Architecture (SOA) nowadays is a well known term providing principles of how to develop and integrate a system of loosely coupled services. SOA not only defines the low-level software architecture design principles but is a complete enterprise software concept including among others security, governance, deployment and integration. The term Open Service Oriented Architecture (OSOA) which is used to define the C@R SOA [1, 2] approach also defines a set of principles to develop and integrate a system of loosely coupled services but also components. The differences to a traditional SOA approach are the concepts the C@R OSOA builds upon and how they are combined to provide the ground of a service oriented collaborative working environment (CWE).

On the software architectural level there currently exist many different 'flavors' and interpretations of service-oriented architecture (SOA) concepts, which are being promoted by different organizations. One of the most popular and active SOA developers group is the "Open SOA (OSOA) Collaboration" [3], which represents an informal group of industry leaders with a common goal. They work together on the definition of a language-neutral programming model able to meet the needs of enterprise developers who are developing software following the SOA principles.

The C@R OSOA follows similar concepts and represents a system that exploits the SOA benefits using language-neutral concepts to build the ground for a service oriented CWE. Since the C@R architecture will be used in a broad community, among different living labs, and in a diverse set of use case scenarios it is essential to build the architecture upon well defined standards and to avoid proprietary concepts. The most important standards used in the C@R OSOA improve the quality of developed software and thus ensure the interoperability, maintainability and reusability of the individual components. This enables the utilization of advanced Collaborative Working Environments even in rural setups.

The C@R CWE System is certainly a different and wider concept than the "OSOA Collaboration Group" proposal and other SOA approaches, as it is not just considering software developers agreeing on a software architecture providing user services, but as a whole Open System to enable a CWE considering all available actors: users, equipment, service providers, software providers, CWE system designers and stakeholders.

3.2 Decoupled Layers – CCS, SCT, OC, LLA

One of the main concepts is a layered architecture design that realizes decoupled components [4] to deal with different aggregation levels of business functionality, namely:

- CCS – Collaborative Core Services implemented as reusable software components that encapsulate distinctive core functionality. Such functionality provides basic services (e.g. 3G connectivity, SMS delivery, order creation etc.). CCSs plug into the C@R Control BUS where they are registered. Every CCS provides a public API, implemented as a Web-service.
- SCT – Software Collaboration Tools [4] comprise aggregated functionality, which can be integrated into a final living labs application, but is of such a degree of independence to be usable for various applications even across different living labs. Simple SCTs provide only one CCS, more sophisticated SCTs orchestrate several CCSs and OC services (e.g. using BPEL) into a business process to the living lab application via a web service interface. SCTs can be defined using different languages. One of the basic objectives of C@R is to use as much as possible standard languages. Current implementations of the SCTs use BPEL [5] and/or BPMN [6] that allows the creation of scripts, which are executed by the orchestration engine.
- OC - Orchestration Capabilities [7] provide collaborative functions and libraries that will be used by executable scripts that define the composition of SCTs. Three orchestration capabilities are identified, namely Context Awareness, Distributed Workspace, and Advanced Services. A Collaborative situation may involve atomic functions from different OCs such as Messages Broadcasting, Shared Display, Videoconference systems, etc. categorized as the three identified orchestration capabilities. OCs can be implemented as Web Services (following the CCS design) or as static libraries deployed together with the Control BUS.
- LLA – Living Lab Applications cover end user interactions (via a User Interface) with a system supporting collaborative workflows that overcome problems related to rural activities. These applications make use of underlying layered business functionality encapsulated in SCTs but also linking directly to CCS and OC functionality.

Additional to these layers a Control BUS has been conceptualized and implemented in order to centrally deal with component registration and brokerage.

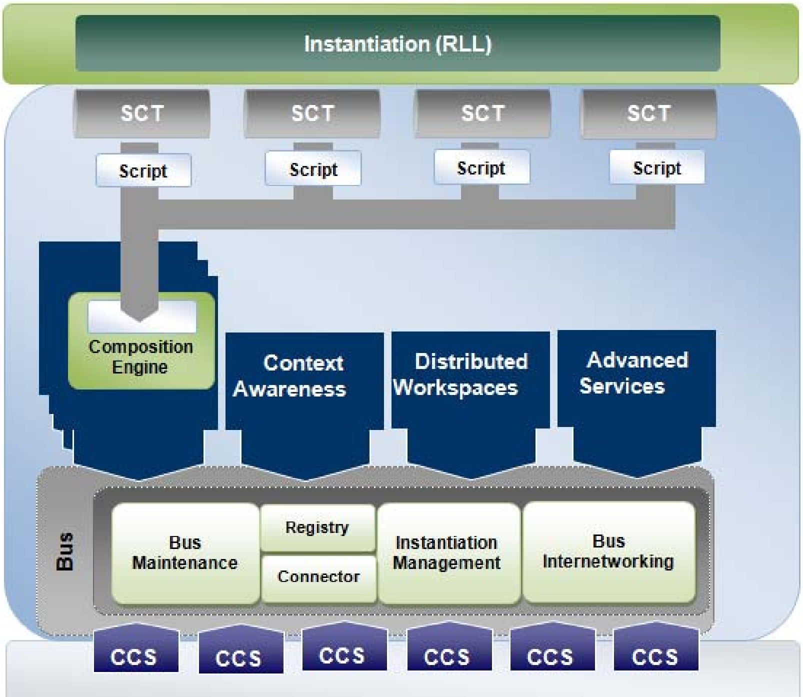

Fig. 1. The C@R architecture

3.3 Control BUS

Control functions of the elements of the C@R Architecture are encapsulated in the Control BUS. It acts as a resource broker, where signaling information about resources is exchanged, enabling the system to search for resources, managing their interconnection and supporting collaboration among different CWEs. The BUS acts as a uniforming middleware that is a conceptual inter-layer space designed for CCS component harmonization, homogenization and adaptation to standards. It makes the C@R architecture more powerful and flexible allowing an easy integration of proprietary or new standard CCS components. This key piece of C@R architecture consists of five modules:

- Bus maintenance. This module is responsible for keeping the logs of all the BUS activities, and for all tasks related to the management of the BUS itself. Furthermore, the module offers configuration files and interfaces for the administrators to control the behavior of the BUS.
- Registrar. This module is responsible for keeping a database of all components (CCS and Orchestration Capability) connected to the system. Furthermore it implements search functionality, allowing any

element to look for other elements (CCS, Orchestration Capability) connected to the platform.
- Connector. This module is responsible for the interconnection of components, and managing the establishment, release and monitoring of connections among them.
- Instantiation management. This module serves to support the instantiation process.
- Bus Inter-working. This module is responsible for negotiating the communication with other C@R platform BUSes, or even control layers of other platforms. It provides collaboration among different BUSes and enables resources sharing

BUS implementations require the establishment of information channels with the resources that it pretends to manage and interconnect. Those Control Communications are centralized by the BUS and use Web Services as transport technology, while Data Communications are P2P and may use any kind of transport technology.

3.4 Orchestration Capabilities

The Orchestration Capabilities (OC), as defined by C@R [7], provides collaborative functions and libraries that will be used by executable scripts that define the composition of SCTs. Three orchestration capabilities have been identified (other orchestration capabilities may be included into OSOA if required):
- Distributed Workspaces includes the minimum necessary methods and data structures to build high-level collaborative functions.
- Context Awareness adds functions providing environmental status and methods for context change reaction.
- Access to Advanced Services includes SIP/IMS & Security capabilities.

C@R has analyzed current collaboration activities performed at rural areas using the seven rural living labs in C@R. This analysis resulted in the identification of 45 services common to two or more living labs and 60 services specific for only one living lab. The identified common services are candidates for inclusion in any of the OCs of C@R in order to provide the basic support for creating complex collaboration services. The rest of this section describes the main characteristics of the three OCs of C@R.

Distributed Work Spaces
Distributed Workspaces (DWS) [7] are collaborative environments where main capabilities are identified and decoupled. The development process is intended to be done in parallel for creating specialized subcomponents with many features. These subcomponents are autonomous, but combining them with an orchestration language, they produce extended and powerful

functionalities. As a result, a decentralized processing will be performed by DWS, taking advantage of parallel and distributed execution and not overloading a central system.

Several components have been included in C@R Distributed Workspace OCs: Mobile GIS, Videoconferencing, Shared Workspace, Calendar, and Message Communication Components. DWS should be naturally integrated into a Distributed Collaborative Working Environment, and thus into the OSOA defined by C@R, where specific rural aspects are very important.

The DWS defined by C@R provides: user management in order to control profiles, security and other related issues; data storage of the business processes executed by the user and/or other applications; intercommunication amongst all the subcomponents shaping the DWS, which also implies the use of scripting languages to coordinate and synchronize the services provided by each subcomponent; a common interface to access all these services, targeting the end-user or middleware applications (e.g. SCTs); easy integration of new capabilities by the addition of subcomponents fulfilling the requirements to be integrated.

DWS is one of the main components of the OSOA defined in C@R. The implementation of the DWS has been integrated into OSOA as one OC, which provided a built in set of capabilities for creating SCTs for Rural Areas. This specific OC has been designed and implemented as a set of individual Components and integrated using the standard capabilities of C@R Architecture for remote access to service components based on Web Services.

Advanced Services IMS

Advanced Services deal with the functionalities needed by the living labs in terms of SIP (Session Initiation Protocol) services, IMS (IP Multimedia Subsystem) services and Security (see paragraph 3.7). The SIP/IMS service architecture allows and facilitates the design and development of services that use the new platform and network capacities. SIP is a signaling, presence and instant messaging protocol developed to set up, modify, and tear down multimedia sessions, request and deliver presence and instant messages over the Internet, and allows two end points to establish media sessions with each other.

IMS [8] defined by the 3GPP as a core network subsystem allows the mobile service provision over IP packet switched networks. IMS defines the extensions over SIP to cover the specific necessities of the 3G mobile networks and creates a common platform to develop diverse multimedia services. Applications and services comprise residential VOIP, entertainment including IPTV and gaming, IP Centrex / IP PBX and business unified communications including fixed-mobile converged services, videoconferencing and web-collaboration.

Regarding C@R implementation and the use of some advanced services, first, the integration of the Marte videoconferencing application combined with instant messaging and presence (IMP) services has been realized. To do that, the basic resources of the Marte system have been divided and adapted into CCSs that provide videoconferencing functionalities and enable the recovery of presence information from the operator (IMS core of a Telco operator) or from other systems. All this serves Cudillero Living Lab users to start videoconferencing sessions with other users available in IMP applications and constitutes a good example of how to integrate already available services and applications into the C@R architecture. Both services use the C@R architecture BUS as a meeting point where they discover and get all the information needed to work cooperatively.

Also, the integration of some typical services of an IMS platform has been exploited. Concretely, a multi-conference (voice and video) system has been integrated into the C@R platform in order to demonstrate that the standard methods defined by the architecture are capable of handling advanced services.

Context Awareness

Context awareness was introduced for the first time by Schilit and Theimer [9]. They defined context of an entity as a set of information concerning the identity of the entity, its location, identities of nearby objects and changes to those objects. Ryan et al. [10] present context of an entity as its environmental information, such as location, time, temperature and its identity. Dey [11] considers context of an entity as its physical, social, emotional, and mental (focus-of-attention) environments, location and orientation, date and time of day, other objects in the environment. The majority of these researchers share a common vision of context as it represents a set on information about location, time and activity of a person. In the C@R architecture, CCS components are context-aware components as they provide contextual information about the user. Actually, these components provide information about user location, user profile, spoken languages and Web sensors, namely the following components have been implemented and used in the individual living labs:

- User Profile: the User Profile Component (UPC) describes the user personal information, preferences and role. This component is for its nature distributed and cross-living labs as potentially.
- Geo-Catalogue: catalogue services are the key technology for locating, managing and maintaining distributed resources. With catalogue services, client applications are capable of searching for resources in a standardized way (i.e. through standardized interfaces and operations).
- Web Sensor: this component presents many opportunities for adding a real-time sensor dimension to the Internet and the Web.
- Multilanguage: the Multilanguage Data Loading Component (MDLC) is a context awareness component which allows user applications to retrieve a set of configuration files which contains the localized texts needed to interact with the end users.

3.5 Service Orchestration into Software Collaboration Tools

The main elements in a service-oriented architecture (SOA) are the services. A service is responsible for a simple action (e.g. send mail) or a single functionality (e.g. messaging). These standalone services can be used separately and they are independent on each other. In a system these basic services are used to define more complex services and if these services are combined in a logical manner the business logic of an application can also be assigned. This logical manner means a higher level definition of service orchestration. In SOA systems the service orchestrations are defined in process languages. Several instances can exist in runtime for one process definition and these are managed and executed by an orchestration engine. Using process languages has a lot functional and non-functional benefits:

- **Flexibility**: Process languages provide a clear separation between the process logic and the services. To support the need of today's fast changing business processes the business logic represented in process languages can be modified easily with swapping out services or adding more services to the process without the need of rewriting code.
- **Versioning**: Since a modified business process can be deployed during runtime the orchestration engines is in charge to manage different versions of the same business process. To avoid errors during runtime deployment of a new version of a business process the orchestration engine only utilizes the new version after all currently active connections to the old version are finished.
- **Composition**: A single business process can interact with several services. A business process can itself be exposed as a service again, so other business processes can interact with it. With this functionality higher-level processes can be defined and business logic can be represented in a transparent and structural way.
- **Persistence:** The orchestration engines provide a mechanism to persist process instance states and contexts, so after a system or power failure the processes can resume and go on.
- **Exception handling**: Process languages have a well-defined exception handling module, which can deal with runtime errors during process executions. In a more complex orchestration engine the error handler elements inside a process can have influence on the control flow.
- **Transactions:** Orchestrated services also manage transactional issues. In a structured business process it is necessary to have a transaction manager supporting nested, distributed transactions, and to handle resources that cannot be locked in a long running transaction. The transaction context is passed through all of the states in a business process to ensure data integrity.
- **Security:** Each service in a process can handle security constraints. A service is maybe available for just a narrow range of users with defined roles. The authentication works similar to Single Sign-On (SSO) in service orchestration so every service in a process also receives the

security context. This context contains information about the invoker and its roles. The security context just like the transaction context is available all the time during a process execution for every service in the business scope of the system.

In several orchestration engines the runtime usage of the functional requirements like transactions and security are achieved by using the so-called WS-* interfaces as the services have web service interface in most cases. The WS-Trust and WS-Security specifications are responsible for security context definitions and the WS-Coordination and WS-Transaction specifications define the transaction context. There are also some other WS specifications available (e.g.: WS-Manageability), but these are not as popular as the others mentioned above and not all the orchestration engines support them.

In the C@R architecture as it is based on the SOA concept, services and service orchestration can also be found. Services are the Collaborative Core Services (CCSs) and Software Collaboration Tools (SCTs) specifies the service orchestration. In a logical point of view an SCT has two main roles. On the one hand it provides the facility to compose more complex services out of other basic services. If for example send eMail and send SMS are two basic services, a complex service called “messaging” can be specified handling decisions whether a message is send via SMS or eMail. On the other hand a SCT can define and describe the business logic that consists of sequences of services to be invoked. In other words SCTs are structured CCS components defining the business logic for Living Lab Applications (LLAs).

The representation of SCT components in the C@R OSOA architecture is based on Business Process Execution Language (BPEL) and Business Process Modeling Notation (BPMN). Even if all the partners used these standards to define SCTs, they did not have to use the same orchestration engine to execute them. This decision was left to the individual living labs to support the diverse platforms and systems running in the different living lab use case scenarios. To summarize it, the SCT implementations are running on different engines (Apache ODE [12], JBoss jBPM [14], etc.) in different living labs, but all of them follow the same concepts and standards. However, the most frequently used process languages were WS-BPEL and jPDL (and a combination of them).

WS-BPEL is an XML-based language defining several constructs to write business processes. It defines a set of basic control structures like conditions and loops as well as elements to invoke web services and receive messages from services. It relies on WSDL to express web services interfaces. Message structures can be manipulated, assigning parts or the whole of them to variables that can in turn be used to send other messages. Some of the living labs used an Enterprise Service Bus (ESB) along with the C@R Bus. In this case there was another facility to deal with SCTs. The service orchestration in an ESB can be implemented as action list where each action is triggered by an ESB aware message. It is really similar to the

BPEL processes but offers more integration capabilities especially for use cases involving many divers (legacy) systems and platforms.

jPDL is a process language built on top of the JBoss jBPM framework. It is an intuitive process language to express business processes graphically in terms of tasks, wait states for asynchronous communication, timers, automated actions, etc. To bind these operations together, jPDL has the most powerful and extensible control flow mechanism.

SCTs in the C@R OSOA comprise aggregated functionality and business logic for Living Lab Applications representing the basic idea behind SOA systems, the service orchestration. As the SCTs specified in the living labs follow the common standards they are reusable and beneficial for all the other C@R living labs. SCTs are collaborative tools and the main part of the C@R OSOA that build the C@R CWE.

Besides the technical benefits of using BPEL and BPMN as a common definition approach, modeling with these two languages allows the graphical representation of the business processes. This enables even non-technical people to easily understand and validate complex business processes. From a management and use case designer point of view this is an important validation feature to conceptualize meaningful and efficient business processes.

On the level of developers the graphical representation of the business process is useful to keep the "big picture" always in mind and to define milestones during the development of the software that is behind the business process. Since the modeling with BPEL and BPMN is programming language independent it enables also the sharing of business processes across living lab borders and use cases and thus can be utilized in very diverse system landscapes.

3.6 Security Model for the Orchestration of SCTs

Given the distributed, multiuser and multi-technology nature of Collaborative Working Environments (CWEs), they are subject to many security threats. Among all, the typical security threats encountered in resource-sharing systems stand out: unauthenticated and unauthorized access to data and resources, session hijacking, reply attacks, Denial of Service (DoS) attacks, etc. Therefore, an architecture like the one implemented in C@R cannot be conceived without mechanisms that provide security. Specifically, it is necessary to enforce authentication and authorization of users, as well as to guarantee the secure exchange of data.

Additionally, one of the basic aspects of this kind of environments is that they require transparent and ubiquitous access, so that the CWEs can be accessible at any moment, any place and from any terminal type. This need for ubiquitous and transparent access makes it necessary to use small size devices, like high performance sensors and mobile terminals, which present some special characteristics, such as low computing and storage resources, battery dependency for their operation, and usage of relatively slow and expensive wireless communication links. Due to these constraints standard security solutions are not suitable for these environments, and so, it has been necessary to design a specific security model for the C@R architecture.

The aim of the C@R security model [7] is to provide a security solution to the users of this kind of environments, so that the communications between the different entities that compose the collaborative applications are authenticated, authorized, and protected from eavesdropping and modification by third parties. However, cryptographic operations are usually highly resource consuming. Therefore, considering the characteristics of the CWEs, the main goal of the developed security model has been to minimize the impact of the security architecture on the performance of the whole system. Thus, the proposed security model is based on symmetric or secret key cryptography, and it introduces an innovative service which performs centralized authorization of users, minimizing this way the load the security solution imposes over the end systems.

The proposed security model consists of two basic phases: a first phase which deals with the authentication of user identities and the distribution of shared secret keys, and a second authorization or access control phase.

As a means to allow the authentication of users and the secure distribution of secret keys between the communicating pairs, a Kerberos [15] based approach has been introduced. The reason for selecting this protocol is that its efficiency is higher than the one of the solutions based on Public Key Infrastructures [16], and therefore, this protocol is considered to be the most suitable to be implemented in systems specially characterized by their low computing capacity and their limited resources.

However, the Kerberos protocol does not cover all the necessities of this kind of environments, since it does not provide any solution to deal with the management of the rights of the authenticated users [17, 18]. This fact, forces the target server entities to implement and maintain their own access control mechanisms. Nevertheless, in environments such as the CWEs, it is not possible for the final entities to maintain updated authorization information about all the possible users participating in the collaborative environment, since these environments often require the interaction between users and servers that do not know each other beforehand. As a solution, it has been designed a novel system which performs the authorization process in a centralized way and gives service to the rest of the participating entities of the collaborative environment [19, 20, 21], as shown in Fig. 2. This way the final entities do not need to maintain authorization information regarding each of the possible users of the collaborative environment, and they are also relieved of the load derived from the maintenance of such information.

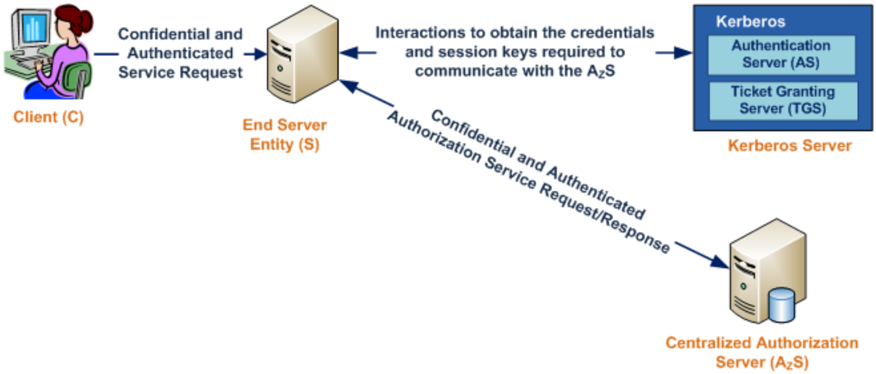

Figure 2 Basic interactions of the proposed security model

Given the heterogeneity of the CWEs, it has been necessary to develop a generic software module, located between the application and transport layers, which implements all the necessary security functionalities and allows the user authentication and authorization management being completely transparent for the final applications. This way, the basic entities that compose the collaborative applications are relieved of the necessity of maintaining and managing any information regarding the security mechanisms, and even of having any knowledge about the underlying authentication and authorization protocols. This fact involves a big time and effort saving for the basic elements in user management tasks, since both the authentication and the authorization are carried out by centralized servers.

On the other hand, it is worth mentioning that the proposed security system provides an additional advantage, which is the possibility to implement Single Sign-On solutions. This feature is derived from the usage of the Kerberos protocol, since once a client has been authenticated by the Kerberos authentication server, he is provided with credentials that allow him to authenticate to any desired service without needing to enter his password again. Regarding the user, the implementation of Single Sign-On solutions means a big advantage, because he does not need to constantly insert his password. Besides this, it also implies an enhancement of the whole system security, because if the users only have to remember one password it is more probable for them to protect it and store it in a secure way.

Finally, it must be noted that the described security architecture is a work in progress and other variations of this basic model are being developed, implemented and tested at the moment of writing this chapter. For example, currently we are working on a modification of the standard Kerberos protocol which avoids the need for synchronized clocks and conveys authorization information inside the Kerberos Service Tickets [22].

4 Implementation at Individual Living Labs

4.1 Cudillero Living Lab

The living lab in Cudillero (Asturias, Spain) [2] has been developed in collaboration with public administrations, the local authorities and with the fishery guilds. Applications developed for the fishermen try to enhance current business processes in order to make fishing production more profitable, e.g. helping on the day-by-day activity of the users in the vessels and in the auction process via the transmission of reports on the catches (arrival hour, sizes of the catches, total weight of the catches, etc.) and thereby contributing with a significant time and workload saving. The applications also contribute to improving the safety of fishermen in case of accidents or health emergencies, providing an immediate response from the health authorities. Furthermore the collaboration between vessel and port will serve to optimize the organization of the port activities.

The following use cases have been implemented in the Cudillero Rural Living Lab: GPS based catches data sending; Weather reports; Alerts management service and safety on board; Messages delivery service by instant messaging and presence. Based on mockups and prototypes validated by the user community, the software platform is implemented according to the principles of the proposed reference architecture. Once prototypes are developed, the basic software components and their interactions are determined. As a result the three layered architecture is mapped onto the individual components (see Table 1, for use case “Catches data sending”).

From bottom to top, CCS (Collaborative Core Services) components are the atomic resources which are orchestrated thanks to a control middleware, by service scripts and collaborative functions in the SCT layer of the architecture. These collaborative core services (CCSs) in layer 1 are registered in the resources broker (Bus) enabling the system to search for resources and managing their interconnection. A homogeneous layer (BusCCSOperations library) registers and connects CCSs to the Bus, in order to make each identified CCS available to the C@R platform.

Table 1. Prototypes split in basic components, in this case catches data sending

Use case	Components	Description
GPS based catches data sending	MQS	Messages Queuing Service. This component is used to guarantee that messages are sent when lack of communication coverage.
	GPS_LS	GPS Service to get the boat GPS position
	SRS	Speech Recognition Service to allow fishermen to fill in the reports through their voice
	MDLS	Multilanguage Data Loading Service. MDLS is a software component that discriminates the application language and texts.
	AAAS	Authentication Authorization and Audit Service to get software components connected and registered to C@R architecture and let users to register in the platform
	DMS	Data Management Service to manage data from CDSApp
	DSS	Data Storage Service responsible for the database
	SMS_S	SMS Service
	EM_S	Email Service
	CDS App	Catches Data Sending Application, including SCTs and user interface
	FIS App	Fishery Information System Application- including SCTs and user interface
	UPC	User Profile Component

Services for Cudillero operate in a main domain where two sub domains are distinguished: the fishing boats sub domain and the fishery sub domain (Fig. 3). Each sub domain relies on one C@R bus. Different sub domains are registered in the Cudillero domain through the bus internetworking capability. This module also enables the reutilization of basic resources or the information exchange with other "domains" as other ports (i.e. Aviles port).

Layer 2 in Cudillero utilizes a specific component as an Orchestration Capability: the Authentication Authorization and Audit Service (AAAS). AAAS acts as a transversal service that needs to be preregistered in the bus to let the rest of CCSs to be authenticated to the C@R platform.

Layer 3 defines the Collaborative services instantiation process. SCTs or software collaboration tools are the key elements to instantiate the collaborative platform relying in each bus. The SCTs deal with the modeling of the business processes of each sub domain. This piece of software is first compiled to get a BPEL (Business Process Execution Language) script. These scripts contain information about all the necessary elements and basic services to be connected and started to run the platform. This BPEL script is uploaded to the SCT scripts repository. When the instantiation process begins, the SCT is downloaded to a server (composition engine) configured with some instantiation parameters (additional code). As a result, CCSs defined in the SCT are deployed to the server, registered to the bus and started.

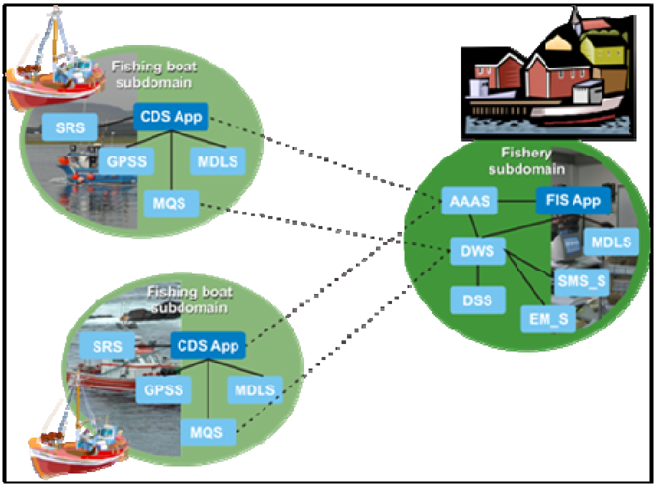

Fig. 3 Software components in Cudillero sub domains

Most of the software components are identified as Collaborative Core Services (CCSs) except the AAAS that acts as a transversal service that needs to be preregistered in the bus to let the rest of CCSs to be authenticated to the C@R platform.

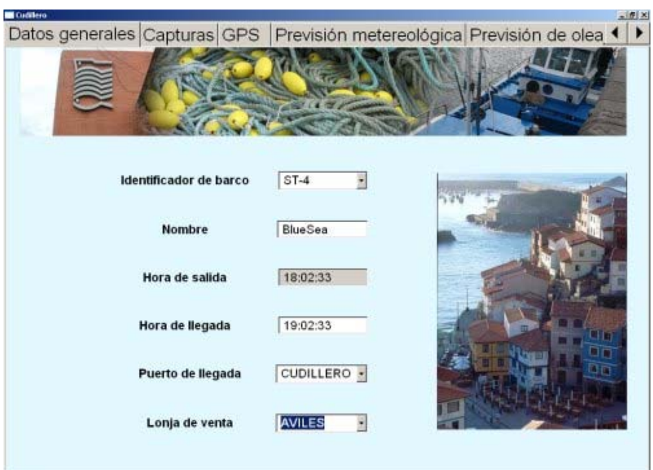

Fig. 4 CDS APP main data screen

Two special CCSs were distinguished in each sub domain: 1) CDS App – Catches Data Sending Application, see Fig. 4, and 2) FIS App – Fishery Information System Application. These specific CCSs (CCS applications) consist of the graphic user interfaces and the service framework. These are main threads that use and orchestrate the basic services (rest of CCSs) to compose end user applications.

4.2 Czech Living Lab

The Czech Living Lab [2] has developed an application to support forest owners that provides approximate pretension to subsidies from the European Agricultural Fund for Rural Development (EAFRD). After defining the area of interest (i.e. based on geo referential data like ortophotos, map of cadastre, forestry maps etc.) the user gets a comparison comprising geographical data of the subsidized locality, intersection and calculation of the user's pretension for subsidy.

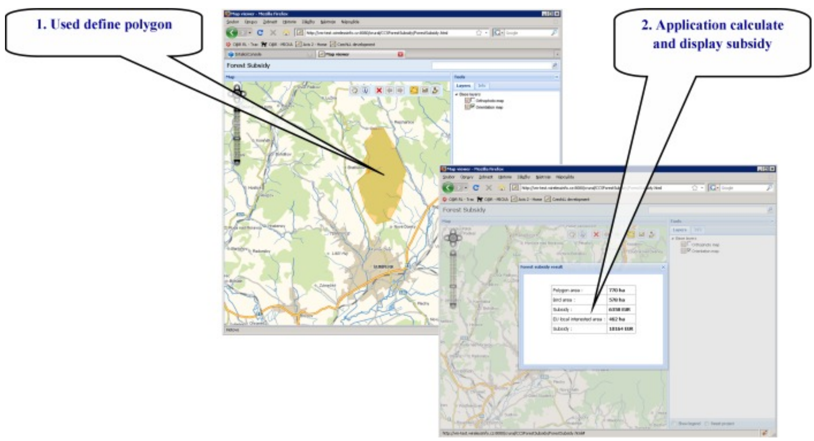

Fig. 5. Living lab application to support forest owners

This use case maps onto the layered C@R architecture as follows. The Living Lab Application with the UI comprises two main components:

- Map component – provides main map functionalities (browsing map, draw polygons in map)
- Data component – provides access to calculated data returned from SCT.

The Software Collaboration Tool (SCT) *Grant Calculation* puts together chained services of the calculation process:

- A Web Feature Service providing user data delivery into WPS calculation
- A Web Processing Service providing layer intersection and calculation of the amount of forest subsidy.

Two Collaboration Core Services CCSOgcServices are invoked, one that encapsulates WFS and another one to encapsulate WPS. The map component of the living lab application sends a request for grant calculation. The underlying SCT *Grant Calculation* calls the CCS *CCSOgcService1* that provides WFS of user's shape (area of interest). After getting the data the SCT calls another CCS *CCSOgcService2* that provides WPS for calculation. The WPS compares data layers and calculates the result for the appropriate part of area. The output of the SCT is presented via the data component of the living lab web application.

The SCT *Grant Calculation* has been developed in Intalio|Designer on top of the Eclipse platform. The BPMN Modeler of Intalio|Designer lets Process Analysts design any process using the BPMN 1.1 or BPMN 2.0 specifications and generates BPEL 2.0 code automatically. The most activities designed in a process require a binding to external systems, or custom data elements provided at runtime by end users when completing human workflow tasks. For this purpose, Intalio|Designer includes a powerful Data Mapper that supports graphical data assignment and transformation for arbitrarily complex XML Schemas.

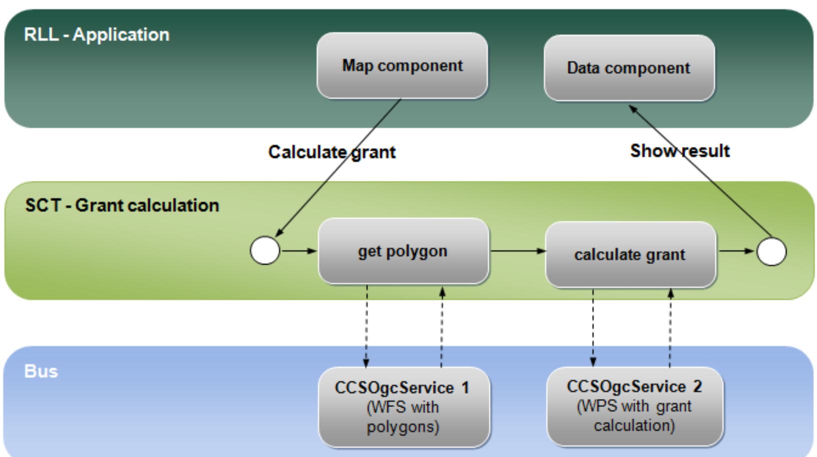

Fig. 6. Deployment model of application regarding SCT

As Intalio|Designer is capable of translating any BPMN diagram into fully-executable BPEL 2.0 processes no code has been written to orchestrate this SCT. The derived BEPL script entails the following data flow:

- SCT gets the userId as input parameter
- Execute WFS request "GetFeature" for passed userId. This request returns a polygon for the user's interest area.
- The returned polygon is passed to WPS request "Execute" which provide the calculation of subsidy.
- An XML file with the result of the calculation is returned from SCT as output.

The created SCT is deployed directly from Intalio|Designer into the Intalio|Server. The Deployment Manager of Intalio|Designer is responsible for packaging all the artefacts required for the deployment of BPMN processes in a production environment, including BPEL, XForms, XPath, XSLT, and WSDL files. The Deployment Manager supports a one-click deployment process convenient for prototyping, as well as the definition of custom deployment processes for testing, staging, and production.

Intalio|Server is a native BPEL 2.0 process server based on the J2EE architecture and certified for a wide range of hardware platforms, operating systems, application servers, and database servers. The deployed SCT is accessible from Intalio|Server by standard SOAP WebService, i.e. usable from several different applications developed in any platform supporting SOAP.

4.3 Sekhukhune Living Lab

The overall vision of the Sekhukhune Living Lab interventions is to create impact on operational excellence of small and micro enterprises. Living lab experimentation has leveraged efficiency and effectiveness by the application of small and micro enterprise incubation mechanisms. Efficiency and effectiveness of small and micro enterprise operation lie:

- in the establishment of economies of scale that overcomes the problem of critical size, i.e. via virtual cooperatives,
- in the bridging between 2nd and 1st economy gaps that causes inaccessibility of profitable markets,
- in the reduction of transactional costs caused by remoteness, bad infrastructure and limited resources,
- in the employment of entrepreneurs providing ICT services that haven't been accessible in rural areas so far.

In the Sekhukhune Living Lab the C@R Architecture was deployed regarding requirements based on the specific infrastructural (low and expensive bandwidth, erratic power network, low end devices) and cultural (illiteracy, novice IT users) impediments of a rural living lab in South Africa. These requirements led to a C@R Architecture implementation different to the other six living labs, which are deployed in much more advanced environments around Europe.

Sekhukhune C@R Platform. The software platform deployed in the Sekhukhune Living Lab [2] is a composition of Open Source and C@R internal software (see Figure 5). The runtime environment is completely designed with Apache Open Source products [23]. One reason for doing this is the user friendly Apache license. The second reason is the easy integration and interoperability amongst Apache products. The individual Apache components have been build to be interoperable and compatible with all other Apache components and thus allow easy integration and guarantee a stable platform.

Sekhukhune C@R Components. During design time of the C@R components the Eclipse IDE was used for the CCS creation, while the more complex process modeling for the SCT components was realized using the Intalio Designer, a free BPMN modeling tool. Modeling the SCT components using an abstract and high level language like BPMN enables also non-technical people to understand the underlying business process quickly. It allows the creation of a high level view of a business process while hiding away the technical low level business logic (see Fig. 8).

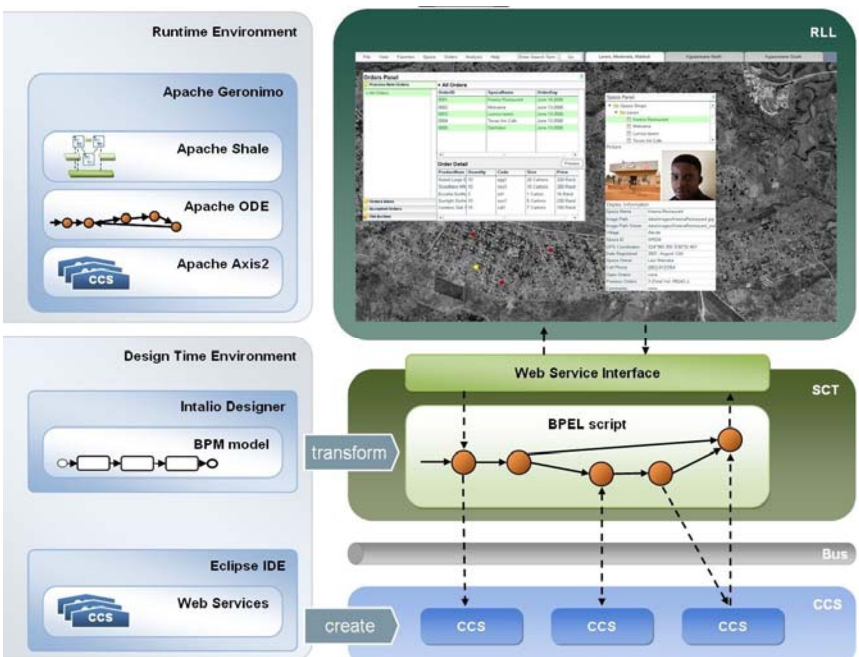

Fig. 7. Sekhukhune Living Lab C@R Architecture implementation

By using BPMN as modeling language it is possible to clearly define the individual C@R Architecture layers (CCS, SCT, LLA) during design time. This simplifies the development of modular and reusable components and ensures the clear differentiation of the individual layers. Also the integration of external components is simplified due to the graphical representation of the process. After modeling the SCT business process the BPMN process model is translated into an executable BPEL script and deployed in the Apache ODE runtime where the SCT component becomes accessible via a web service interface.

In the Sekhukhune Living Lab the C@R Bus is deployed in a very restrictive way due to the specific environmental requirements. Since the C@R Bus is used to interoperate between several loosely coupled components via a network it is necessary to have a proper network connection in place. In the Sekhukhune Living Lab there is only occasional connectivity and thus it is not possible to use the C@R Bus like in the other living labs. However the Sekhukhune Living Lab benefits from the C@R Bus as a local registry and connector. The software environment in the Sekhukhune Living Lab is designed to run offline most of the time. This is realized with a local server installation on the client machines. The C@R Bus is utilized to serve as the central integration point for reused components from other living labs. The integration itself is standardized due to common implementation rules for SCT and CCS components with the C@R Architecture definition.

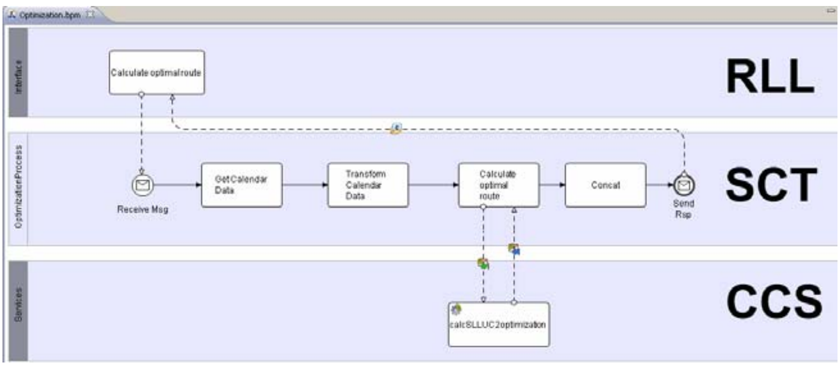

Fig. 8. Business Process Modeling with Intalio Designer

4.4 Homokháti Living Lab

The goal of the software tools developed in the Homakháti Living Lab [2] was to enhance the most important and innovative processes present in the agriculture and tourism sector. In the field of agriculture a Collaborative Working Environment has been specified covering collaborative procurement (orders and offers) and the collaborative data collection and analysis framework (yield prediction). In the field of tourism the service exchange framework was defined as an umbrella for providing a unified and integrated framework for handling both the processes behind the service management (e.g. massage management) and the vertical ICT services for the tourism (centralized invoice handling).

The architecture integrates the Enterprise Service Bus (ESB) [24] and the C@R Control Bus. It consists of logically separated layers to provide a loosely-coupled, well-managed distributed system. As they are fully self-sufficing layers they can be managed, configured and even clustered separately. Each layer has its own responsibilities and functionalities. The following layers can be found in the architecture (see Figure 9):

- **Portal:** The Portal [25] layer contains the user interfaces for the end-users and provides the SSO (Single Sign-On) feature between the independent applications. The Portal also handles content management issues to setup personal and role based layouts and designs. Each application is presented as a portlet. Besides the web pages these portlets also contain the user interface logic and navigation rules as pageflows [14].
- **Service Gateway:** The Service Gateway acts as an access point for none ESB-aware software components just like the user interfaces. The services can be reached through this layer from outside the system. The Service Gateway transforms the requests to ESB messages and creates the security and transaction contexts for them.
- **Service Mediator Center:** The Service Mediator Center has two main parts. One of them is the ESB that handles security and transaction contexts forwarded by messages between services. It also contains a routing system to transmit the ESB messages from one service to another on a specified route. These routes are defined by a rule engine which can describe even Content Based Routing (CBR) rules [26]. The ESB has a management and monitoring service that provides information on messages and services for administrators. The other part of the Service Mediator Center is the C@R Bus. It has three main functionalities. Services can register themselves to the Service Registry. Each service can be searched and reached through this registry system and through the Service Broker. The third main functionality is the Bus Federation to be able to connect other buses where more services can be registered, searched and used.
- **Service Orchestration:** The Service Orchestration layer defines all the business logics and processes coming from the applications as workflows (SCTs in C@R concept). These workflows build a chain from services and handles the input and output data for them. It is an easier way to orchestrate or describe complex processing of data in contrast to hardcode them. Using workflows makes it possible to build base reusable services with simple functionality.
- **Collaborative Core Service (CCS):** The Collaborative Core Services are simple, independent services. A service offers a distinctive functionality for the system. Services encapsulate well-defined parts of business logic or points of integration with legacy systems.
- **Database:** The Database layer contains all kind of databases that can hold data. It can be a relational database, XML files, etc. All the data saved in this layer for applications, services and workflows.

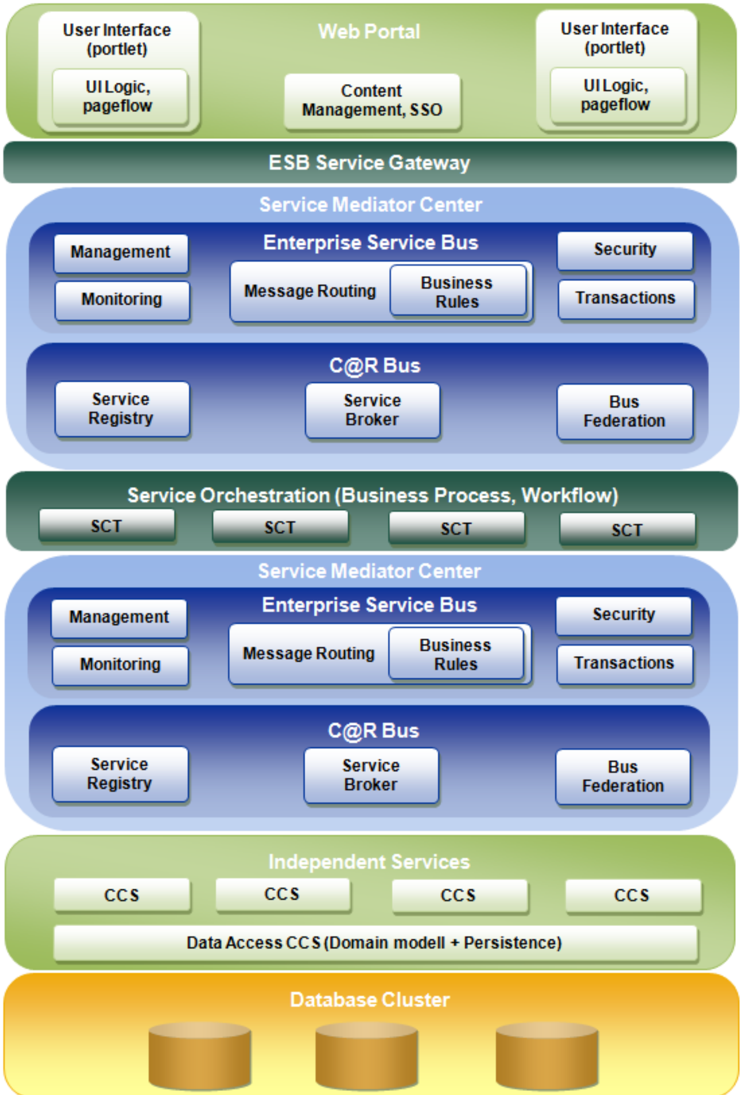

Figure 9. Homokhati C@R architecture implementation

A typical three-tier web application nicely fits in this architecture. The Portal layer holds the user interfaces; the business logic is represented as workflows in the Service Orchestration layer (SCTs), the entities and data are provided by the Collaborative Core Service and by the Database layers. The connection and communication between the layers are organized and managed by the Service Mediator Center which handles also the security and transaction issues for each application.

5 Architecture Validation

The C@R project started with the following research hypothesis regarding the reference architecture: "If there is available an approach, based on open standards and developed in the most generic way, that enable the orchestration of software collaboration tools and components, then, it will be able to define and develop new integrated collaboration environments in a more flexible, dynamic and economic way". In order to validate that the proposed approach satisfies the research hypothesis, it is necessary to achieve the following validation objectives:

- Validate the added value provided because a Software Collaboration Tools can be developed as orchestration of Collaboration Core (Web) Services.
- Determine the support of the proposed approach to reuse already existing collaboration services.
- Determine the degree of flexibility in the development and operation of platforms according to the architecture principles.
- Determine the degree of openness and interoperability between CCSs coming from different platforms to implement a Software Collaboration Tool.
- Evaluate the performance of SCTs using the base components of the architecture
- Evaluate the cost and effort required to develop a software collaboration tool differentiating between a) SCTs orchestration by means of scripts; and b) encapsulation of already existing components in terms of CCSs.

Due to the nature of the validation and the objectives stated, the most effective approach to perform the validation activities must be based on the execution of controlled experiments to create Software Collaboration Tools according to the local context and purpose. Although the C@R project considers seven different living labs, the validation findings presented in this paper only correspond to the living labs previously discussed.

After the evaluation of trial implementations of the C@R reference architecture, it is necessary to remark that end-users do not experience any particular benefit or damage that can be addressed unambiguously to the use of the solution provided. Nevertheless, several benefits regarding software engineering have been obtained due to the capability of the C@R architecture to create Software Collaboration tools as orchestration of Collaboration Core (Web) Services. These benefits are:

- The C@R reference architecture facilitates the reusability of already existing collaboration services, concepts and components across design and runtime environments of different CWEs.
- The required degree of flexibility to develop and operate software collaboration tools has been assured through the usage of the most relevant standards in the fields associated to services, namely BPEL – Business Process Execution Language, BPMN - Business Process

Modeling Notation, WSCI – Web Service Choreography Interface, SOAP and WSDL. Moreover, it is important to mention that the scripts for creating SCT tools can be developed using several tools already existing in the market. This fact assures the sustainability of wider usage of this approach to orchestrate advanced CEs.

- The C@R architecture ensures the openness and interoperation of CCS components for SCT orchestration coming from different platforms. As an example of interoperation amongst different living labs, the User Profile Component (a component enabling context awareness functionalities) is shared between the Cudillero Living Lab and Frascati Living Lab. Moreover, there are other examples of interoperation with already existing commercial systems, such as the integration of Google calendar in Homokhati SCTs.
- The performance of SCTs using the base components of the architecture is satisfactory. Although, there are no particular performance benchmarks available, the end-users that have validated the tools have not reported any problem about performance.
- Considering the performance of the components that have been reused and encapsulated, the performance registered is very similar between both versions (encapsulated and non-encapsulated).
- Nevertheless, due to the necessary interchange of messages during the operation of the C@R Bus, proper network connections need to be in place. In many rural settings, there is only occasional connectivity and thus it is not possible to use the C@R Bus to its full potential. In those cases, the C@R bus provides main benefits as a central integration point and repository for reused CCSs.
- Cost and effort required to develop software collaboration tools are competitive. On average the compilation of SCT scripts could be determined to 1 person-month (including the BPEL specification and tools related training). Related encapsulation of existing components in terms of CCS requires 8 hours (on average) of effort. It is important to remark that the effort to encapsulate components provided by third parties was higher due to tasks related to: documentation examination; functionality understanding; and unexpected problem solving. The effort was lower for the components that had already been developed by the same programmers.

CCS encapsulation activity supposes only marginal effort and is performed once per component to make it available also for reuse.

The utilization of a common C@R OSOA approach among all C@R living labs improves the collaboration on technical and business level. Problems and concepts in software and architecture design can be solved and implemented collaboratively in all living labs. Problems and concepts on business level can be discussed and realized collaboratively without the barriers of different underlying architectures and thus easily transferred across living lab borders without major technical modifications.

Using the power and resources of another C@R living lab to collaboratively design and develop common components is one of the major benefits of the C@R project. Following the C@R OSOA the efforts can concentrate on creating solutions instead wasting time on interoperability issues. Due to the common C@R OSOA concepts followed by all C@R living labs an effective collaboration among different living labs and different use case scenarios is realized.

Besides the benefits on the technical level also the collaboration during use case design, development tools evaluation and knowledge sharing profits from the C@R OSOA approach. As an example the Sekhukhune living lab established a collaboration with Åboland Living Lab and Czech Living Lab on a higher level. The collaborative efforts concentrated on use case design and knowledge sharing regarding specific software tools and standards. The utilization of knowledge from other living labs following the same principles, the C@R OSOA, improves the collaboration on topics outside software development. Since it isn't necessary to discuss and clarify low level details the collaborative efforts can concentrate on higher level problems and thus also involve use case design and topics that improve the system on governance and management level.

The benefit of the common C@R OSOA used among all living labs is that interoperability and interfacing is not a problem to be solved by each living lab individually anymore. The living labs can collaborate and concentrate on working on the individual business processes and services to solve the problem.

6 Conclusions

One of the key objectives of C@R is the development of a reference architecture reflecting advantageous concepts that overcome a variety of challenges and pain points typical for rural CWEs. Deriving common characteristics of such architecture turned out to be difficult due to the limited capabilities of end users to reflect on technical needs and due to the differences in target sectors of the seven living labs involved.

Nevertheless C@R found out overlaps between architectural needs if not between all living labs at least between some of them. These overlaps have been translated into several principles (decoupling, open standard compliancy, flexible infrastructure support, service orchestration, interoperability etc.) that drove the architectural design and the flavored implementations in the individual living labs.

The common principles of the reference architecture have been realized exemplary and subsequently validated in terms of added value. Such common principles include the usage of most important standards (e.g. web services, BEPL), component representation (e.g. BPMN), tools (e.g. Intalio Designer), reusable, encapsulated functionality (OC services, CCSs), security models (e.g. AAS) or service brokerage (e.g. BUS). Besides commonalities the flavored implementations in the different living labs also showed distinctive differences that reflect the local specifics, e.g. the usage of the sub domain concept in Cudillero (fishing boats) or the limited usage of the BUS in Sekhukhune due to network impediments.

The full potential of architectural benefits couldn't be leveraged during the lifetime of the project. Nevertheless the validation of architecture implementations in distinctive experiments provided promising results: In particular the C@R reference architecture is capable to facilitate the reuse of collaboration services, concepts and components across design and runtime environments of different CWEs.

The required degree of flexibility to develop and operate software collaboration tools has been assured through the usage of the most relevant standards in the fields associated to services. Openness and interoperation of CCS components for SCT orchestration coming from different platforms has been showcased. The performance of SCTs using the base components of the architecture is satisfactory and cost and effort required to develop software collaboration tools are competitive.

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Chapter 5

A Living Lab for Stimulating Innovation in the Fishery Sector in Spain

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Abstract. The objective of Cudillero Rural Living Lab is to support the fishing industry through jointly developing innovative services and applications and offering technical support, in particular related to small vessels devoted to traditional ways of fishing. The Cudillero rural innovation environment is presented in order to contextualize the living lab activities. It is illustrated how open innovation methodologies improve the quality of life of inhabitants in this rural and coastal area. This chapter presents the results from the living lab methodology application in the Cudillero fishing sector including a series of experiments targeting different scenarios, and we discuss the process of software development and applications validation resulting in collaborative environments supported by the platform proposed in C@R.

Keywords: Collaborative Platform, Fishery, Living lab, Innovation, Rural

1 Introduction

The coastal and traditional fishing is mainly characterized by the lack of financial resources linked to the lack of capability to accede to the technology which is essential for the search for new working processes and business models. The business model for the traditional fishing production relies on the fishermen's guilds, created to promote the fishing sector and to ensure that the interests of the fishermen are observed. The current marketing processes make these organizations very vulnerable. In practice, these organizations have limited capability to take decisions, because their proposals, initiatives and management plans are under the intervention and approval of the regional authorities. However, the regulations don't specify that the first sale centers has to be managed like that, but fishermen associations, very used to ancient customs, don't feel autonomous enough to manage their production systems and they keep under the umbrella of the regional authorities. Traditional fishermen's organizations are financed thanks to the fees coming from the associated fishermen and from a percentage of the sales, limited by the regional authorities.

The traditional fishing sector relying on the coastal fleet is immersed in several interconnected problems such as over exploitation of fishing resources, economical problems derived from an inefficient marketing and lack of labour force for the fleet crew. These fishermen seem to be dissociated from the marketing chain. Other fishermen devoted to more industrial ways of fishing have even their own logistic system (i.e. transportation or cold stores) and commercial contacts (i.e. manufacturers, wholesalers, exporting companies), so they can offer their products with more information and knowledge of the market. However in the traditional fisheries, the fragmentation between the production and the marketing is complete and the lack of their own infrastructure prevents fishermen from designing long term strategies.

Cudillero is a small council located in the north of Spain. Its identity is determined by its fishing activity. The Cudillero fishing sector relies in a coastal and traditional fleet and the production is focused in few, but high quality species as the hake, caught by means of a very traditional way (by hook) deprecated in other areas. This way of fishing is less rentable than others but on the other hand is less abrasive with the environment and the product should have greater commercial value since arrives at shore with more quality and freshness.

The fish market, in which the first sale is made, is located at Cudillero port and managed by the fishermen's association "Virgen del Carmen". Cudillero fishery is physically closed to Avilés, a big and innovative fishery, and fishermen usually unload their products in Cudillero port and then they transport them to Avilés or other bigger fisheries looking for a higher price. This produces a decrease of the supply and then a decrease of the buyers and then again the fall of prices. With this production system, prices vary a lot daily and seasonally and do not cover exploitation costs. Cudillero fishermen tend to increase the fishing effort what makes the long term situation worse because of the over exploitation of resources.

In the onshore and traditional fishing, the fishing resources in which they are specialized are suffering over exploitation by other fishing arts, like the trawling. Fishermen's income decreases and new generations abandon the sector.

Sometimes, Cudillero fishermen don't know the products prices in other first sales markets and even it's difficult for them to calculate the transportation costs. Intermediaries or wholesalers take benefit of the ignorance of the fishermen about the market, to control the auctions. Almost all the production is first sold through the auctions, apparently very smart and transparent process. However in practice, the production price is in hands of the intermediaries. First sale prices are not governed by the law of supply and demand but the wholesalers' speculating strategies. Cudillero fishermen are aware of the situation but their association has not resources enough to implement new strategies.

All this suggests a radical change in Cudillero production system, and a new approach to innovation in the fishery industry.

2 The Cudillero Rural Innovation Environment

In order to enhance the rural innovation system in the fishing areas it is essential to provide people involved in the fishing sector with tools to start progressively being independent from the public funding, in order to change their current business processes. As a starting point, Cudillero Rural Living Lab works towards a first objective: to provide people in the fishing sector in Cudillero with tools to innovate in their commercial processes, giving greater visibility to their products and attracting buyers and producers to Cudillero port. Tools such as origin certificates to complement quality hallmarks that increase the value of the products, and introduction of Internet access on board which is considered an highly promising area of innovation in Cudillero Rural Living Lab, as it improves the production and trading process and brings the benefits of Internet based services to the end users. On the other hand, with open innovation strategies, fishermen should be more capable to take decisions in main resolutions taken by the policy makers. Policy makers usually try to ensure that the Regulation is enforced which limits more and more the fishing grounds trying to optimize the resources exploitation. But measures taken usually don't take into account the onshore fleet situation and needs.

One of the EU priorities is to promote all-embracing policies with the aim to decrease the differences in the quality of life between the country and urban areas. Tragsa's duty, as a public company, is to support the national policies to foster the rural development. Since the beginning Tragsa committed themselves to the living lab concept oriented to new models of open innovation, cooperation among policy makers and citizenship, including in a very significant way, the citizens collaboration.

As said before, Cudillero fishermen's association "Virgen del Carmen", specialized in few species and in a very traditional ways of fishing, is in a critical situation. Fishermen see in the Cudillero Rural Living Lab establishment a great opportunity to start innovating in their commercial processes, diversifying the economy and giving greater visibility to their products. For the constitution of the rural living lab the Regional Directorate of fisheries advises the Local Action Group Valle del Ese-Entrecabos to become also a Coastal Action Group. Then this Local Action Group, beneficiary from the EAGGF (European Agricultural Guidance and Guarantee Fund), is also managing part of the EFF (European Fishery Fund) to boost the creation of new developments for the fishing zones. Fishermen assume directly the leadership being an active part of this Coastal Action

Group for Cudillero and other organizations working for rural development in Cudillero area.

In Cudillero Rural Living Lab, the Cudillero town council is an active part as well, providing economical support, access to the village infrastructure, and supporting the initiative disseminating the results in local and national governments. C@R team's role has been essential in Cudillero Rural Living Lab, identifying and validating the scenarios and use cases and setting the strategy to involve the end users in the validation process. The team is also the first responsible for the software development and platform deployment, for testing and for experimenting the scenarios on wide scale. The goal to achieve in Cudillero as in other rural areas and sectors is to develop strategies to enhance the quality of life in rural inhabitants. These strategies are oriented to create local user communities, autonomous enough to take their own decisions about local developments. The collaboration among these stakeholders configures the perfect environment for creating new services and innovation in this rural area.

3 Living lab Methodology and Experiments

The Cudillero Rural Living Lab emerged under the C@R framework when Tragsa and the Regional Directorate of Fisheries decided about the Cudillero fishing sector as a target area to develop. The Cudillero fishing sector, in decline, turned into the best chance to promote measures in favor of the improvement of the well-being and stay of the rural inhabitants, guaranteeing the environment quality and its current employment. In the beginning of the project, the Cudillero user community was not very enthusiastic with any kind of innovation or change. Therefore Cudillero Rural Living Lab started with developing a working plan based on a strategy to involve users in the validation process since the beginning. First phases are very relevant: needs and goals are detected jointly and the group of stakeholders leading the living lab is agreed. After these first phases, scenarios and prototypes are designed and implemented in cooperation in the validation process. At the end of the validation process, end users have their own validated prototypes to be disseminated to the policy makers. The following phases were agreed in the Cudillero development process:

- Phase 1: Detecting the needs
- Phase 2: Detecting goals and identifying the stakeholders
- Phase 3: Identifying scenarios and use cases
- Phase 4: Validation process
- Phase 5: Results dissemination and exploitation

Asturian surveillance crew

Asturian regional authorities

Fish market staff

A fisherman

Fig. 1. Detecting needs. Pictures taken during the analysis on current practices

3.1 Phase 1: Detecting the Needs

In this first stage, a previous analysis was carried out on current practices for collaborative work in fisheries. Potential interested parties in Cudillero were contacted as the surveillance staff, fishermen, policy makers, and officers, and several questionnaires and surveys were distributed among them. Needs identified are the need for increasing the fishing production value, and the need for a greater level of collaboration with policy makers to better fit fishers' needs.

3.2 Phase 2: Detecting Goals and Identifying Stakeholders

The main goal to achieve was identified together with the potential stakeholders: to provide people in the fishing sector with tools to innovate in their commercial processes, giving greater visibility to their products. Goals would have to be reached jointly with regional and local authorities. Several meetings took place with potential interested parties to define and elaborate the main goals. After several meetings and events, main stakeholders were involved. As a result, they assumed the projects' leadership. In this phase also local and regional press started echoing the project.

In this phase, Cudillero Living Lab was also included in the European Network of Living Labs (ENoLL) taking benefit from the networks' experiences, and sharing the strategies in order to look for synergies. Lessons learnt from Cudillero have also been disseminated through territorial cooperation projects on living labs and through several initiatives on national networks.

3.3 Phase 3: Identifying Scenarios and Use Cases

The way considered to achieve the main goal is to provide the production with added advantages such quality labels that increase its value. Origin certificates linked to quality labels are essential to back up the quality hallmark's credibility. The traceability to serve the end consumers and other agents within the supply chain allows the fishing products gaining in value and therefore strengthening the traditional fishing sector. Collaborative services supports this quality label by giving technological solutions in order to guarantee the traceability from the origin as well as to certify the fishing grounds, the ship-owners and the working day duration.

The establishment of a traceability system in Cudillero "Virgen del Carmen" fishermen's association is considered the first step to radically change the business processes in Cudillero fish market. Guaranteeing the traceability from the fishing grounds and making their production data accessible to buyers and consumers through the Internet, the fishermen association would start working towards e-commerce and the direct sale. Therefore, the first use case is identified: 1) Quality hallmark with origin certificates, informative webs and SMSs services, GPS based catches data sending on real time.

On the other hand, the Cudillero coastal fleet would count also on Internet access. This is considered an open field for new developments to innovate in Cudillero Rural Living Lab, improving the production and trading process. Based on this Internet connection and in order to provide fishermen with services to enhance their working lives, the next two use cases and services are also considered and developed: 2) On line access to weather reports; and 3) Instant messaging and presence, safety on board. All the services derived from these use cases are accessible through a common software user interface. Through this user interface, fishermen gather and send daily catches information, access several meteorological data sources, manage the safety on board and establish voice or audio conferences.

Besides, the Cudillero fishermen' guild web site was developed and tested by the users. Through this web site (www.cofradiacudillero.com), different users had access to available online services. These services were allowing fishermen and wholesalers to get information about the catches and to configure their user profiles.

Fig. 2. Fishermen's guild web site

Use case 1: Quality hallmark with origin certificates, informative webs and SMSs services, and GPS based catches data sending on real time. In order to introduce the origin certificate in the production, Cudillero Rural Living Lab works on the fleet GPS tracking, sending data on real time from the fishing grounds to the auction. It works also in developing information systems compiling and managing all data received about daily catches. Therefore the production data is available through a web page and SMS bulletins to the fish market's staff, consumers and other agents within the supply chain, even before catches are unloaded at port. Once unloaded at port, catches are labelled with the quality trade mark including a unique batch code that identifies every boat's daily production. These value-added services to the production are expected to attract producers and wholesalers to trade in Cudillero.

Fig. 3. Cudillero Rural Living Lab main scenario

Through several forms fishermen send the catches data before arriving in port. Through these forms fishermen also send their GPS position. Once in the fishery located at the port, the officers and users query data sent by the fishing boats. They also certify the hake origin with the information about the GPS location sent by each boat at the moment in which the hake is caught. Fishermen are sending their position during their daily journey, sending also their departure and arrival time. Data is stored together with catches data allowing certifying the product origin. On the other hand this service allows the auction centre's officers to speed up their production processes and to inform wholesalers and trade agents about the daily production.

Use case 2: Online access to weather reports. Accessing several meteorological data sources from a user interface installed in the boat or in the fishermen's mobile phones, is essential for fishermen as their daily tasks are depending absolutely on the weather.

Use case 3: Instant messaging and presence, safety on board. The boats working in the same time on sea manage conferences and establish sessions combining all services installed in the boats such as presence, group and lists management, VoIP, content sharing, sessions control and GPS location. The safety on board service discover and use contextual information based on sensors, i.e. user location, date and time, proximity of other users and devices, available networks, available network bandwidth, the ambient noise level, in order to detect an emergency situation and then send an alert. From the user interface installed in every boat the end users register and connect to an Instant Messaging and Presence service and through this user interface nearby boats are visualized on a geo referenced map. This service lets the fishers and surveillance crew establish conferences.

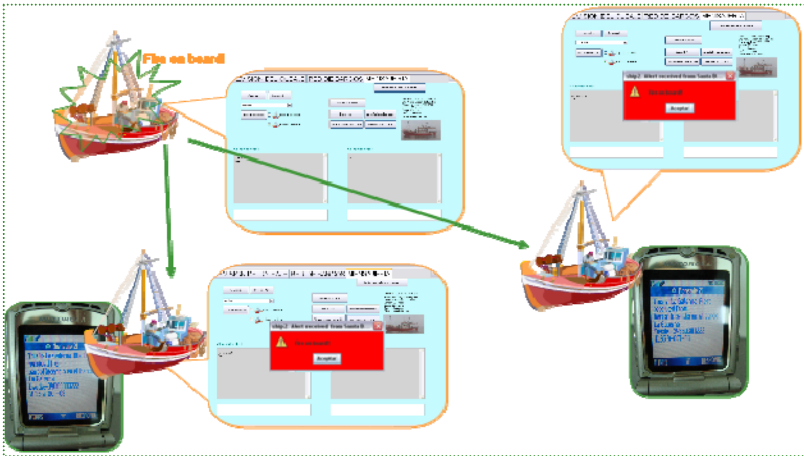
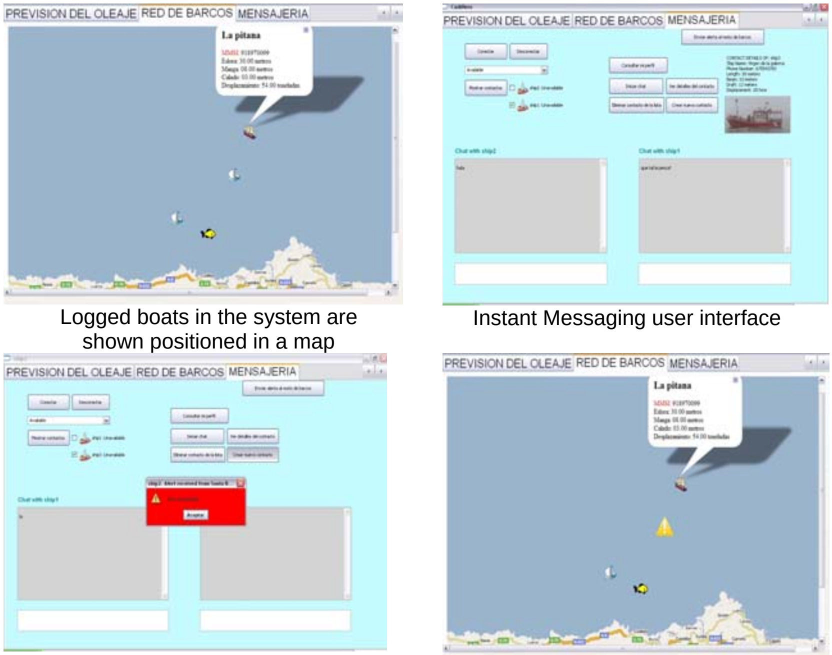


Fig. 4. Safety on board user interface

The instant messaging and presence and the safety on board use cases are integrated together in order to manage conferences among fishermen establishing sessions combining all the services installed in the boats such as presence, group and lists management, VoIP, content sharing, sessions control and GPS location. If a fisherman falls down overboard a group of sensors detects the emergency situation and sends alerts to nearby boats, connected through the messaging service. On the other hand the alert messages are also sent to the fishery via SMSs or via phone calls to the involved users. Safety on board is not derived directly from the users' real needs, since fishermen have already their own procedures and infrastructure to solve emergency situations. The most important value here is the Internet access on board, showing end users how to derive benefits from the Internet based services even in emergency situations. The presence service is a key service, since with it fishermen can establish sessions automatically to cooperate in any situation. On the other hand, developers get a lot from this use case in order to validate the architecture platform proposed in C@R.

To set up the services, a broadband connectivity is needed for the coastal fleet to access the services. Cudillero Rural Living Lab area counts on GPRS/UMTS available in main fishing grounds but a good service cannot be guaranteed. A solution based on Wimax is studied as a fixed and mobile technological alternative to provide with an added value in a mixed environment in the coast where there are services for both the fishing grounds and the inland. In order to realize a quantitative approach of the Wimax scenario, a first approach of coverage is studied in this environment including one sitting near the port to provide with coverage up to 10 miles in the sea covering the fishing grounds (area comprised by coordinates 6º 30' W – 5º 40' W and 43º 32' N – 43º 55' N) and other sitting near the urban centre to provide with coverage to official buildings and to give the connection services to the port.



Logged boats in the system are shown positioned in a map

Instant Messaging user interface

Pop up alert in case of an emergency situation

The boat in trouble is shown in the map

Fig. 5. Safety on board and Instant messaging user interfaces

3.4 Phase 4: Validation Process

In this phase, the user requirements discovery process is strongly conditioned by the different groups of users involved because of their conflicting interests. The fishing sector in Spain to some extent is different than other rural environments. This sector is depending strongly on the public funding. Despite of fisheries and first markets are surviving thanks to this support and even they aren't supposed to be autonomous, policy makers are cautious in order not to choke this sector in decline.

In order to avoid suspicions and in order to encourage the end users since the beginning of the validation process, a strategy to assure their participation is set. This strategy is based on cyclic development: different prototypes are presented to the Cudillero Rural Living Lab's groups of stakeholders in a systemic way in order to achieve quick responses and feedback from the user community and to learn jointly and effectively. Stakeholders contributing in the validation process are as follows:

- Policy makers: Fishing Directorate of the Principality of Asturias; Cudillero Mayor
- End users: represented by the Cudillero fishermen guild association "Virgen del Carmen"

- Developers: C@R partners contributing to the Cudillero Rural Living Lab
- Field assistants: Surveillance crew.

In this cyclic process an important part arises: **the intermediary**. The fishing sector is characterized by stakeholders very dependant each other and the rural living lab approach aims at fishermen to assume the leadership of developments. Fishermen are now taking the initiative what causes some reservations in the rest of stakeholders. Breaking barriers here is essential. The intermediary here is a figure whom stakeholders, contributing in the validation process, trust. The intermediary is responsible for disseminating prototypes' updates to the rest of stakeholders during the first steps. The strategy is illustrated in next figure and explained below.

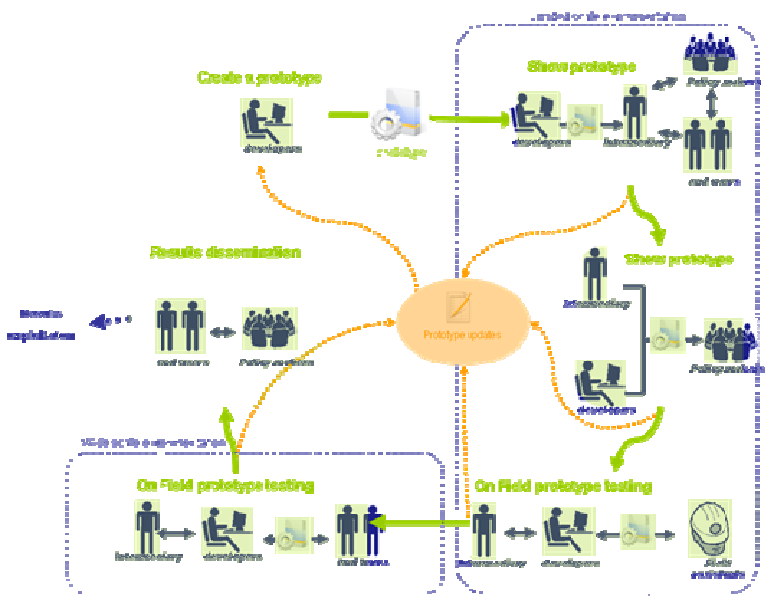


Fig. 6. Strategy to involve users in the validation process

- Developers suggest and create a prototype. Technology push is observed to be essential in the first stages of the validation process. Then, the **limited scale experimentation** begins with the **co-creation basic activities**. This prototype is first presented to the intermediary. After this first presentation, the intermediary suggests prototype updates and developers take benefit of this intermediary's better knowledge about the strategic environment.
- When first suggestions are taken into account in creating a new prototype, the intermediary and the developers present it to the policy makers. After these steps more prototype updates and new prototypes come up.

- For **on field prototype testing**, a new group of agents plays here its role. These are the **field assistants**. Developers together with these field assistants test the prototypes on field. Before the prototypes are tested by the end users, these field assistants help in testing the prototypes in the ground. This previous step before the wide scale experimentation is necessary in order to not discourage end users with the first technical fails. New prototype updates arise from this stage. The aim of this stage is to improve the prototypes before wide scale experimentation.
- Once the prototypes are tested on field the **wide scale experimentation** begins with the end users.
- Once the prototypes are validated, the final results coming from the experimentation process are presented to the policy makers to decide about exploitation.

After the wide scale experimentation, end users have their own validated prototypes to be disseminated to the policy makers. Barriers have been broken. The conversations are now easy because all users were aware of the prototype since the beginning of the process: users are completely involved in the process and prototypes have been validated by everyone.

As explained, the validation process consists of two main tasks, developed according to the strategy set: (1) Limited scale experimentation. This includes software development and platform deployment, co-creation basic activities, and on field prototype testing; (2) Wide scale experimentation. This includes on-field prototype testing and wide scale trial. We now go in more detail into these tasks.

Limited scale experimentation: software development and platform deployment. Developers create prototypes in order to validate the scenarios identified. Basing on the mockup and prototypes validated by the user community, the software platform based on the proposed reference architecture in C@R begins to be implemented. Once prototypes are developed, they are split into basic software components and it's studied their interactions. As result the three layered model begins to take shape (Table 1).

Next figure 7 shows the C@R OSOA (Open Service Oriented Architecture) for services developed in Cudillero Rural Living Lab. Some of the developed basic services (Collaborative Core Services) are represented in the architecture layer 1. From bottom to top, CCS (Collaborative Core Services) components in Layer 1 are the atomic resources which are orchestrated, thanks to a control middleware represented by Layer 2, by service scripts and collaborative functions in Layer 3.

Table 1. Prototypes split in basic components

Use case	Component	Description
GPS based catches data sending	MQS	Messages Queuing Service. This component is used to guarantee that messages are sent when lack of communication coverage.
	GPS_LS	GPS Service to get the boat GPS position
	SRS	Speech Recognition Service to allow fishermen to fill in the reports through their voice
	MDLS	Multilanguage Data Loading Service. MDLS is a software component that discriminates the application language and texts.
	AAAS	Authentication Authorization and Audit Service to get software components connected and registered to C@R architecture and let users to register in the platform
	DMS	Data Management Service to manage data from CDSApp
	DSS	Data Storage Service responsible for the database
	SMS_S	SMS Service
	EM_S	Email Service
	CDS App	Catches Data Sending Application, including SCTs and user interface
	FIS App	Fishery Information System Application- including SCTs and user interface
	UPC	User Profile Component
Weather reports	CDS App	boats user interface
	WR App	mobile user interface for weather reports
	DDR	Device Description Repository
Alerts management service	CDSApp	boats user interface
	Emergency	basic service to detect an emergency situation from the sensor network
	IMP	Presence service to locate nearby boats logged into the system
	SMS_S	SMS Service
	MPCA_S	Mobile Phone Call Alert Service
	GPS_LS	GPS location service
Messages Delivery service. Instant messaging and presence	CDSApp	boats user interface
	IMP	Presence service to locate nearby boats logged into the system
	Marte	Service to establish audio and videoconferences
	GPS_LS	GPS location service

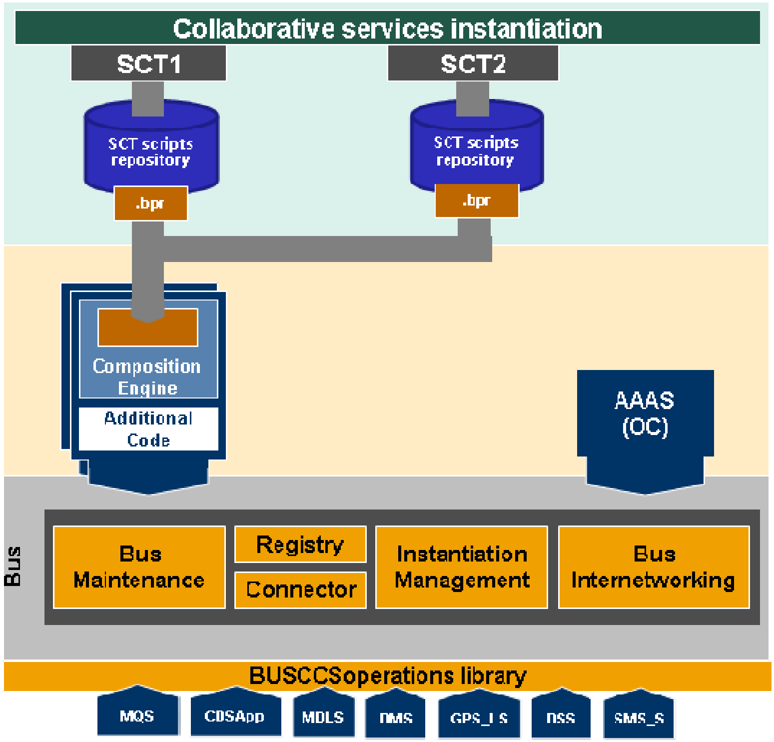


Fig. 7. Software architecture for developments in Cudillero Rural Living Lab

These collaborative core services (CCSs) in layer 1 are registered in a resources broker (Bus) enabling the system to search for resources and managing their interconnection. A homogeneous layer (BusCCSOperations library) is developed to register and connect CCSs to the Bus, in order to make each identified CCS available to the C@R platform. Services for Cudillero operate in a main domain where two sub domains are distinguished: the fishing boats sub domain and the fishery sub domain. Each sub domain relies on one C@R bus. Different sub domains are registered in the Cudillero domain through the bus internetworking capability.

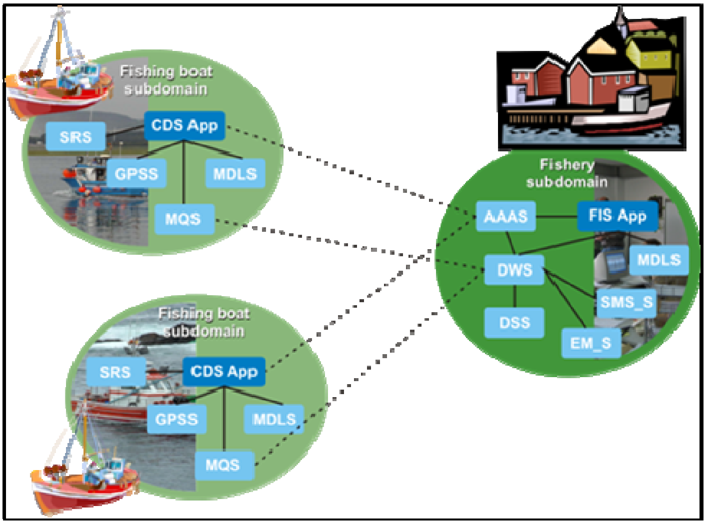


Fig. 8. Software components in Cudillero sub domains

Layer 2 in Cudillero counts on a specific component as an Orchestration Capability: the authentication Authorization and Audit Service (AAAS). AAAS acts as a transversal service that needs to be preregistered in the bus to let the rest of CCSs to be authenticated to the C@R platform.

Layer 3 defines the Collaborative services instantiation process. SCTs or software collaboration tools are the key elements to instantiate the collaborative platform relying in each bus. The SCTs is a piece of software modeling the business process of each sub domain. This piece of software is first compiled to get a BPEL (Business Process Execution Language) script. These scripts contain information about all the necessary elements and basic services to be connected and started to run the platform. This BPEL script is uploaded to the SCT scripts repository. When the instantiation process begins, the SCT is downloaded to a server (composition engine) configured with some instantiation parameters (additional code). As a result, CCSs defined in the SCT are deployed to the server, registered to the bus and started.

Most of the software components are identified as Collaborative Core Services (CCSs) except the AAAS that acts as a transversal service that need to be preregistered in the bus to let the rest of CCSs to be authenticated to the C@R platform.

Two special CCSs were distinguished in each sub domain: (1) CDS App – Catches Data Sending Application, and (2) FIS App – Fishery Information System Application. These specific CCSs (CCS applications) consist of the graphic user interfaces and the service framework. These are main threads that use and orchestrate the basic services (rest of CCSs) to compose end user applications.

After the validation process, C@R open software oriented architecture has been fully implemented and validated as an interesting solution for developers and software engineers to implement collaborative platforms. Next table 2 shows Cudillero software developers' conclusions about the open architecture implementation in Cudillero "GPS based Catches Data Sending" scenario.

Table 2. C@R software architecture pros and cons for GPS-based Catches Data Sending scenario

C@R Architecture pros	C@R Architecture cons
Components reinstallation (changes in components) without compiling the whole system thanks to instantiation process	Whole fleet software maintenance. Heavy software infrastructure (AXIS, MySQL) installed in every boat
Scalability thanks to the instantiation. Easy to include new functionalities in the whole fleet.	So bus internetworking in not feasible in case of communications QoS not guaranteed
Adhoc Rural Networks are possible to manage different kind of communication networks, thanks to the bus internetworking	Signaling transfer is much higher that user data in this specific use case. Costs are high if we are using mobile GPRS
Easy monitoring of the fleet software	

All the platform capabilities are possible thanks to the efforts from the vertical group for Spanish living labs. This multidisciplinary group was set up to integrate the different tasks to be done in C@R joining efforts to speed up the developments and getting advances related to the Soria and Cudillero Living Labs. As results from this vertical group work, it is worth remarking:

- A better understanding of the common software architecture, CCS definition, security, the BUS functioning and the orchestration and instantiation process.
- Version controlled releases of software components encapsulated and integrated with the C@R platform
- Several demonstrations on the C@R platform performance.
- The reuse of components developed in the beginning for other living labs.

Co-creation basic activities. Different prototypes and mock-ups are shown to the end users in order to validate the scenarios.

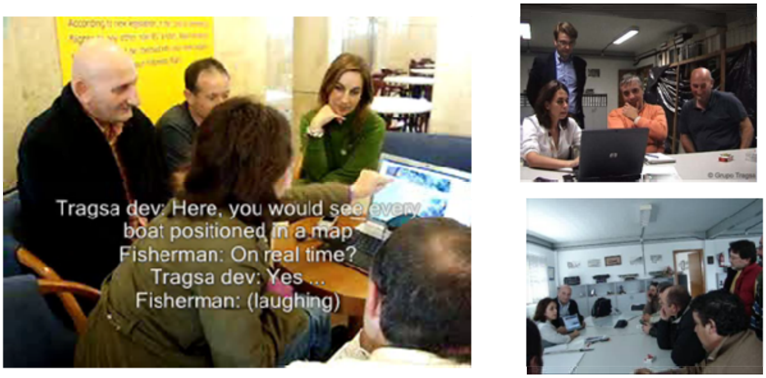


Fig. 9. Validation process. Co-creation basic activities. Different meetings with Tragsa, fishermen, ship owners, Valle del Ese- Entrecabos, Local Action Group representatives and fishery staff.

Within this task, it was decided to travel and visit other fishermen's associations more rentable and more innovative to share experiences and to stimulate Cudillero fishermen in innovating in their working processes. These events are considered essential and the inflection point for fishermen to start believing in the need for change. Fishermen start being aware of the need for making changes in their business and creating added value to their production, even if this implies to change their working processes, to introduce new commercial strategies and to include new technologies in their working life. From that moment on, most of the Cudillero fishermen are actively supporting the validation or testing of new services and prototypes. These activities result in getting feedback from the end users and to compile suggestions from people in the fishing sector that can experiment the pilots in-situ, with different perspective. Suggestions and feedback on the scenarios are well reflected for example in the graphical user interface evolution that becomes a good indicator for the validation process. I.e. at the beginning, software was developed for small devices as PDAs, then for common laptops and at the end for touch screen laptops as a proven solution more usable for fishermen.

Fig. 10. Graphical user interface on board. GUI evolution

On field prototype testing. In this task, several small prototypes on the developed services are validated by end users. The first tests on field begin with the support of the surveillance crew.

Fig. 11. On field testing

Wide scale experimentation. For this activity, two boats are selected as samples to simulate the quality label implementation in daily catches.

Fig. 12. Wide scale experimentation trial. Sample Boats and boat owners-volunteers.

The whole trial serves to check the scenarios feasibility for the implementation in the whole Cudillero's fleet. It includes:

- A software trial to enable sending catches data and the rest of value-added services for fishermen. This trial demonstrates the origin certification of the production, apart from the services as the weather reports, the messenger, the emergency management or the SMS reports to the wholesalers.
- To follow a good practices guide to handle the caught fish to come with the quality label establishment.
- A simulation of the new working process to integrate the labeling in the auction.

Fig. 13. Sketch on labelling Cudillero's fish

The trial takes two boats as samples. These boats are equipped with two ruggedized laptops with the needed software installed to access the services. A server on land captures and manages data. Catches are handled following the defined good practices guide. Once in port, catches are uploaded and tagged with the quality label, provided that the software application indicates it, according the GPS positions marked by the volunteers. This real life experiment is working during a year and every month' results are being analyzed. A broadband wireless solution based on Wimax is also tested and validated as the best way to introduce the broadband connectivity and Internet access in the Cudillero fleet. Data coming from this trial allows extracting some conclusions and let developers take new decisions on debugging software applications. This trial produces also interesting secondary results to be used as data sources for future projects (i.e. on natural fishing resources or fishing products marketing):

- Boats daily routes linked to their captures. This is becoming an interesting result as it is a good indicator of the Cudillero fishing effort.
- A good estimate of the Cudillero fishing production volume to be certified and labeled.

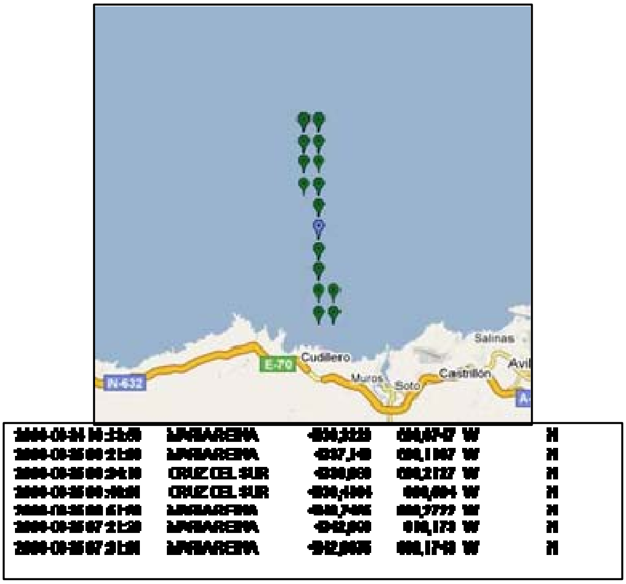


Fig. 14. Boats' daily routes

3.5 Phase 5: Results Dissemination and Exploitation

Results from the trial together with the implementation plan were considered as key elements for the community's stakeholders to decide about the future of this living lab. The trial was observed carefully by local and regional authorities in order to decide about financing the implementation in the whole fleet. In this stage, the implementation plan was presented and disseminated. Several funding sources have been detected but the most likely is the European Fishery Fund (EFF 2007-2013) that is financing the Coastal Action Groups. Fishers are taking part in the potential Cudillero Coastal Action Group area, so they can influence this group's strategic plan.

4 Evaluation and Conclusions

During the Cudillero development process, users identify scenarios, use cases, business models and decide technical solutions according to a strategy to involve users in the validation process. This strategy is based on the experimentation of concrete prototypes including all the issues that make a scenario reliable, showing the scenario's feasibility through demonstrations on the whole scenario. For instance, fishermen experiment with laptops installed in their boats, with broadband connectivity onboard, with a good practices' guide to handle the fish and with new working processes for the quality label establishment. But they also experiment with the impact generated by the new working processes, in their local businesses, in the supply chain and even in the rural and fishery policies, analyzing the reactions of the wholesalers (or agents trading with them) and the policy makers.

In order to foster the rural innovation in the traditional fishing sector, it's detected that it is essential to provide people involved with tools to be autonomous for changing their current business processes and models:

- The establishment of a traceability system in Cudillero "Virgen del Carmen" fishermen's association is considered the first step to change radically the business processes in Cudillero fish market. Guaranteeing the traceability from the fishing grounds and making their production data accessible to buyers and consumers through the Internet, the fishermen association would start working towards the e-commerce and the direct sale.
- The introduction of broadband connectivity and Internet access to the Cudillero fleet supposes fishermen to accede to new tools and services. This is an open field for new developments for the sake of innovating in Cudillero Rural Living Lab.

The open innovation strategies considered in Cudillero Rural Living Lab make possible that policy makers together with the fishermen experiment and take decisions directly on use cases, services and even software applications on development. This produces interesting results:

- This joint effort generates in both groups of users at the same time, the interest to deploy and exploit these new services.
- This joint effort facilitates and speeds up the creation of public and private partnerships which lead the rural living lab and guarantee its sustainability. The creation of public private partnerships makes the rural living lab community more capable to take decisions and to diversify the fishing sector.
- Based on open innovation, a higher degree of collaboration was enabled, enhancing understanding and confidence among government and fishermen for a sustainable fishing.

Cudillero Rural Living Lab developments open new horizons to fishermen now more given to change in their production processes. E-commerce or direct sale are considered good solutions to break the current fragmentation between the production and the marketing. With tools provided by Cudillero Rural Living Lab developments fishermen have more resources to implement new strategies (quality hallmarks, eco labels certification programs, collaboration with other fishermen associations …) and sell their products through alternative channels (e-commerce, direct sale to restaurants, online auctions).

Acknowledgements

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Finally, we are very grateful to the village of Cudillero and its people and the Cudillero Council for their warm reception and kind support, especially Cudillero Major Francisco Gonzalez.

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Chapter 6

Homokháti Small Area Living Lab Benefiting the Agricultural Sector in Hungary

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Abstract. The goal of this chapter is to present the results achieved in the C@R project in the Homokháti Small Area Rural Living Laboratory. The goals were twofold: building a sustainable living laboratory and applying the common collaborative working environment (CWE) designed and developed by the project consortium. In order to get a better understanding of the local issues, we will present a short introduction of the area and a high level overview of the actual innovation potential of the small area. In order to improve this situation in the field of agriculture, we applied a methodology developed in C@R for user involvement and software development. A high level overview of this methodology, the developed applications, and the business model behind the applications and the living laboratory will be presented in this chapter.

Keywords: Agriculture, Business Model, Living Lab, Sustainability

1 Introduction

The Homokháti Small Region is located in the southern part of Hungary near the Serbian border. About 45000 people live in this region. The fact that every second person in this region lives in detached farms is a special feature of this region. Among the detached farms, there are 15 settlements in this area. The largest one is Mórahalom with 6000 citizens. The major source of income in this region is agriculture. Most people live from fruit and vegetable cropping. Most of the work for this produce can be done only by hand without machines. Therefore, the farmers spend a significant time of their day on the fields. The planted vegetables need continuous care and observation. Tourism – especially village and detached farm tourism, and the bathing/wellness tourism – is becoming more important year by year. The city of Mórahalom is the center of the Homokháti Small Region. Similarly to the inhabitants of the region, most citizens of Mórahalom work in agriculture. Due to the large backyards, this work is done even in the city center. Mórhalom is the center of tourism too because of the well-known Erzsébet medical bath.

To be able to compete on the regional and international fruit and vegetable markets, the farmers of Mórahalom and the Homokháti Small Region formed the first producer association in Hungary. This association is an excellent sample of the self-organizing bottom-up associations. The farmers are the owners of this association with equal rights; no one has a larger share than the others. Currently, the association has about 650 families, who are members and stakeholders at the same time. It runs on a non-profit basis; the goal is to achieve the best possible price on the market for the farmers, and provide a common know-how database about the latest technologies.

Numerous projects are addressing the improvement of infrastructure, fostering the creation of new workplaces and better and more easily accessible public services. The municipality is doing an outstanding job. It is probably one of the most active municipalities in the southern region of Hungary. A high level overview of the projects running in the small area is shown in Fig. 1.

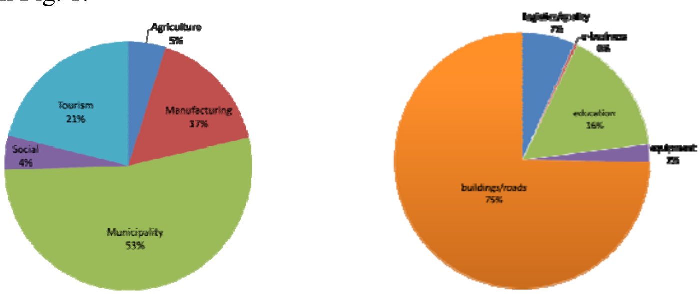

Fig. 1. Projects running in the Small Area

The total volume is about 14 MEuro. From the left, there is an overview showing the target fields of the projects. It is interesting to see that despite its strategic importance, the field of agriculture receives only 5% of the total money. The figure on the right side shows the different types of projects. It can be clearly seen that the money won for concrete and steel projects outweighs the money won for other fields. The second largest field is education starting from drug prevention and ending with the workshops for energy efficiency. The highest ICT content can be found in logistics/quality assurance and e-business deployment. The incubation/innovation is addressed by one project that is worth about 573.000 Euro and aims at building an incubator house and its infrastructure.

2 The Role of the Living Lab in the Rural Innovation System

The living lab as a general tool, an ecosystem, or even as a company perfectly fits into this system. It could help the municipality to overcome most of the weaknesses mentioned in the previous section. The declared goal of the Homokháti Small Region Rural Living Lab, which was an initiative of the University of Szeged, the municipality of Mórahalom and the Small Region government, is to take part in this battle as a strong facilitator and coordinator, or even a funding partner of these projects. One of the main roles of a living lab is acting as an incubator for projects. It should support projects throughout their whole life cycle. As the first step it should promote projects and generate new ones with the help of different networking events (workshops, etc). Then, it should support the coordinating activities during the project proposal preparation. It should also provide support, or even coordinate projects when they are officially accepted and funded. Besides the aspects of competition, living labs should provide support for sustainability. With this activity, the goal of the living lab is not generating big revenues, but running projects which are important for the local ecosystem. It should not only support large-scale projects, but also micro projects which provide services for the local ecosystem. In most cases, the creation of the hardware and software infrastructure for the services is too expensive for the local ecosystem, but if the living lab had the necessary infrastructure it could become profitable. In the previous section, we saw that the municipality is currently a trend/technology/solution follower, not an innovator. With a living lab in place and the ecosystem behind it, this situation could change. In the chosen areas the local participants can use and provide state-of-the-art solutions. In our view, a living lab acts as a facilitator in building the social networks at all levels. During the projects the participating SMEs, municipalities, research institutions, multinational companies, and end-users will take part in a project specific social network, and a part of this network will remain stable/active after the end of a given project. This way, the local entities may participate in large international social networks, and with the help of these networks, they will be able to exchange knowledge and generate new projects and new businesses. The power of the growing local social networks is very important, probably one of the most worthwhile benefits of a living lab.

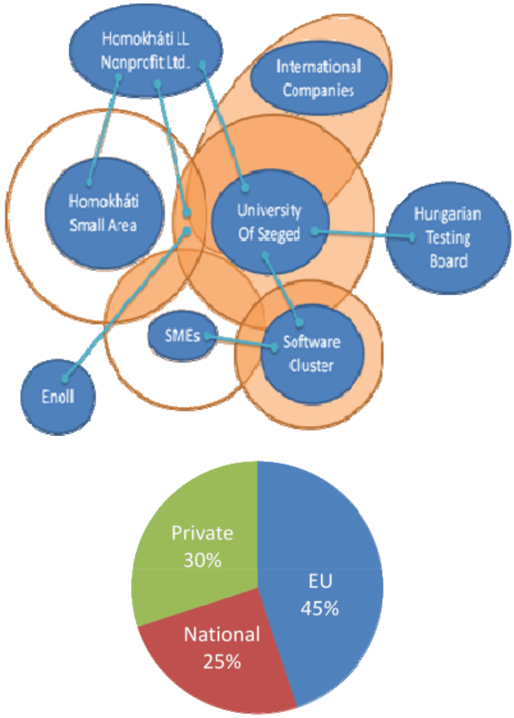

Fig. 2. The actual status of the Homokháti Small Area Living Lab

Fig. 2 presents a high-level project-based overview of the small region. The blue circles show the most significant entities. The orange circles represent different projects. The intersections of orange circles represent the common projects. The blue lines represent different kinds of relationship. From the viewpoint of the living laboratory, the most significant entity is H-LAB Nonprofit Ltd., 50% of which is owned by a spin-off company founded by the employees of the University of Szeged, and 50% by a non-profit company of the municipality. This company is responsible for all living lab-related projects. These projects are represented by the intersections of the projects run by the University of Szeged and the projects run by the municipality. Within this ecosystem, there is an assortment of companies starting with multinational companies such as General Electric Ltd. and Telenor Ltd., and ending with small local SMEs such as Raguza Ltd. In addition to these companies, there are three main associations in this ecosystem. One of these associations is the local software cluster founded by about 30 local software development SMEs and University of Szeged. As a technology transfer center, University of Szeged plays a key role in this association. The second one is the Hungarian Testing Board where University of Szeged is a founding member with an accredited education centre. Both associations could play a significant role in the future of the rural living lab ecosystem. In the long term, we believe that one of the main services of the living laboratory could be the value-added validation of the various hardware-software systems. In this testing/validation process, the potential customers could be the members of the software cluster, and the standardization of the living lab-based testing could be done with the help of the Hungarian Testing Board. The third association is ENOLL (European Network of Living Laboratories) which could play a significant role in fostering international collaboration, idea/best-practice sharing, networking, and project generation.

Fig. 2 also shows the actual funding structure of the projects running within the living lab. The fact that one third of the total funding comes from private companies tells us something about the current level of its sustainability.

3 Evolution of the Living Lab

A living lab is a sustainable ecosystem of SMEs, independent end-users, local authorities, and public institutions with some expertise in the given domains. In this ecosystem, the SMEs provide sustainability and the end-users provide a long-term innovation potential. In order to involve the key players, different strategies are needed.

3.1 Development Phases

Our first step during the phase of preparing the living labs development was to establish a long-lasting partnership with both the independent end-users and the stakeholders. Here, the key step was winning the trust of our partners. In order to achieve this, we applied various methodologies/strategies. After winning their trust, we started a series of brainstorming sessions in a given domain with a selected set of local partners (stakeholders/local heroes). The information coming from these brainstorming sessions was analyzed by the team of University of Szeged to provide an input for the next brainstorming session. This way, on a step-by-step basis, the brainstorming sessions were focusing on progressively narrowing issues. After the series of brainstorming sessions, we had draft proposals about the innovative services needed in the given domains. When necessary, focus group meetings were organized on a specific topic. The outcome of these focus group meetings also provided an input for the next series of brainstorming sessions. The result of the first phase was a collection of basic use-cases.

The second phase, the Limited Scale Experimentation, was based on the use-cases. The goal of the second phase was to refine these use-cases with stakeholder and local hero involvement. Mock-ups were developed and evaluated by the partners in a cyclic manner. The opinions and experiences of users were then discussed at face-to-face focus meetings. The results of these meetings were shared within the partner teams. Based on this information exchange, the use-cases were further refined. In parallel, the design and definition of the required modules were formulated by the team of University of Szeged and by the partner teams. The output of this phase was a set of detailed use-case definitions with a complete system documentation and work plan defining the dividing-up and the scheduling of the software development work among the partners and the team of University of Szeged.

The third phase, the application development and field experimentation, was based on the work plan and system documentation provided by the second phase. Here, based on the agreed schedule, the software modules were developed and tested by the local heroes and the group of end-users coached by them. Before the testing phase, training sessions were held by University of Szeged employees in most cases. The training material was also elaborated on by University employees. The experiences gained from the field trials were discussed with the team of University of Szeged during the face to face meetings. From this phase, a software prototype was created.

The goal of the fourth phase, the user-led co-creation and living lab business model operation, was the real-life deployment and integration of the application and the involvement of all the potential end-users (open group of end-users). Face-to-face meetings were held with the stakeholders and the local heroes to work out a work plan for real-life deployment, training, advertising, and monitoring. After the deployment, we started online collaboration sessions with the end-users to encourage user-led co-creation. The result of this phase was a group of selected new local heroes, and new ideas for the new cycle emerged.

3.2 Stakeholder Interaction

Stakeholder interaction was is the most important step for the sustainability of the living lab. At the early stage we experienced a certain degree of distrust towards the living lab as a theory and as a tool. Stakeholders could not see any perspective in collaboration after the end of the project either. To overcome these issues, a series of focus meetings was organized with the stakeholders to find out the best strategies for sustainability. A separate group was formed to look for additional sources of finance. In the first case, from the side of University of Szeged, graduating students were employed to help with the given IT problems of the stakeholders (e.g. system level management of the desktop machines, etc). In other cases, the University paid for the devices needed for the first version of the deployed mesh network and the development of the application that met the specific needs of the target group (e.g. integration of the climatic computer, dealing with the electronic cashier till issues).

With these efforts, University of Szeged has proved that it takes the forming and setting-up of the living lab seriously, and it has long-term plans with the living lab even after the end of the C@R project. The end-users and the stakeholders have also had something useful in their hands. After successfully finding some new sources of finance, and with the real, working applications developed, the stakeholders now see what can be achieved with a good collaborative venture.

Most of the end-users themselves are very busy individuals who do not have much time for the project and do not trust the "IT wizards". However, we have found several exceptions. Some people were interested in collaboration and saw its potential value. It was interesting for us to note that in most cases these people were respected members of the local communities. They became our local heroes. They acted as the means of access to the rest of the end-users. We also tried to provide working software (or mock-ups) as quickly as possible to prove that our words could be backed up with real deeds.

4 Homokháti Rural Living Lab Scenarios and Use Cases

As no single information source existed that could provide a unified view about the target domains, we decided to gather and organize the information derived from different sources and experiments, and as a puzzle, we generated an integrated view of the workflows, best-practice physical conditions, and the already existing infrastructure. The result of our reverse-engineering process is the so-called ACWE-Agricultural Collaborative Working Environment. In this working environment we have developed four applications covering four out of six workflows in the value chain of greenhouse based vegetable production. These applications are integrated in one framework. Details about the technology applied can be found in the Architecture chapter of this book.

4.1 Orders-and-Offers and Mass SMS Applications

Fig. 3 presents the orders and offers and mass SMS application. All the producers make their offers to Mórakert Producers Association. A manager at Mórakert can see all the offers coming from the farmers and the orders coming from the supermarket chains, which depend on customer demand and the season of the year. With this information in hand, the manager can easily decide which offer should be accepted and which offer should be rejected. After the farmers receive notification about their offers, they can transport the required amounts to the delivery.

At present, they use a call centre for this purpose, but due to the outside noises (tractors, etc) misunderstandings frequently occur. The communication channel between the Producers Association and the farmers is the telephone. With this means of communication, it is not always easy to transmit the necessary information. Using an SMS for communication is very popular in Hungary, and it is a perfect channel for transmitting information. Another aspect is the tight time frame available for the farmers to make their offers. This tight time window is frequently busy due to the lack of free phone lines. The assistants in the call center use a common excel sheet for organizing and sharing the information. The shared access to this resource is solved manually, which is a very time consuming process.

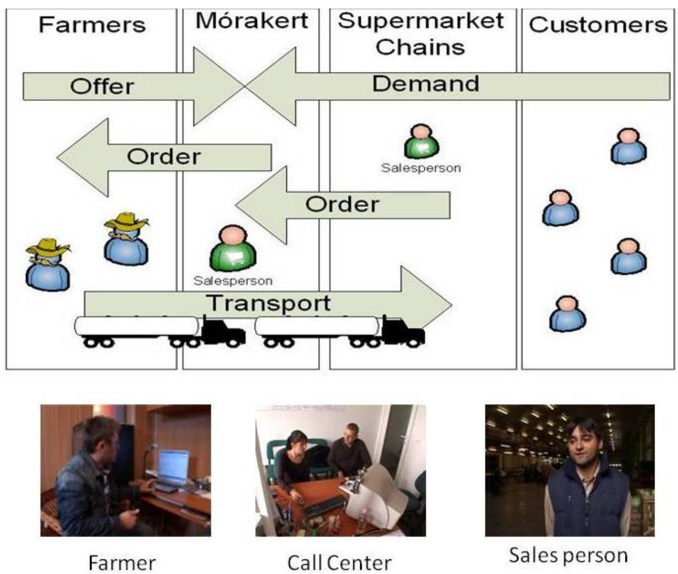

Fig. 3. Orders and offers and the end users

The application provided new opportunities to the farmers. In the traditional process for the farmers, there is a tight time window when they can submit their offers. Due to the congestion in the call centre, it may happen that they have to keep calling the call center for over half an hour without success. On the other side, there may be an intense pressure on the sales staff and on the call center assistant too. With the help of the developed application, the producers of agricultural products make offers to the Producers Association by each entering his offer into the system via a Web page or by sending an SMS. The system allows repeating orders without any difficulty (one entry, multiple orders), and the farmers can also submit the offers without any time limit. In some cases, the offers can be handled automatically. With the mass SMS application, the Producers Association is able to maintain an address book with different groupings and send SMS messages filled with specific templates.

4.2 Predictions Framework

The goal of the salesman who is employee at the Producers Association is to sell all the offered products at the best possible price. If the quantity offered is higher than the ordered one, the salesman can lower the price of the products to encourage a purchase. To be able to do this, he has to know about the quantities offered one month in advance. Now, there is no framework for this. He can only use the data from the previous year. However, due to the varying weather conditions, this could give incorrect data in most cases. Another aspect of price manipulation is when the demand is higher than the offer by the farmers; in this case, the salesman can raise the prices for agricultural goods. As we have seen, the demand for the products varies from time to time. There are well-known events and periods when the demand is higher. In such cases, the prices will also be higher. The farmers are interested in finding out how they can tune the plants and the environment in the greenhouse so as to achieve maximal yield in these important time periods. In order to be able to predict the yield and learn the correlations between the different greenhouses; specific parameters tuned by farmers and the yield information are needed. At present, this information is occasionally collected on paper by some farmers independent of each other. There are better ways for collecting and analyzing the data. The so-called study groups chaired by agricultural advisors probably have the best approach for performing data collection and analysis. One weak point of the data collection process is the lack of data export capability of the climatic computers. The farmers have to capture or print out the screen to paper and retype it. Currently, there is no information exchange among the farmers and the Producers Association.

Also here, the application provided new opportunities to the farmers. With the help of ICT-supported study groups, the farmers and the agricultural advisors are now able to make in-depth analysis of the collected information. The framework enables and fosters the collaboration among the participating farmers. The integration of different data capturing devices and information sources is also a very strong motivation for the farmers to use the system. They can save about 40 minutes per day with this framework. With the tunable visualization framework, they can study the different data sets and look for correlations among the data sets. In the long term, the data collected should be quite valuable, as it will provide a solid basis for tuning the different yield prediction algorithms. With the yield prediction capability in hand, the integration into the procurement system of the Producers Association (orders and offers system) could provide significant benefit for both the farmers and the Producers Association (this was the original use case).

4.3 Service Market and Tourism

The set of services provided in the Homokháti Small Region is currently fragmented. There is no central repository for the services provided. In the area of tourism, this means that despite the attractiveness and market potential of a given service, the market is narrow. The advanced transactions related to the provided services (booking, payment, scheduling) are done automatically, and in most cases through personal contact or phone conversations. Without value-added services the number of days spent by tourists in this area cannot be significantly increased. For the service providers, one of the most time-consuming processes is the billing process. This is done manually and requires a lot of time and patience from the tourist and the service provider alike. The billing applications available on the market are too expensive and cannot be tailored to fulfil the special needs of the given domain. (E.g., there are tourist cards with a lower tax rate, but the validity of these cards need to be checked at the time of payment). The management of the resources is done mainly on paper. For the accommodation providers there is a software solution the so-called Desotour, but it focuses only on accommodation related issues.

We found that similar issues arose in the Sekhukhune and Czech living labs. Working in close collaboration with these vertical groups and the end-users, we identified about 30 use-cases. In the area of tourism, the set of the so-called tourist products on offer plays a major role in making an area a tourist success. It is no trivial to develop tourist-oriented products as the need for them depends on local capabilities, and the number and type of visiting tourists. Currently, there are only basic tourist services in the living lab (e.g. accommodation, medical bath). A clever integration of the various services into one tourist-oriented product (e.g. combinations of bath, wellness, gastronomy) could foster the use of the currently not so well-known services, and it could also make some well-known services more attractive.

New opportunities provided by the application are as follows. With the help of service management and integration with Desotour, the service providers are now able to readily define and manage services. Tourists are now able to look for and book different services. The booking could be organized into a central schedule for tourists, defining the activities and the timing of these activities during a holiday. This way, the services with little or no visibility can now be accessed by the consumers. The integrated framework enables a seamless collaboration among the service consumers and the service providers. The central billing solution integrates the electronic cash tills utilized at different sites and it shortens the time from 4 to 5 minutes/making out a bill to about 20 seconds. This is a significant gain for both the service provider and the service consumer. A good aspect of this solution is that there will be a central repository of information enabling data analysis and the use of different social advertising solutions.

5 Evaluation of the Living Lab Experiments

In this section, we will provide an overview of the high-level results of the experiments, presenting the level of the user-led co-creation we have achieved. One metric of the experiments might be the level and intensity of the interaction with the end-users. We can measure this with the requested modifications and the type of modifications. A second metric might be the log of the real usage of the applications.

As the yield prediction framework was one of our most innovative applications, we would like to analyze the user involvement and the innovation value added by the end users with the help of the development history of this application. The history is kept in the versioning system at University of Szeged and in the memos summarizing the outcomes of the F2F meetings with the end users. Starting with these information sources, we defined the following categories of user co-creation:

- Simple feature request (e.g. the size of the fonts on the generated pdf file, the outlook of the pdf file etc.);
- Small modification of the functionality (e.g. the order of the pages in the pageflow, the controls on a page);
- New functionality/significant modification (e.g. a summary page is needed in order to compare the information coming from different farms, local saving capability on the handheld devices – the farmers do not trust the durability of the IT devices);
- Testing a given functionality (we asked the farmers to test a specific part of the software);
- Bug reports (with a framework the farmers were able to report the bugs).

On the left side of Fig. 4, the activity of the farmers is shown as a summary of the different co-creation events grouped by face to face meetings. It can be clearly seen that the intensity of the interaction is increasing (shown with the orange line representing the linear interpolation). On the right side of the figure, a chart shows the percentage of the different co-creation activities compared to the sum of these activities. The simple feature requests (SF on the chart) has the biggest share in the pie, which is not surprising. The small percentage of the reports (shown as B – 13%) is the result of the applied software development methodology (for most of the functions there are unit tests, functional tests, and load tests available during the development). The 13% share of the new feature request (show on as SF on the chart) means that every 10th request contained significant innovative aspect in order to tailor the application to the local context/needs.

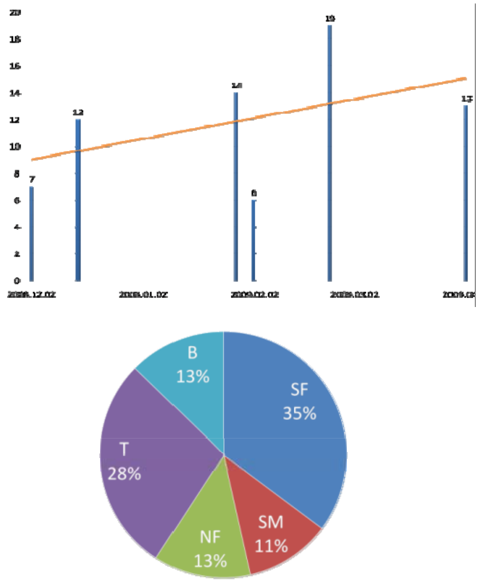

Fig. 4. Innovation

6 The Living Lab Business Model

In this section we will discuss the business model behind the Homokháti Small Area rural Living Lab. In contrast to the business models of the traditional IT fields, the business models behind living lab is a new area with few examples. In [3], the importance of open innovation business models is described and a first attempt was made to analyse living lab business models. High level business models are shown for several C@R living labs, including the Homokháti Living Lab. [4] provides an in depth overview of the living lab community in Europe. It also contains a very intuitive classification of the different types of business models employed by living labs. In the next section, we describe the business model behind our living lab and the business models behind the developed applications.

As we have described it in the first section, we have found a company to represent the living lab. H-Lab Nonprofit Ltd. was formed in 09.2009. Currently, the company has two half time employees, a half time executive director, Tibor Török, and a software developer to provide support for the applications. The owners of the company are Aensys Ltd., a spin-off company of the employees of the University of Szeged, and Homokkert Nonprofit Ltd., a company owned by the municipality.

6.1 The Living Lab Benefiting the Rural Environment

In previous section, we described the actual innovation environment in the Homokháti Small Area. Here, we provide a short summary of the benefits for the local players:

- State of the art technology: Trend/solution provider not follower (e.g. R&D institutions, multinational companies, SMEs with special knowledge);
- Multidisciplinary solutions, the whole value chain behind a specific domain could be covered (e.g.: eAgriculture – from seed purchase to selling the product to large aggregation facilities);
- Network of networks: domain specific social networks, local social networks, R&D social networks, international social networks, etc: the living lab is the meeting point of these networks thus, new networks / projects could arise from the intersection of the already existing networks;
- Novel industry for the local players (details about this will be presented in the next section).

We have already seen the benefits for the local players taking part in the forming of a living lab, but what is the benefit of the rural environment (if there is any)? The people living in rural areas provide a significant part of the global market. Due to the special social and territorial properties, there could be a significant need for specific or tailored local solutions (e.g.: are the farmers willing to collaborate, what about the local ICT infrastructure? In the urban areas, the 3G coverage is good; do we have the same in rural areas? If not, what can we do? etc.) From this perspective, the rural living lab could provide very important contextualized, domain specific information or services related to this piece of the market.

Several experiences were gained during the development of the yield prediction application. It has turned out that the subproject should not be a green field solution, as there is an existing ICT infrastructure for managing the greenhouses. The integration of the greenhouse ICT infrastructure into the C@R infrastructure was of critical importance for the end users. The 3G service is not available at some sites where the greenhouses are located. A single WiFi could not cover all the greenhouses. A local WMN was the right solution.

6.2 The Business Model of the Living Lab

The goal of the business model is to describe the value creation approach chosen by a given entity or a group of entities. There are several ways and methodologies to define the business model. Here, we will use the methodology described in [5].

There is one strategic business model for the living lab itself. It acts as an umbrella covering the lover level business models for the developed services/applications. In the following chapter, we will describe the business model behind the living lab. We are aware of the fact that the business models should not be carved in stone [6], but in an iterative manner, it should be tuned or modified based on the lessons learned and the changes in the economic and scientific environment. As we have described it, there are living lab level stakeholders (University of Szeged and the municipality) who are responsible for the strategic planning and the decision making. These stakeholders chose their representatives into the steering committee of the H-LAB Nonprofit Ltd. (currently: Csaba Fodor from the municipality, Ferenc Havasi and Vilmos Bilicki from University of Szeged). This group is going to re-evaluate the business model and the ongoing work twice a year.

6.3 Business Model Behind the Living Lab

The value/product created by the living lab should be based on the infrastructure of the living lab. This infrastructure is owned by the H-LAB Nonprofit Ltd. The details of this company will be described later. This infrastructure provides the basis for our offerings towards different markets. We have defined the following strategic areas:

- Providing fee based services relying on the applications developed in different projects. This way, we will be able to ensure sustainability for the applications. The details of the application level business models will be described later in the application specific business models.
- In the target domains (eHealth, Agriculture, eTourism, and Energy) the R&D projects are financed by the Hungarian government, the EU, or private partners. This is of critical importance for the community because it enables the flow of ideas and technologies.
- Providing context based ICT solution testing/validation and consultancy services. Currently, the software testing community focuses on the ICT solutions as separate entities without considering the effects of the different contexts. The added value of the living lab is the different levels of context (social, ICT, economic, etc,) where an application could be validated and enhanced. This service will not only provide better quality code but it will also provide better integration in different context. Functionality could also get enhanced with the domain specific innovation capacity existing in the living lab. To sum up: the software will be of better quality regarding both pure software quality and functionality.

The markets for the first type of services will be described in the next section. The potential customers for context based testing could be the members of the local software cluster and the multinational companies in our partner network.

The income of the living lab will come from the commercial services it provides and from different national or international funds. The current structure of these funds is described in the introduction section. We will try to keep these ratios in the future too.

6.4 Business Models Behind the Applications

Our living lab is not built on a monolithic application but on a high level strategy, and on domain specific projects. In the following as an example we would like to describe the business models behind the orders and offers application. The business model behind the orders and offers is based on the provided efficiency. Now, communication is done by phone. When the farmers are sitting in the tractor, due to the big noise, there is a frequent misunderstanding between the employees in the call centre and the farmers. This misunderstanding costs the Producers Association and the affected farmers money. On the other hand, the employees in the call centre can have another more useful job.

Table 1. High-level description of the service market application business model

Infrastructure	• Application • Hosting • Cluster of producer organizations • Farmers using the applications • IM infrastructure
Offering	New collaborative platform among the Producers Association and the farmers concentrating on procurement
Market	Producer organizations (partners of Mórakert)
Income	• Monthly fee from the Producers Association ~ 20.000 Ft (~ 3-4 Producers Associations could be potentially interested) • Monthly fee from the farmers for added value services: ~ 1000 Ft/Farmer (about 50 farmers could be interested) • Total income/month: ~ 200.000 Ft
Expenses	• Hosting\Maintenance ~ 15000 Ft/month • IM access: ~ 20000 Ft/month • Total: 35000 Ft/Month

Table 1 describes the high level details of the business model behind the service market application. In the first stage, it could provide an income for funding about 3 pm / year for the development of the application. We hope that we will be able to meet these targets during next year. This way, not only will we achieve sustainability, but we will be able to provide solid funding for further simple improvements.

7 Evaluation and Conclusions

In this chapter, we summarize our experiences gained during the projects, the main results we have achieved, and the impact of the living lab on the social, economic, and ICT environment.

7.1 Living Lab Results and Methodologies

As we described it in the section about living lab evolution, we have applied cyclic experimentation models each consisting of four steps. As a result of this approach, four applications have been developed. Most of these applications are used on a daily basis. With the technological framework (CWE) developed in C@R and extended with our technological solutions we were able to use the rapid prototyping approach. One interesting lesson we learnt was the importance of this approach. With long development cycles, one cannot fully discover the local context. The end users are in most cases busy people; they do not have time for one-day long meetings and detailed discussions. They do not like to read documents but like to see and test working application. The best way to gain the trust of the end users is visiting them and showing them the working application instead of providing them with papers to read.

7.2 Innovations Generated in the Living Lab

The applications developed in the living lab contain the innovative commitment of the end users. No big innovations have been invented in the living lab (like Twitter or Facebook). However, the applications in a given domain have significant innovative content. A short list of the most significant novelties provided by the applications:

- Orders and Offers: it changes the way of procurement. In some cases, the handing of the offers can be done without human intervention.
- Yield Prediction: The original goal of the application was to predict the yield, but it was not feasible due to the lack of needed information bases. Instead of predicting the yield, it provides tools for analysing the information collected by the farmers. It also provides the services for information exchange among the farmers. With the help of this tool, the farmers are now collaborating with each other in a novel way (they see collaborating partners in each other instead of competing ones)
- Service Exchange: the novel way of handling and combining services could provide a significant increase in the income of the service providers.

7.3 Impact of the Living Lab Work on the Local Community

One of the metrics of the impact of the living lab is the trust relationships formed during the project. The end users are coming up with more and more ideas about how to improve the application (experience shows that for each application a full time employee is needed to fulfill the requests!), what kind of application is missing (e.g. collaboration facilities for family doctors, offline capable map solutions showing the water taps for fire brigades etc.).

Table 2. Lessons learned in the Homokháti Living Lab project

Lessons learned	Explanations
Trust is the most important basis for collaboration	Both stakeholders and end users are busy. They would not spend time taking care about things in which they do not believe. Initially, they did not believe in the living lab concept.
Local heroes are a good way to gain the trust of the rest of the end users.	A key agricultural expert was identified (Alfréd Forray). We won his trust by providing him with a working application within a very short time frame (2 weeks). With the help of his social network, 10 other farmers were involved and they are now actively taking part in the work.
Real end users should be involved in the living lab specific development process from the beginning.	It is not sufficient to involve stakeholders (in this case, an organization of the end users). Involving only the stakeholders may lead to total failure of the development In the case of collaborative logistics, we were provided with the idea and the use-case by the stakeholders (in this case, by the producer organization, which is an alliance of the participating farmers). Based on this information, the mock-ups and the basic functionality behind the application were prepared. We then organized a meeting with the most innovative end users. It turned out that they would not like to collaborate with each other because they did not trust each other.
Short development cycles and rapid prototyping is an important factor for success.	End users like to test, view, feel the application; they do not like to read documents. The details of the local context could be discovered only by using the application (e.g.: can one use a touch screen based application in the greenhouse? traditional web application – NO, touch screen oriented application YES).
The use of a video camera during both the meetings and the workflow capturing process could provide more detailed pieces of information.	One can make more detailed memos, from the captured videos in the office compared to the memos captured on the site. In some cases, it is worth watching a video again to get the local context (e.g.: what are the detailed steps in a given captured work phase).

On the higher level, the stakeholders are also actively thinking of further project collaboration (even in new fields such as energy efficiency etc.). On the other side, the results achieved in C@R (the living lab and the software architecture) enabled us to win new project proposals in both the private and public sector (see the introduction). This way, we can provide part time funding for 5 family doctors who are taking part in our eHealth related projects. The H-LAB Nonprofit Ltd. and its employees (2 half time) are also the result of the C@R project. Now, we have four new full time software developers working on our living lab related projects, which is also a result of the living lab and the C@R project. The impact of the applications can be measured only on a longer time scale.

As a summary: in the Homokháti Small Area, and thanks to the University of Szeged and all partners, by now a vibrant active community has been formed. This community is open for new challenges and it is actively seeking new solutions to improve local life.

7.4 Lessons learned

Table 2 is summarizing the most interesting lessons learned in the project. However, the whole living lab oriented development is about continuous experimenting and learning.

8 Conclusions

We believe that the C@R project has achieved its goal. The Collaborative Working Environment framework developed by this community provided us with important services needed for rapid prototyping (and on a longer time scale for scalability). The theoretical framework elaborated by the C@R community provided us with a very useful compass showing what and how we should organize in the living lab. There are numerous metrics of the success starting from the number of publications ending with the number of new workplaces, but we believe that the most important metrics is the level of sustainability achieved by a given community. The impact of the living laboratory could be ensured only on a longer term and only with sustainable solutions. We believe that our living lab is a good seeding ground, and it will be able to fulfill its goal: it will really improve the life of local communities.

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Chapter 7

A Living Lab For Spatial Data Management Innovation in the Czech Republic

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Abstract. The Czech Living Lab - WIRELESSINFO represents a research and development environment in which several research institutions, business companies and regional authorities work together in order to develop projects in the area of new technological concepts. The living lab is focused mainly on research and development of new technologies for geo-data providing and exchanging. Development of applications based on collaborative technologies, implementation and integration geo-spatial services and tools into new Open Service Oriented Systems represent the main activities of this living lab not only within EU funded projects, but also in day to day working environments. The target applications are usually formed from collaborative tools – individual and independent components, which should have some of following characteristics - Open Web Services, Collaborative Environments, User Involvement for technical solutions, Technological platform independence, Re-using of existing tools, methods and technologies, De-centralized data sources, Open interfaces. C@R architecture based on the Collaborative Working Environment has been implemented in several use-cases for different branches: forestry, territorial planning and sensors in agriculture.

Keywords: Living Lab, Web Services, Collaborative Working Environment, Territorial planning, Open Service Oriented Architecture

1 Introduction

Progress of information technologies working with geospatial data is in the ascendancy, especially during recent times. This progress has come about through the digitizing of original data, greater availability of global geospatial information (e.g. satellite images) and also by advanced technical infrastructure enabling the transfer of increasing amounts of data. Despite the strong development, these methods are still at a relatively low level. This slow development is a result of the fragmentation of available data sources. Also there is no possibility to combine data from different sources and create new derived information from them. The data is transferred physically which is more complicated because of incompatible data sources and difficult data updates – data transfer must be done again after every update. Spatial data is very important for decision-making processes in the domain of public services, for example in territorial planning or forest owners support (See Section 4).

The Czech Living Lab – WIRELESSINFO (CLLW) researches and develops mainly new technologies for geo-data providing and exchange. The technologies are based on the use of open communication standards and they offer the possibility of connecting remote data through external servers (where the data was created or up-dated. The technologies have incorporated Open Geospatial Consortium (OGC) standards and respect INSPIRE (Infrastructure for Spatial Information in the European Community) Directives. This process supports the possibility of data sharing and exchange amongst systems, which have implemented the same functionalities and standards. Implementation of the Open Service Oriented Architecture (OSOA) has been agreed within the C@R project. This is a progressive step in the continuing innovation process in software development of the CLLW.

The main objective of this chapter is to present the living lab activities and their results in C@R. The CLLW is trying to overcome several obstacles that are preventing new users from using new technologies. Introducing these new methods of work is a slightly difficult issue. People, especially from government organizations (our existing and potential users) prefer old techniques and are reluctant to test new processes which might be complicated in the beginning. However once the technology is mastered it will be of benefit to users in their work.

2 Description of the Living Lab

The CLLW represents a research and development environment in which several research institutions, business companies and regional authorities work together in order to develop and implement projects in the area of new technological concepts. CLLW members assign experts into individual teams for each project. The involvement of these members depends on their interests and the possible benefits they can acquire from each individual project. Members can be involved in several individual projects at the same time. The main characteristic of this living lab is that it is constituted by a collaboration of consortium members developing and using technologies in the area of spatial data. Depending on the type of project in which the living lab is involved, some of the members may act as end-user (when some functionality is being developed directly for them) or can be a representative of individual end-users. The latter may happen, for example, in the case of software development for communication between the public and local authorities. The solution concept is mostly evaluated with the authorities in the first stages and then facilities are made available for input from the public.

2.1 Concept and Philosophy

The living lab focuses mainly on research and development of new technologies for geo-data provision and exchange. A main element of the approach is the establishment of new software tools that enable the change of the physical data transfer (for example on a CD) into new web services. In this way the source data remains on the original owner's server and can be easily updated. Users of the applications are able to access updated data at any time and use it for their work.

Project partners working together in the CLLW define their requirements within the innovation process. These requirements create the basis for a definition of the target applications. The target applications are formed from collaborative tools, which are independent components comprising some of following characteristics and principles: open web services, platform independence, re-using of existing tools, methods and technologies, de-centralized data sources, open interfaces, and user involvement for testing technical solutions. Benefits for users and stakeholders are the following:

- The living lab brings experts from different fields together to cooperate in special ad-hoc teams. These members work in different spheres of interest (e.g. private and public institutions, government and universities); therefore their special skills can be shared and used by various parties within the living lab.
- The collaboration of companies and universities enables a cross-over of various areas - research knowledge can be tested directly by practical testing and again user requirements from private companies can be developed more thoroughly using better equipped university facilities.
- Technical tool sharing brings large cost savings.
- Shared development in research will help create new processes of geographical data transfer, data management, and publishing and improve user-friendly applications. This is the only way to attract a large number of incoming users who do not have a high level of GIS skill.

The living lab also generates benefits for the rural environment. The activities contribute to the availability of public information by regularly updating, expanding and enlarging information bases and data sources. CLLW enables flexible working environments based on use of Internet resources i.e. e-mail and video conferencing. Therefore highly qualified people who are maybe limited by time, family and travel problems can work flexible hours from home or in non-fixed office environment. The technologies developed in the living lab are compatible with INSPIRE principles. The implementation of such technologies enables users to obtain subsidies more easily (see e.g. our use case related to support for forest owners).

2.2 Structure

The style of work in the CLLW arises from the need to establish teams of the best people to solve the problems of defined tasks. A project team is formed to include those partners who expressed their interest to cooperate in the proposed project. Generally this team gathers experts from universities together with business specialists and also people from the public sphere, mostly as direct or potential users. The living lab is not a "fixed working structure" company but is an "open flexible" working environment. The structure of the CLLW represents the best way of collaborating. The core of the CLLW network consists of the non-profitable research association Wirelessinfo and the non-governmental organization Czech Centre for Science and Society (CCSS). Business relations are ensured by several private companies, for example HSRS (Help Service Remote Sensing), Help forest Ltd, MJM Litovel, Lesprojekt services Ltd, Jan Machovsky – Cartographic services and Knesl and Kyncl architects. The policy support for development is represented by government organizations FMI (Forest Management Institute) and CENIA (Czech Environmental Agency). Several Regional and Local Authorities in Olomouc, Sumperk, Chotebor and Vysocina enable users better communication with offices with the help of the developed user-friendly web applications. Masaryk University in Brno and University of West Bohemia in Pilsen ensure research, primary testing and the development of new web applications. The Czech University of Life Science (CZU) cooperates with the CLLW in the area of education and awareness.

2.3 Activity

The main principle for development work within the CLLW is not to develop dedicated and strictly specialized applications. The main attention is paid to the development of general technological components which correspond to Open Service Oriented Architecture (OSOA) principles. These components are able to be used in a collaborative environment and may be implemented into various systems. In the scope of the C@R project, the CLLW aims to develop innovative applications based on collaborative technologies to improve decision making processes. The main focus is on demonstrating the possibilities of implementing and integrating geo-spatial services and tools into new systems: supporting eGovernment and eParticipation principles for decision making support.

One example is the work in Territorial Planning. Spatial data for territorial planning is developed on the level of municipalities; on the other hand this data can be accessed by regional institutions as well. So the Regions are able to organize their decision-making processes more effectively. The CLLW eliminates the difficulties of physical transfer of data and enables the upgrading of data anytime through its developed applications. Another example is the Forest Owners Support. This scenario involves the calculation of subsidies for forest owners with forests in nature protected areas. They are not allowed to fully utilize their own forests. Spatial data of the borders of reserved areas is provided by the Ministry of the Environment to Forest management Institute (FMI). The FMI represents a user in this case. The data is easy to access with the help of the application developed in the CLLW. Each forest owner is able to test the application and calculate the possible amount of the subsidy in advance. Other areas of CLLW interest are Risk Management, Environmental Awareness, Tourism, eLearning, eGovernment and Precision farming.

3 Collaboration Principles

Innovation processes are usually different for individual living labs, but collaboration is one of the most important aspects of software development in each of them. The CLLW emphasizes two main collaboration principles: the User Collaboration Principle (collaboration with living lab customers and partners) and the Developer Collaboration Principle. Next sections explain these principles.

3.1 User Collaboration Principle

The User Collaboration Principle accentuates user involvement in the innovation process, focusing on the role of users as CLLW customers and partners. Users define their requirements for the application, test and validate released versions during the developing process. Understanding and consensus on the functionality of the final application is one of the most important points of the successful innovation process.

The development process in CLLW goes through the following procedure. The first idea for innovation may come from anybody, from users (customers, partners) as well as from the developers' side. In the first step of the process, users define their requirements on the proposed innovation and developers with respect to these requirements specify the first design of the product. In the second part of the process, living lab users directly involved in development provide comments on the first design; also developers tests themselves the version and modify developed products according to these user comments and testing results. This second level of the developing process is repeated as long as the main errors of the software are corrected and the main idea and principles of the innovation are visible from the product.

Then the product is available for tests from other living labs and external users, but still not public. Again the comments and requirements are included in the modifications; also this level can be repeated, if it is necessary. The final level is publication of the product. Of course, new requirements or comments should come also from public users, on the basis of public user validation and public tests. Minor changes are corrected directly by developers; new ideas for innovation usually start the whole innovation cycle.

An example is in the area of tourism and territorial planning. The CLLW has been contacted by the municipality of Sumperk, which is acting as user. The municipality required several maps - the plan of the city, the estate plan and maps for territorial planning. The CLLW created applications which were able to provide easy access to data. The applications were developed in several steps to cover different requirements of the municipality. After several testing procedures the map application was launched on the city information portal. Several companies - for example, ones dealing with engineering, will be able to use the applications for their own needs. The CLLW is able to modify the application in several ways according to user requirements. The main group of end-users may be formed by tourists. The application containing tourist points of interest is now in on-line status, available for testing and can be improved upon in several ways according to the users' needs.

3.2 Developer Collaboration Principle

The Developer Collaboration Principle emphasizes interaction among technological components developed by different partners. Collaborative tools (i.e. tools, which have the ability to interact with other software tools and together create new services) can operate separately, but also can be integrated into new applications. Individual CLLW members are responsible for the development of different technological components; in case of a new innovation process these components can be integrated into new applications. The process of designing applications covers analyses of software architecture and the definition of available data sources, services and other existing components. The example presents the system development of data transfer from sensors and the publication of the data on the web through open web services. Independent tools developed in different institutes are integrated into one web application. A specific example of this is the Sensor use - case (See Fig.1):

- West Bohemia University deals with the technologies providing data transfer from the sensors and data uploading onto a storage server.
- Lesprojekt services produces hardware for this data transfer.
- Help forest solves the tasks associated with spatial data management and data integration into the new map compositions.
- Help Service Remote Sensing develops the new map client HSLayers for data visualization onto web and spatial analyses based on WPS (Web Processing Services).

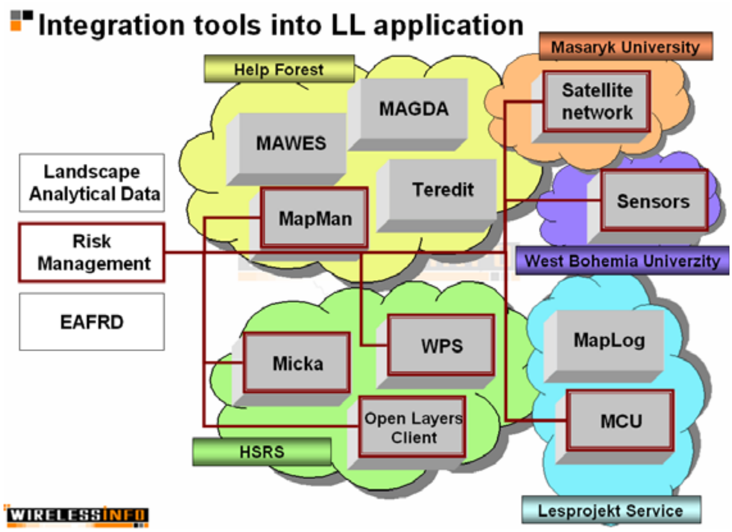

Fig. 1. Developer Collaboration Principle

The outcome of the CLLW members' cooperation is data visualization from the meteorological sensors into the web application (for more details see Section 5).

4 Open Service Oriented Architecture - Applications

Within the scope of the C@R project, the CLLW provides development of applications based on collaborative technologies to improve geo-spatial data availability and usage of geo-spatial data in decision making processes. CLLW users asked for application development covering geo-spatial data exchange processes together with OSOA principles proposed in the project intention. The CLLW proposed several scenarios at the beginning of the project where the C@R OSOA should be implemented. Finally the OSOA has been implemented in 3 scenarios:

- Territorial Planning - provides access to geographical information of landscape and territorial plans. Users (public, authorities) can get information about a specific area and display regulators relevant to this area with help of individual components developed within the C@R project
- Forest Owners Support - users (forest owners) can calculate approximate amount of subsidies in case of limited exploitation in their forests
- Sensors in Agriculture and Risk Management - users need to get relevant data about their area of interest, for example farmers need to know current climatic conditions in their regions which will affect their land and the work they therefore do. They can install a net of sensors, collect data from them and provide analyses in a specific web application to make applicable decisions.

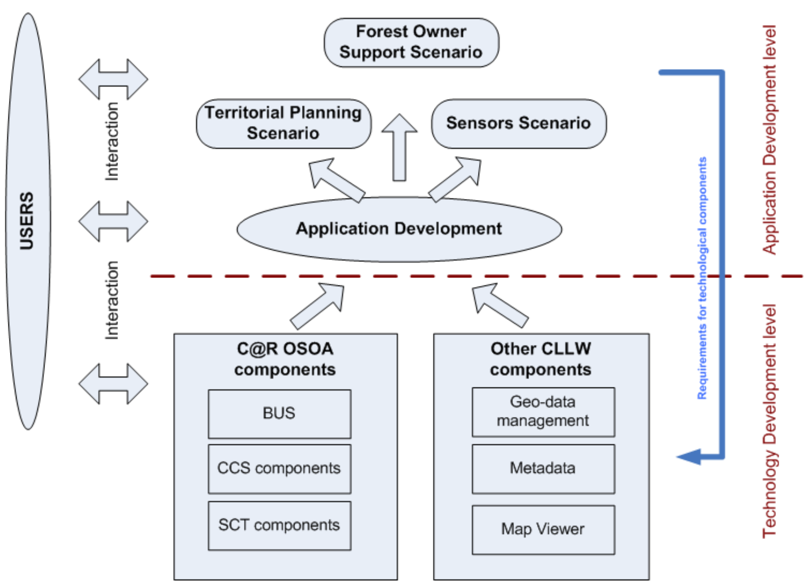

Fig. 2. Integration components in C@R scenarios

The final applications are laid out in the following sections. Based on the user requirements for the functionality of the final applications, CLLW developers proposed the solution that integrates current CLLW components together with new components developed within C@R project. These technological components have been used for development of final applications. Users contribute to this innovation process partly with proposals for the functionality of final applications, partly with tests and comments to released versions of the application. The design of the technological components has been drawn up with respect to their reusability in different final applications. Also components from other living labs and C@R project partners have been implemented in CLLW scenarios (Fig. 2).

4.1 Original CLLW Components Re-used in C@R Scenarios

Original components are the software tools developed by CLLW members and partners in previous projects. These components have been re-used and modified for integration into the C@R OSOA architecture.

- **DataMan.** This is an application for the management of spatial data in the Internet. It supports the management of data in databases or files, the export and import of this data and also the publishing and updating of related metadata. In databases, it is possible to store both, vector and raster data, including their attributes. Also for file oriented storage, it supports both, vector and raster data. From raster formats, it currently supports IFF/GeoTIFF, JPEG, GIF, PNG, BMP, ECW, from vector formats ESRI Shapefile, DGN, DWG and GML.
- **MapMan.** The Map Project Manager (MapMan) is a software tool for users who want to publish or create new map projects and compositions. The tool was originally developed in the NATURNET-REDIME project (www.naturnet.org) and the EarthLookCZ project (www.earthlook.cz). It supports the publication of spatial composition from locally stored data (fields or database-stored in DataMan), with external WMS, WFS data services. MapMan provides visualization in web browsers using such clients as OpenLayers, GoogleMaps, DHTML client, Desktop viewer GoogleEarth, DIS Janitor or publish data as OGC WebMapService (WMS), OGC WebFeatureService (WFS). All published data is also connected with metadata stored in the metadata catalogue Micka.
- **Catalogue and Metadata system**. The Micka is a spatial metadata catalogue, which supports standards ISO 19115, 19119, 19110, Dublin Core (ISO 15836). The Micka contains several pre-defined profiles in the system - ISO 19115 mandatory elements and core elements, Full ISO standard, ISO/DC profile and INSPIRE profile. The user interface is multilingual. English, Czech, German, French are currently supported and Polish is in the process of being developed. (New languages may be added by filling in the corresponding database table.) Users may switch languages by clicking corresponding flags on the top bar of the program. The Micka uses Gemet (GEneral Multilingual Environmental Thesaurus) and AgroVoc Thesaurus and supported WFS Gazetteers.
- **Visualisation client HSLayers**. HSLayers is a derivate of the OpenLayers and Ext JS (JavaScript libraries) and has been developed by the company Help Service Remote Sensing and partners. HSlayers provides easy implementation of the dynamic map window into web pages. It can display map tiles and markers loaded from any source. HSLayers/OpenLayers provides map data visualization in web browsers without server-side dependence.

OpenLayers implements an object-oriented JavaScript API for building rich web-based geographic applications, similar to the Google Maps and MSN Virtual Earth APIs. OpenLayers is able to display various types of raster and vector data formats. It supports OGC WMS specifications as well as common image formats (in PNG, GIF or JPEG format). There is also support for multiple proprietary formats, like Google Maps, Yahoo maps and others. OpenLayers do use so called tiling of raster data. Numbers of vector (and text) data formats are supported as well. There is the possibility for rendering vector features in GML, OGC WFS, GeoRSS, KML formats.

Creation of regular shapes (boxes, circles) is supported as well. Points can be displayed as special point features with image icons or vector like point features. A number of controls are available to support map interactivity and customization. These include zoom bar, overview map and layer switcher. Various toolbars and mouse action handlers can be used. Therefore the programming of the new functionalities is user-friendly.

4.2 New OSOA Components Implemented in Scenarios

The C@R OSOA philosophy and some technical details regarding OSOA components developed within C@R project are mentioned in Part II: Collaboration technologies and solutions. Some of them have been implemented in the CLLW directly (Control BUS); some have been developed by CLLW experts and tested in CLLW scenarios (SCTGrantCalculation). From the CLLW point of view geo-spatial data management: *CCSOgc, CCS MapViewer, CCSMetadata and CRuralJS components* are the most important components related to CLLW goals.

CCSOGC components. Publication and connection of OGC web services (WMS, WFS, WPS) into C@R architecture make them accessible for other C@R components and applications. Individual OGC web services are encapsulated into new CCS, registered into C@R BUS and via standard BUS functionality available to other components. OGC web service is registered into C@R architecture using the Service/Data Management Tool - an application that provides user interface for register process. This application can provide also the establishment of new web service. An example of the application is Map Project Manager (MapMan), which provides new map compositions from both the external and internal data sources and publishes them as a new web service. This is one way, how to register original simple OGC web service from external source or how to create new original geospatial service from the database and files. Service/Data Management Tool connects CCSOgcPublication component that creates new CCSOgcService for specified web service. When the new CCSOgcService is created, CCSOgcPublication connects CCSMetadata component and provides creation of metadata records for new services. Rural living lab applications are able to connect these new services directly or search them using metadata catalogue.

CCSMetadata components. People who will work with components registered to the BUS need to know which components are registered, what their functionality is and which of them are available for exploitation. Therefore each component that will eventually be registered into the BUS should contain a short description of itself - *metadata*. The catalogue components developed in the CLLW automatically collects metadata about these components and registers them into the metadata catalogue. Once registered, the metadata can be extended or updated using the Metadata editor. The CCSMetadata components are implemented into CLLW BUS. If a next CCS joins the BUS, the metadata CCS is automatically called, and metadata of this new CCS is stored into the Metadata Catalogue. Metadata records can be edited using the CCS Metadata Editor - using a CCSMetadata.updateCcsMetadata() method with the required parameters (ID, Name, Abstract, Organization). The metadata stored in the Metadata Catalogue is available for external systems. In the case of the Czech Living Lab, the Metadata Catalogue is a core part of the CLLW Portal www.livinglab.cz (web portal developed as an environment for integration of CLL collaborative tools). Also metadata from other living labs can be made available in the catalogue. The CCSMetadata components are implemented into new BUS and configured for interconnection with the CLLW metadata catalogue**.** Then the metadata can be stored. User can also produce metadata of the components or services directly via CCS Metadata Editor, without the necessity of implementing CCS metadata component to their BUS.

CRuralJS Library. Individual components of the C@R architecture are usually written in Java code. However, sometimes developers need to connect components also using other types of code. The CruralJs is the JavaScript library developed by the CLLW that provides connection of JavaScript application into C@R architecture. The CruralJS library mainly provides the following functionalities: 1) encapsulate generic CCS code for developing specific CCS in JavaScript; 2) encapsulate communication with C@R BUS for easier usage in JavaScript applications.

MapViewer components. To be able to display geo-spatial data easier, CLLW members developed components called HSLayers (mentioned above). Web map applications based on HSLayers have got functionality typical for such kind of applications – zoom, pan, info for objects, map layers, etc. To be able to use HSLayers for CLLW scenarios, several components have been developed improving HSLayers functionality towards to C@R architecture called MapViewer C@R components (Fig. 3).

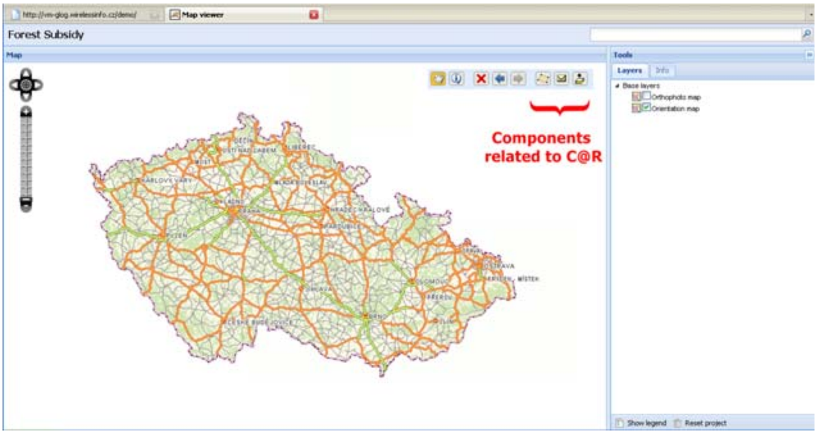

Fig. 3. MapViewer C@R Components

These functionalities include:

- **Sending email** directly from the web map application: using CCS functionality through JSP wrapper. E-mail components integrated into web map application give possibility to user to send emails directly from web map application. It is beneficial mainly in such cases, when user wants add to the e-mail also image of current map, current coordinates of some map objects, etc. The functionality is used in the Territorial (Landscape) Planning scenario, where the application uses an e-mail component developed and registered in the Frascati Living Lab BUS. It demonstrates possibility to share C@R components and functionality among different living labs.
- **Adding WMS layers** to existing map application: connecting to the C@R BUS and CCS and using the CCS functionality directly. If a user wants to add new WMS layers into his web map application and wants to do it through C@R architecture (e.g. because of register of these processes in BUS) he can use CruralJS Library implementation. Web map application is placed on the Server1. If user wants to add a new WMS layer, the web map application calls CCSMapViewer component with request on WMS layer addition. CCSMapViewer component establishes connection with BUS and CCSOgcPublication components placed on the Server2. The CCSOgcPublication component return list of available WMS services. The user can select required WMS from the list and the CCSMapViewer component connects to this WMS.
- **Using a SCT directly from applications**: connecting to the SCT through CCS component. SCTGrantCalculation is a component used in the Forest Owners Support scenario. A forest owner will obtain subsidy

if he will keep the demand in the framework of subsidy titles EAFRD on his estate. To know which area is under subsidies and what the amount of subsidy is, FMI has prepared a web application which shows user's approximate pretension. A user defines an area of interest directly in the web application and SCTGrantCalculation provides intersection with subsidized locality and calculates the result (see 5.2).

5 Open Service Oriented Architecture Scenarios

The components compliant to Open Services Oriented Architecture developed by the CLLW have been tested in 3 main scenarios: Territorial Planning, Forest Owners Support and Sensors in Agriculture and Risk Management. Individual scenarios reflect user requirements and implemented components providing geo-data management on OSOA principles.

5.1 Territorial Planning

A municipality territorial plan determinates an urban conception, deals with area utilization and deals with the organization and basic regulation of the municipality area. The goal is to harmonize several activities in the municipality and minimize the negatives impacts of these activities. The municipality territorial plan contains both text and maps. The text part includes description of proposal of the urban and technical infrastructure ideas, limits for the area utilization and specification of the public works areas. The text must contain an independent part with binding regulators of the functional utilization and the spatial organization of the area.

Applications for territorial planning represent possibilities of C@R architecture utilisation for geographical data in alternative areas. An example of an executed scenario includes the accessibility of geographical information about currently processed territorial plans for the public, interconnection between this information and textual part of the plan and also implementation of communication tools ensuring contacts "users – offices". The application is available via the Internet and individual components of the system are registered into CLLW BUS.

The user starts the web application of the territorial plan and finds the area of interest within it. Different kinds of landscape utilization are presented by different colours of the area; the meaning is described in the key of the application. Using independent tool, the user can get information about each area (e.g. the type of landscape) and display possible regulators relevant to the landscape area. The changes of the territorial plan running in several periods are also included in geographical data. The application connects the BUS of the CLLW and uses other components developed within C@R project. One of them is the communication client ACC that enables e-mail communication between users and offices. If the user does not understand some information from a specific locality of the territorial plan, he can generate an E-mail message using this tool; the message includes inside a link for the displaying of the specified locality (Fig.4 shows an example).

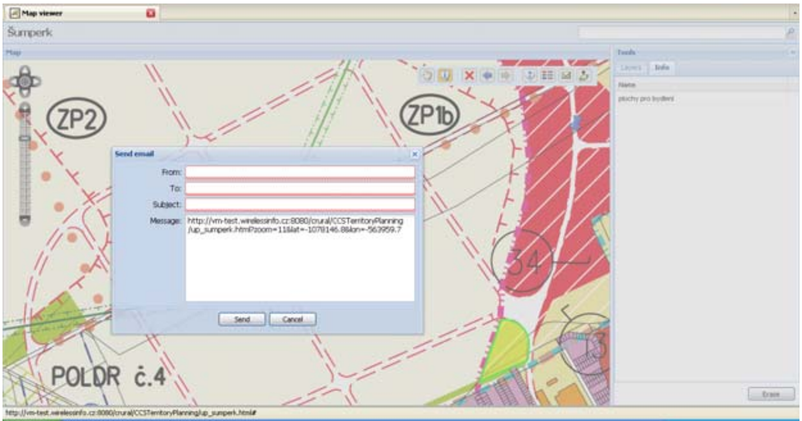

Fig. 4. E-mail Notification in Territorial Planning Scenario

This way, the responsible office worker keeps precise disposition of specific areas, to which the demand is related. Communication client ACC is processed as CCS and registered in BUS. The next registered services via BUS are the OGC service providing concrete landscape data. With the help of individual tool, user can add other map layers into project. The layers are registered into relevant BUS and users have the possibility of choosing alternative BUS. In the future, the registration of the web services into BUS will enable the monitoring of application processes or data access validity – e.g. in the case of data with limited or paid access.

5.2 Forest Owners Support

Subsidies in terms of the Natura 2000 in forestry are provided in order to preserve a species composition of the forests in allotted Sites of Community Importance or Special Protection Areas. The forest owners, part-owners or their associations will be paid 60 Euro per hectare for twenty years as a partial compensation for the reduction of economic utilization of their forests. The Forest Management Institute has created a web application supporting forest owners when they are looking for information about potential amounts of subsidies. There is free public access to this application. Users can draw the area of their interest as a new polygon in this application; then the system compares the created map figure with geographical data of the area (that fulfils the funding conditions) and calculates an approximate amount of possible subsidy. The Web application has been created in two versions – as a DHTML client and as an HSLayers client, by the testing components developed within C@R project.

The user starts the web application with geographical data of forest lands and protected territories. Then he finds out the locality – object of his interest and outlines a polygon – area for his subsidy calculation. The system compares selected fields with data of protected landscape areas and calculates the selected area, which belongs to subsidy demands. For this area, the relevant amount of subsidy is calculated and visualized for the user in the table. The calculated amount is only approximate and the forest owners use it as orientation groundwork for application delivery.

Several components developed within C@R project have been tested in the application. CLLW developers created new BUS according to OSOA architecture agreed in C@R project. It made it possible to connect various CCS components and create a new application with appropriate functionality. The polygon determined by a user is stored into geodatabase and published as WFS. This WFS for polygons is registered as independent CCS into the BUS. The next part of the system is SCT for grant calculation. SCT is a tool, which originated from the integration of several basic CCS components with different functionalities.

The SCTGrantCalculation uses geographical data accessible via CCS_WFS components, which serve to give access into the process of grant calculation for a particular area of interest. The calculation is solved through WPS. The complete chain of these processes represents the SCT for calculation of the grant. The technical details are described in the chapter "Reference architecture for collaboration tools interoperability".

The technologies implemented in this web application have created greater potential for users mainly for the re-using of data in similar tasks. A computing process has been segregated into independent SCT, input data for calculation are delivered in the form of a web service. This architecture enables implementation of the same tool in the several different applications solving the analogical issue – setting the output on the base of geographical data access. After some modifications, it should be possible to use this tool for example for land price rating, in geo-marketing applications or for environmental analyses.

5.3 Sensors in Agriculture and Risk Management

Sensor data represents important data bases for object monitoring (status and behaviour), analyses and risk management. Having also sensor location data, experts are able to provide analyses also with respect to sensor location in reference to each other or with regard to other objects. The components developed within the CLLW enable the utilization of this sort of data also into the OSOA architecture.

CLLW together with Frascati Living Lab have solved sensor data collection and processing regarding up-to-date climatic conditions data in vineyards. To ensure crop quality, the wine growers need to know, what are the current weather conditions in their vineyard and if critical values have not been reached. Frascati Living Lab has established sensor networks on experimental vineyards, where current values of temperature, humidity, atmospheric pressure, rain intensity and wind parameters have been monitored. This sensor data is continuously saved to database on the server via GPRS data transfer. The data is displayed in HSLayers client, which is registered via CCSMapViewer component into BUS. Map client contains also other C@R components for email notification (e.g. when critical value is reached) and for other geo-spatial data layers adding; users can add new map layers registered in BUS (e.g. geology or soil layers, climatic data layers, topography and others) to the map project. If users want to work with sensor data, they can select the appropriate sensor in a specific web application and time period for data; system displays sensor data in graphs (Fig. 5 shows an example).

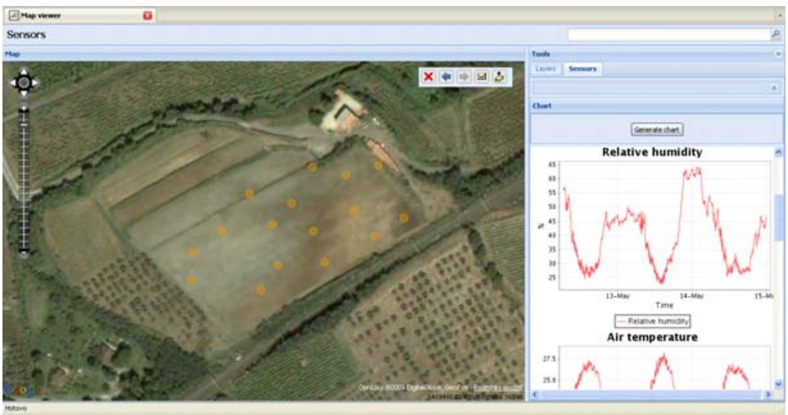

Fig. 5. Sensor Data Visualisation

In the future we propose to also integrate automatic email notification, when the critical values of sensors are received and implementation of SMS notification. Similar systems could be applied also in other branches; sensor networks for fire hotbeds, flood sensors, climatic conditions in market-gardening or crop growing and so on.

6 Conclusions

Geo-spatial information plays one of the main roles in decision processes; a possibility to locate objects and explore their interaction and relation to other objects represents an important step in IT development. Open Services Oriented Architecture tested within CLLW shows new methods of how the data can be exploited, managed and published. Core parts of C@R OSOA as developed in CLLW (CCSs components for OGC web services registration, metadata registration, Software Collaborative Tools) and their implementation in scenarios demonstrate the potential of innovations in the processes within the concept of living labs. Collaboration among experts from different institutes and their interaction with users is the main benefit of living lab ideas. Also re-usability of components is an important part of living lab development; components and software tools developed in previous projects (AMI4FOR, EarthLookCZ and others) have been implemented into C@R scenarios and also new developed components are able to be integrated into new applications. Results are presented on the living lab web portal www.livinglab.cz and they are implemented also into several other web solutions (http://www.envirogrids.cz, http://www.earthlook.cz/portal/, http://portal2.bosc.lv). There is the possibility of testing these applications or actively promote the process of their future development. Each application can be adjusted to specific user's needs.

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Chapter 8

Sekhukhune: A Living Lab Stimulating Economic Growth of Rural Micro-Enterprises in South Africa

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Abstract. The Sekhukhune Rural Living Lab in South Africa is one of only a few living Llabs in an emerging economy and is firmly rooted in a representative rural African and developing context. It concentrates on incubation mechanisms to support SMMEs (Small Medium and Micro Enterprises) which could provide a backbone for socio-economic development. Socio-economic development in an area like Sekhukhune turns out to be much more than a particular discipline and it is clear that it requires coordinated efforts. Amongst these efforts are process reengineering in close cooperation with the end user community, suitable application and platform development and live piloting applied to real world use cases. The latter provided some very promising results, specifically with regard to end-user adoption and the sustainability of the underlying business model.

Keywords: Living Lab, micro enterprise, emerging economy, cooperative, economies of scale, micro franchising, Infopreneur

1 Introduction

The following chapter describes the main results of the interventions in Sekhukhune, rural South Africa, which took place between September 2006 and Augustus 2009 in the scope of the C@R project. We focus on the end-user perspective, taking into account the socio-economic conditions and related cultural challenges and technological bottle necks. Beyond that, we investigate the degree to which tangible benefits for the community have been achieved within specific project use cases. Specifically, we take an in depth look at the results of the pilot implementation, which has been in 24x7 live operation for a period of nine months. From that we draw conclusions regarding the potential for a future sustainable business model.

2 Description of the Sekhukhune Rural Living Lab

The C@R project has established seven Rural Living Labs. The Sekhukhune Rural Living Lab, named after a rural district in the Limpopo province, is the only Living Lab in an emerging economy and is firmly rooted in a representative rural African context [1]. The district municipality is one of 13 Rural Development Nodes, prioritized by South Africa's president and has a population of more than 1.4 million people (2002 statistics). It consists of a traditional /former "ethnic homeland" area with high population pressures and unemployment levels and a low density of commercial farming and mining. It is very representative of remote and rural African contexts and the learning obtained here can therefore easily be applied in large parts of rural Africa.

The Sekhukhune Living Lab concentrates on incubation mechanisms to support Small, Medium and Micro Enterprises (SMMEs) which could provide a backbone for socio-economic development in South Africa. SMMEs (in particular in rural areas) face huge economic challenges that are mainly related to critical sizes of enterprises and their supply chain volumes [1, 2]. As a result, they miss sufficient access to markets, financial and logistical services that are available to the established economy. Evidently there is a gap between the informal and the established economy (in-flow as well as out-flow). It is thus the overall vision of the Sekhukhune Living Lab interventions to create an impact on operational excellence of small and micro enterprises specifically with regard to:

- the establishment of economies of scale to overcome the problem of critical size,
- the bridging of gaps between players of the informal and formal economy supporting accessibility of profitable markets,
- the reduction of transactional costs caused by remoteness, bad infrastructure and limited resources,

- the employment of entrepreneurs providing ICT services that haven't been accessible in rural areas so far (Infopreneur concept by CSIR / Meraka).

2.1 Rural Living Lab Scenarios and Use Cases

Based on the focuses of other rural living labs in the C@R project and the specific needs of South African rural enterprises (including information /knowledge intensive SMMEs like Infopreneurs) the following scenario framework was used as the focus for the Sekhukhune Living Lab.

- Scenario 1: Collaborative Procurement & Logistics
- Scenario 2: Collaborative Stock Management & e-Commerce
- Scenario 3: Collaborative Knowledge Sharing, mentoring & support
- Scenario 4: Spatial Analysis Support Services

Infopreneurs (see below) in the Sekhukhune area play a vital role in the provision of many of these services to enterprises in the living lab area. Their business case is enhanced by living lab experiments supplementing the existing portfolio with services to support above mentioned use cases.

2.2 Stakeholders

In general, the stakeholder community in the Sekhukhune Living Lab can be divided into the following groups:

- Local 2^{nd} economy participants and opinion formers. Typical 2nd economy activities include small scale trading (both basic retail goods and agricultural produce), small scale farming as well as some limited small-scale mining. Opinion formers are those individuals in the community who have an exposed position and elevated status. The traditional chief is a good example, but also people known for their social commitment to the community, as well as operators of successful small businesses.
- Local individuals serving as current or potential future intermediaries between the 1^{st} and 2^{nd} economy. In the current setup of the living lab these individuals are represented by the so-called Infopreneurs, a small group out of the local community with a distinct inclination towards entrepreneurship. They typically have an above average education (12^{th} grade "matric certificate") in comparison to the rest of the community and have undergone various ICT-training modules through the Meraka Institute of the CSIR. Their selection was also based upon their track record of social engagement within the local community. 'The community of practitioners' currently comprising more than 50 Infopreneurs in different provinces of South Africa
- 1^{st} economy players with a current or future interest in engaging in business activities with the 2^{nd} economy. This group includes all

potential business partners within the living lab coming from the formal economy (in the case of enterprises) or from the more wealthy South African middle class (in the case of individuals).
- The rural community, for example customers of the Spaza retail chain.
- CSIR/Meraka institute as part of the System of Innovation dealing with the set up of the 'community of practitioners', use case and service design, business model design, legacy system integration (InTouch) etc.
- SAP Research as partner of the System of Innovation dealing with architecture design, OSOA realization, use case and service design, mockup and application development, business model design, migration plan for legacy systems etc.

3 Methodology

3.1 Living Lab Evolution 2006-2009

The Sekhukhune Living Lab has gone through all four different phases of the Living Lab lifecycle [3, 4] Phase 1 benefited from early engagements in case of CSIR/Meraka and the established infrastructure for Infopreneur business. Nevertheless, extensive efforts have been spent on the requirement analysis that seamlessly entered into early prototyping and limited application development (phase 2). The most critical part of the living lab activities has been phase 3 when fully functional software had to be developed ready for real life roll-out. Phase 4 has only been reached recently. It became evident that the rolled out solutions are used on a daily base supporting real business transactions that have an impact on the core business of several local stakeholders.

Based on the spiral development approach several action research activities have been applied:

- Establish various agreements among participants through an extended negotiation process. The Sekhukhune Living Lab strongly builds upon long term established relationships amongst the different stakeholders. This also included the local communities as important drivers for open innovation and as customers of knowledge based information services. On the 1st economy stakeholder side the phased buy in of large wholesalers and retailers reflect the evolution of living lab organizational set up optimized for technical feasibility experimentation at an early stage to business model verification and experimentation in a later stage.
- Diagnosing the issues and challenges, doing interpretation and data collection leads to theoretical assumptions. In case of Sekhukhune this step has been clearly driven by the end users. End user interviews have been executed that have subsequently been evaluated. Identified pain points are based on data collection from different perspectives of supply

chain participants including the producers, wholesalers, Spaza shop owners and their customers.

- Action planning: specifying improvements and interventions, action plans experimentations. Four rural specific business scenarios and subordinated use cases have been designed as part of the project. Based on a first draft of business model the technology has been selected. In parallel synergies have been detected within a network of European living labs [5, 6]. Real life experimentation became the major focus in the last nine months of the project. Due to the mature state of the developed applications the system runs stable in 7x24 mode. Experimentation activities could therefore concentrate more and more on end user training, feedback collection and impact assessment.
- Action taking: implementing changes, carrying out experiments, continuous monitoring, and feedback to participants. Starting with mock ups, rapid prototypes have been developed; services have been identified and mapped onto the architectural layers of the Open Service Oriented Architecture [7]. Change management activities became more and more important and required higher efforts in the last phase of the project than technology development.
- Evaluating: collaborative evaluation of outcomes, problem redefinition. Continuous validation activities and end user interactions resulted in incremental improvements of existing functionality and the introduction of new functionality. These kinds of changes are well reflected in the SCRUM backlogs and different versions of the functional design documents that have been used.
- Specifying learning: first practices developed into good practices and finally into best practices. The captured learning has been extensively used to improve functional implementations, change management approaches, end user interactions, stakeholder acquisitions etc. Numerous unforeseeable challenges (e.g. interest of a whole stakeholder group has not been recognized) have been overcome taking the learning of early cycles carefully into account.

3.2 Agile Development Methodology

In order to improve the effectiveness of the development efforts during the prototype development we introduced the SCRUM agile development methodology [8]. SCRUM supports rapid development cycles with daily 15 minute status meetings. Using SCRUM improves the visibility of all involved developers and fosters the “big picture” of the current status during the development cycle. Weak points and possible hurdles are identified earlier and can be avoided. More details can be found in the final cyclic report of the Sekhukhune Living Lab.

3.3 User Driven Open Innovation

The planning and implementation of our live pilot was guided by a number of principles:

- Chose a phased approach and be open towards use case changes.
- Clearly identify the main innovation and make sure it remains part of your first real life implementation! The main innovation is the selling argument for all further activities and must be proven as soon as possible. All remaining innovations can come at a later stage.
- Choose your focus group stakeholders carefully. In the case of business partners: give preference to established and successful partners. They are not economically dependent on quick wins, they can take the risk of experimenting with concepts that a mere theory up to now and once the implementation was successful they are much better partners for up-scaling
- Use as little as possible technology and only as much as necessary. In Sekhukhune every extra technological hurdle will dramatically decrease the final end-user community and thus the chances of creating success and impact. Once the concepts have proven to be successful, technological fine-tuning will happen soon enough.

To narrow down the “Sekhukhune Living Lab end-user community”, so-called focus groups have been identified and brought together for each of the C@R use cases. Although such focus groups are not fully representative for the whole community, they do act as a research test bed for a roll-out in circumstances as close as possible to real-life conditions. This stage was a well facilitated and closely observed endeavor, ensuring business process and technical compliancy while allowing for a continuous communication with all stakeholders. For the duration of this experimental stage, preliminary business agreements have been reached between all focus group players (e.g. a preliminary revenue model).

4 Collaborative Applications

The following section discusses one selected scenario of living lab interventions, namely the use case of a virtual buying cooperative enabling collaborative procurement amongst small convenience stores, so called Spaza shops. A Spaza shop is defined as an informal shop/business operating within a formal or informal residential area. Typically, Spazas either operate from a section of a privately used home or from a simple stand-alone building. The term "Spaza" means "hidden" in the Zulu language and emerged during the apartheid era when the establishment of black-owned businesses in townships was declared illegal. Spazas form an important part of the informal trade sector in South Africa, which in turn makes up approximately one third of all informal sector activity (Ligthelm 2002).

4.1 Scenarios / Use Cases Explored in the Living Lab

Spaza shop customers typically buy products at Spaza shops related to very basic needs. For them, Spazas are convenient to reach and they therefore play an important socioeconomic role in the community. However, compared to the shops in the remote cities, non-availability of products is a common problem with too few goods being offered at too high a price by the Spazas. Spaza shop owners on the other hand typically have an extremely low financial liquidity. Thus they very frequently buy small quantities of trading stock and therefore pay excessively high procurement prices. In addition, procurement transaction costs are prohibitively high (transport, effort) which causes high sales prices and commonly yields a non-availability of goods. Spaza shop owners usually have no possibility of buying on credit due to a perceived lack of creditworthiness by the traditional financial service providers. Beyond that, they typically suffer from a combination of inadequate knowledge and insufficient bargaining power to effectively negotiate discounts. Although very few spaza shop owners buy stock together, they nonetheless seem to be open towards the concept of cooperative buying schemes.

Wholesalers in Burgersfort, Bushbuckridge and Nelspruit (some of the larger towns serving the procurement demand of Sekhukhune) typically don't offer any Spaza specific services although they consider the spaza market to grow in size and importance in the future. Spazas now already form an important part of their customer base.

The end user interaction sessions clearly indicated a very typical situation for South African rural areas that we chose to call the ***small trader's dilemma*** [9]: typically, rural Spaza shops need to buy stock in small quantities (due to an extremely limited financial liquidity), and thus buy stock in exceptionally quick cycles (to try and nonetheless meet the high demand of their under-serviced customers). Yet market conditions require them to buy stock in large quantities to be able to take advantage of bulk discounts offered by suppliers and to generally increase their bargaining power, and to keep the number of procurement cycles to a minimum due to disproportionately high transaction costs.

Through the introduction of a combination of different measures including information intermediaries, technological innovations and a franchise-like organizational structure we have been able be demonstrate the potential for significant improvements in terms of trading stock costs as well as procurement transaction costs. Beyond that, a significant future decrease in the time span between the detection of a demand for a product and the replenishment of that specific product seems realistic.

4.2 Collaborative Applications Developed

The GIS procurement application used by the Infopreneur to manage the collaborative procurement and logistics scenario in the Sekhukhune Living Lab has evolved into an advanced prototype that shows the benefits of the combination of a GIS based User Interface (UI) together with Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) functionalities like customer registration, order tracking and processing and business analytics. The GIS based UI is a result of the unique African context of the Sekhukhune Living Lab, e.g. in dealing with rural circumstances where there are no street names and addresses.

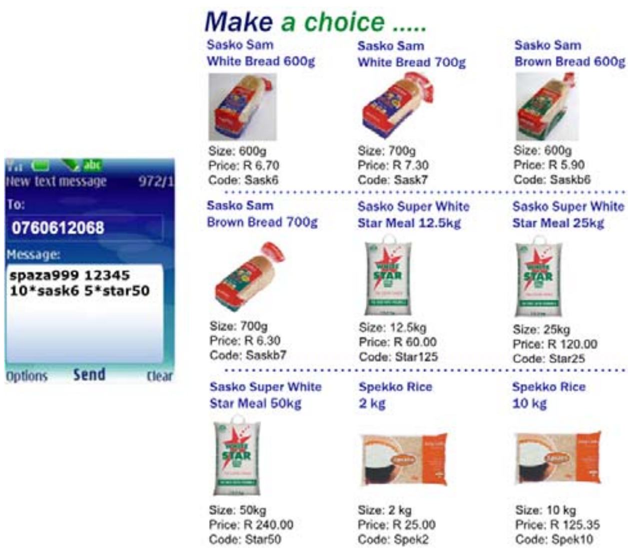

Fig. 1. Structured SMS and Paper-based Product Catalogue

The process of the first prototype version starts at the Spaza shop with the order placement via a structured SMS. For this the shop owner was provided with a paper based product catalogue. In the example shown in Figure 1 the Spaza shop owner sends a SMS with “username” “unique id” “product amount x product code”. In this case he orders 20kg Selati Brown Sugar and 2 Sasko Sam White Bread.

The SMS then is forwarded to a SMS-C (SMS centre) server where all orders are stored until the Infopreneur logs into his GIS procurement application to synchronize the order list. The GIS procurement application (see Figure 2 is able to run all processes offline and to synchronize at a later stage. It enables the Infopreneur to manage the Spaza Shops (business data and geographical information) and to process incoming orders.

After processing new orders offline the Infopreneur uses the synchronization capabilities to synchronize his local business data with the central server. The further steps of order processing like sending out confirmation SMS messages to the Spaza Shops and sending the order email (official order document with all processed orders) to the supplier is handled by the server without any additional interaction on the client side. In the current use case the supplier has logistics in house and is in charge to package and deliver the order items to the end consumers.

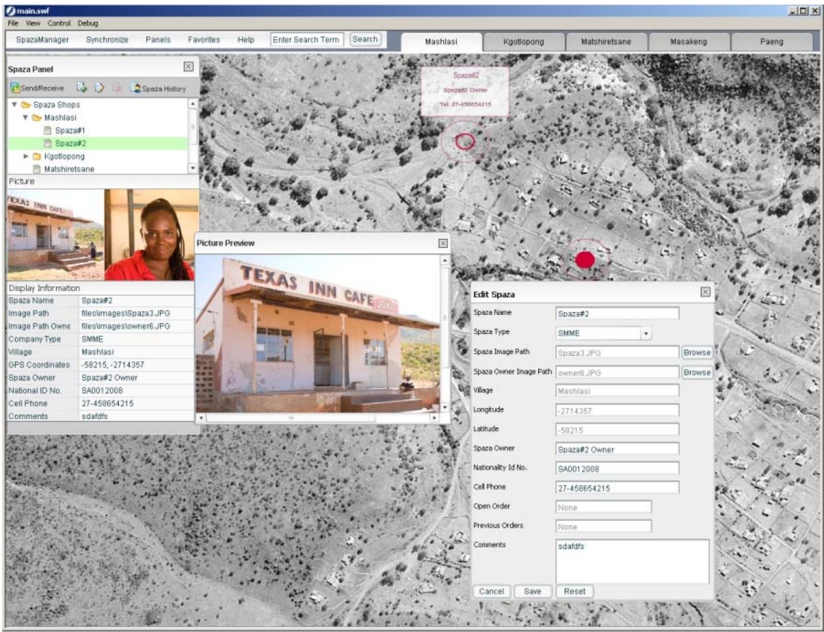

Fig. 2. GIS procurement application

5 Living Lab Experimentation Cycles

A number of specific engagements with members of the end user community in the Sekhukhune Living Lab took place [10]. The purpose of these interactions was to enter into understanding business needs and pain points, to gather requirements and to run validation exercises with focus group members regarding particular business process and technical (mostly user interface) issues. These interactions provided some distinctive examples of how the Sekhukhune Living Lab end user interaction resulted in reengineered use cases, real life scenarios, service offerings and products.

5.1 End User Community Interactions

Below is a summary of the different types of end user engagements we undertook. The details can be found in the final cyclic report of the Sekhukhune Living Lab:

1. Use case requirements capturing via interviews and pilot site investigation
2. Process validation workshops
3. User interface validation workshops
4. Value proposition meetings
5. Planning meetings
6. Regular telephonic communications with Infopreneurs and supplier representatives
7. Live operation feedback channels for all value chain stakeholders

5.2 Examples of End User Influence on Service and Product Design

To gather the user feedback we executed end user tests and recorded the end user working with the prototype. The recording has been done using screen capturing software (Techsmith Morae). The combination of technical tool usage, notes captured by 2 observers per end user and subsequent interviews reported distinctive usability issues of the then prototype design. The results of these end user evaluations were put into a list of usability issues to be improved. These tasks were taken into account in subsequent SCRUM application development sprints.

Navigation patterns were validated. For the Collaborative Procurement application a Geospatial Information System (GIS) based User Interface was proposed to the end users. Initially it was not clear whether end users were coping with the navigation pattern of these kinds of applications. It only became evident after the end user observations that a GIS based interface adds value to the end user in terms of usability and productivity. End users expressed their clear appreciation and preference for this kind of geographical UI compared to e.g. a table based end user interface (for ERP transactions like Spaza shop registration). Tests were also done comparing the usability of an aerial photo view (as shown above) versus that of a vector-based map (like a GPS device), and we found that the end-users clearly preferred the aerial photo view.

The decision to use a paper based SMS ordering system is another example of user influence on the product design that not only enhances usability but also reflects the extraordinary conditions of rural areas. We investigated 2 alternative ways to place an order using mobile phones with the end users: 1) using structured SMS and a paper based catalogue of goods available; 2) a browser based application including an electronic catalogue of available goods. The investigation indicated that a paper based catalogue in conjunction with structured SMS offers clear advantages from an end user perspective:

- Independence of type of mobile phone
- Compatibility with low end mobile phones (e.g. without a browser)
- Robustness in terms of connectivity failures
- Compliancy with ubiquitous end usage paradigm (e.g. SMS sending and receiving is widely adopted compared to mobile browsing).

These advantages were only discovered once the alternatives were discussed with the end users.

5.3 User Roll-Out

The roll-out preparation activities for the collaborative procurement scenario included extensive training efforts to both the end user communities of the Infopreneurs and the participating Spaza shops. The final product catalogue was distributed to the Spazas and they were trained how to place SMS orders. Infopreneurs then captured the required master data about the participating Spaza shops using the new application.

Fig. 3. The Infopreneur Simon Motumi and SAP employee Carsten Friedland are training Spaza shop owners on the usage of the paper based catalogue to submit orders via SMS.

The collaborative procurement system went live in January 2009 involving about 30 Spaza shops and 2 Infopreneurs responsible for the Sasko delivery route in Kgautswane. The real life experimentation comprises a product catalogue of 9 products of which 5 are not related to Sasko's core business (bread) but to the business of their holding company Pioneer Foods. During the pilot period, Infopreneurs provided further feedback regarding the usage of the application to track and submit bulk orders. In workshops and open discussions further insights into the rural community mindset, business activities, challenges etc. could be gained.

5.4 Evaluation and Impact Assessment of the Living Lab Experiments

Figure 4 illustrates the order volume per months since the beginning of the live experimentation until the end of the pilot life time. Taking the exceptional interaction end of March/beginning of April into account (when we've had one dedicated researcher on site for 10 days) there is a general trend of turnover increase. The number of actively ordering Spaza shops on a regular base has increased. The system proved to be stable in a 7x24 live operation and the participating Infopreneurs made an extra salary of 200-500 ZAR/month, depending on performance and turnover.

The live operation has shown that regular change management and end user interaction is most important for the sustainability of the business and technology models. Expanding the product basket to include all typical products will be essential for the future. For this purpose first activities to acquire additional suppliers are on their way.

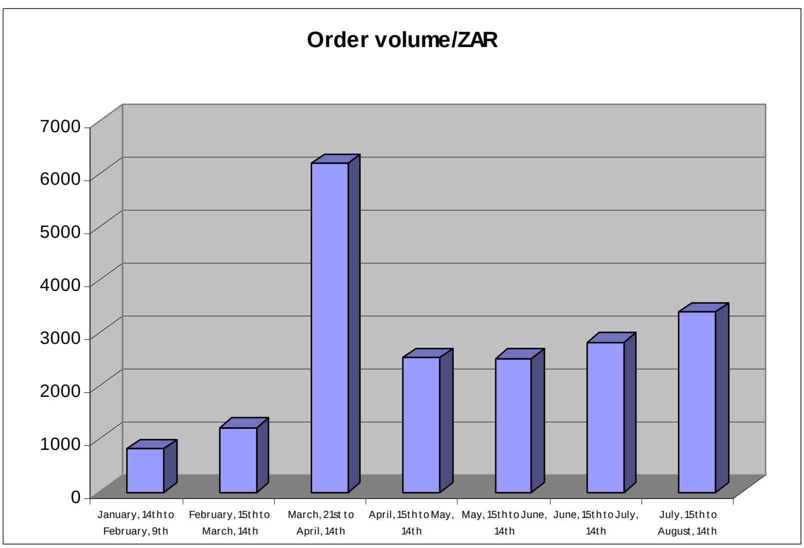

Fig. 4. Order volume per month in the collaborative procurement use case

In May 2009 a field research was carried out to find out, whether the Sekhukhune Living Lab interventions already show measurable impact with regards to the envisioned goals and objectives. This study included all Spaza shops that have already been registered for the SMS collaborative ordering. Beyond that, both infopreneurs and representatives from Sasko bakeries have been interviewed. More detailed results can be found in the final cyclic report of the Sekhukhune Living Lab.

Out of the total 21 interviewed Spazas, 16 confirmed that they are actively ordering via SMS (fig. 5) Referring to the question why they order via SMS, 13 stated that they order via SMS because it is cheaper for them.

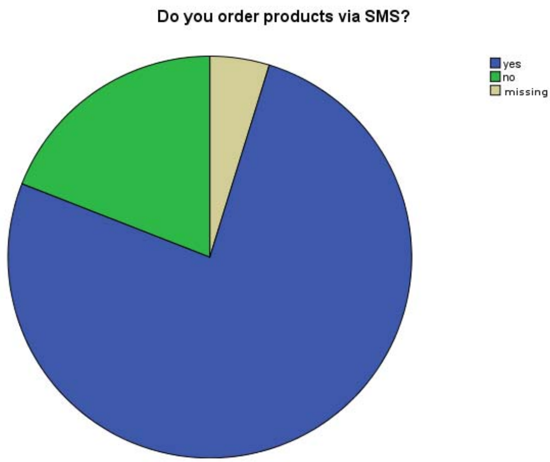

Fig. 5. Distribution of actively ordering Spaza shops

To the question why they don't order via SMS, answers ranged from network problems (2), need for more training (2) and having a lack of airtime (4). The question "Is there any extra value for you ordering via SMS?" was answered by 19 with yes. The most popular view on the extra value for ordering via SMS was the granted discount (10).

To the question "If you were able to get all products via SMS and get them delivered (e.g. once a week) and thus save your transport costs, how much will this improve your income?" 14 answered that this would significantly improve their income.

From the side of the supplier the SMS ordering is regarded as a promising extension of their business portfolio. It helps the company to trace the route of the drivers and to have more control over them. Also they stated that they experienced a 2% increase in sales. They are open to the idea of a joint venture with other companies. The biggest challenge for them is that the spazas do not order in big bulks, so up till now a target of discount could not be matched. For the future it is also possible to think about another mode of payment than cash and of giving credit for spazas that have performed good records. The sales manager thinks that if the project works out well the cost-benefit relation for the company will still improve.

In conclusion: adjustments are still needed in the field of network coverage and providing more training to those spaza shop owners that have little education. Also there is the wish to reduce the 2 SMS that are needed to finish the ordering process to 1 SMS due to a lack of airtime. In addition, the language of the SMS messages should be changed into sepedi (this has already been planned before the interviews and has been implemented since then). However, all the Spazas were coping with the process, irrespective of whether they were experienced mobile users or even illiterates (in the latter case, they typically asked someone else in the family to place the order). Simply put: if a shop owner wanted to order via SMS, he did.

6 Living Lab Business Model

The large numbers of informal workers in African economies constitute a considerable challenge to the continent's economic development ambitions. Compared to the formally employed, the informal work force remains to be significantly more volatile to harassment, exploitation, economic insecurity and poor working conditions. Some of the reasons can be found in the informal sector's typical characteristics of low productivity, limited access towards credit and capital, weak networks and low level of skills and education. It should also be noted, that the informal economy typically employs more women, who suffer from a marginalized position anyhow.

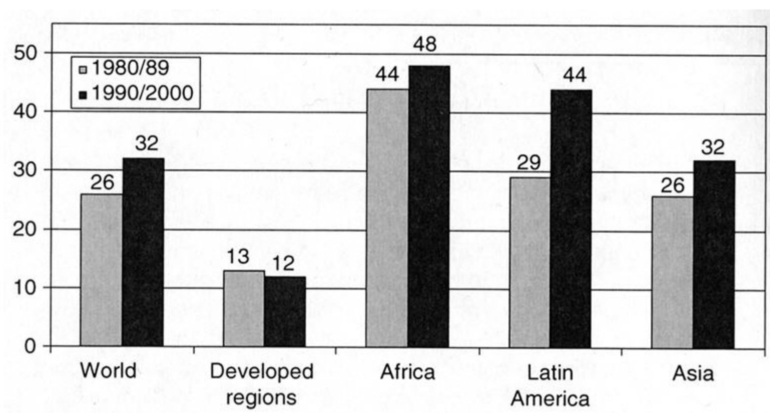

Fig. 6. Informal employment as percentage of non-agriculture employment [11]

There is also no doubt, that the informal economy is growing. Despite an overall economic growth, African countries have experienced a percentage increase of informal employment in the last twenty years, which is also in line with the general trend in developing regions of the world (Figure 6). Hopes, that informal employment might only be a transitional phenomenon which will disappear once the formal economy is strong enough to absorb higher numbers of workers, have thus not materialized up to now [11]. On the contrary: there are strong indications that the informal economy is suffering from several market failures, preventing it to link up with established markets.

These market failures or market imperfections present themselves in diverse ways, in different industries and also in different levels of severeness (both in the direct and long-term impact). In some cases there is simply no mutual value proposition for both sides to enter into a business relationship. This will be difficult to change. In other cases, there might be an indirect business relationship, but one that is burdened with inefficiencies or a lack of transparency, the cost of which is typically born by the informal economy (e.g. small scale farmers suffering from exploitation due to a network of intransparent intermediaries). And in even other cases, there might be a theoretic mutual interest to do business with each other, however, this is prevented by a lack of a common set of business modalities that are meaningful and acceptable to both sides (e.g. an informal entrepreneur who fails to qualify for a loan since the bank has no way of dealing with the related risk).

The informal economy in South Africa in general and specifically in the Sekhukhune Rural Living Lab constitutes no significant exception to the above. In our pilot experimentations we therefore intended to directly connect some parts of the informal economy to established markets which are currently only indirectly connected. Our experiences with regard to the virtual buying cooperative in Sekhukhune have shown, that an innovative business model combined with appropriate technologies can provide means to increase the bargaining power of the informal economy, formalize and digitally track previously informal business processes and thereby provide the basis for a more transparent and direct business relationship with the established economy. Secondly, such innovations can form the basis for business transactions that previously have been impossible. This is also well illustrated by the example of Sekhukhune. While having had no means of proving their reliability or creditworthiness in the past, rural shops now have a system at their disposal which tracks and documents each of their business transactions. This is a first important step to provide the securities required for future business transactions (e.g. financial services).

In our approach, we fully subscribe to the bottom of the pyramid (BOP) approach prominently described in [15], who considers business actors in the informal economy to have the potential to be reliable and profitable partners in an economically sustainable business relationship with established business. “Typical pictures of poverty mask the fact that the very poor represent resilient entrepreneurs and value-conscious consumers.

An approach is needed that involves partnering with them to innovate and achieve sustainable win-win scenarios where the poor are actively engaged and, at the same time, the companies providing products and services to them are profitable" [15]. In fact, some of the rural Spaza shops in Sekhuhkune have been in business for more than 30 years and have thus sufficiently proven their capability of running a sustainable business. However, we also acknowledge that there are huge differences within the so-called bottom of the pyramid regarding literacy levels, business skills and entrepreneurial capabilities. Our concept for a economically sustainable buying cooperative therefore specifically foresees local agents of an above average qualification who are provided with an economic incentive to facilitate the necessary local business processes. This specifically refers to all activities and tasks related to more advanced information technologies. Our experiences with the "Infopreneur"-concept in Sekhukhune have confirmed the value and potential of such a setting [12]. In order to ensure an economically sustainable business for such extension agents, we foresee a microfranchise structure, which combines the entrepreneurial incentive model of a franchise with very detailed and comprehensive business support from the franchisor towards its franchisees [13, 14].

Following these approaches, we intend to significantly improve the cost-value ratio for the informal economy both in the cases of an outflow of products and services (e.g. local logistics, tourism) as well as an inflow of products and services (retail), thereby directly supporting economic development within the informal sector in Sekhukhune.

7 Conclusions

We consider the overall outcomes of the Sekhukhune interventions to be very promising. Initial ideas and use cases proved to be relevant and realistic. Through a close cooperation with the end-user community processes were reengineered, suitable applications have been developed and a live pilot period of 9 months provided some very promising results, specifically with regard to end-user adoption. There is a realistic chance that follow-up projects (some of which are already in concrete planning) will be able to build upon these results and will be able to develop the current pilot implementation into a more encompassing sustainable business.

End note

Andries Naude passed away in November 2009 after a long period of illness. With deep regret the co-authors of this chapter would like to thank Andries for his dedicated and passionate support of the Sekhukhune Living Lab activities.

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Chapter 9

ArchipeLabo – Building a Rural Living Lab for Governance and Rural Development

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Abstract. The goal of this chapter is to present the results achieved in the C@R project in the Åboland islands in Southwest Finland and to exemplify the role of the living lab in linking innovation and rural development. Rural ArchipeLabo has focused on two cases, Mobile Direct Sales and eDemocracy Toolbox. It facilitated the related process of strengthening the innovation and economic potential of the local stakeholder network. Implementation of the two cases provides insights into the methodology and operation model of a living laboratory from the point of view of governance and as a mechanism for rural development, functioning in a locally sustainable way. The evaluation of the living lab approach emphasizes the role of collaborative innovation as a process of stakeholder co-operation.

Keywords: Rural development, Living lab, Governance.

1 Introduction

ArchipeLabo, the C@R-facilitated rural living lab in the Finnish archipelago, has created an environment of innovation in collaborative services as an instrument for regional and rural development [1]. ArchipeLabo is situated in the Åboland/Turunmaa islands along the coast of Southwest Finland. The organizational setting of local public and academic actors and local businesses constitutes the living lab as an enabling innovation facility to generate ICT-enabled services that improve working and living conditions in the sparsely populated islands. Internet access for the secluded population on the islands is provided by the publicly owned network company at market prices, but innovations in ICT-enabled services are needed for the rural population to benefit from the public investments in WiMax infrastructure. To this end the rural living lab functions as an incubator of services leading to new local businesses. The chapter starts by presenting scenarios of two application cases, Mobile Direct Sales (MDS) and eDemocracy Toolbox (eDT). It highlights aspects of participative action and co-creation with regard to the operation (business) model and governance of the rural living lab. Special attention is given to the process of engaging users in the innovation process from the beginning of the project. The potential of a rural living lab as a facility for innovative services for citizen and local business is elaborated with reference to application development and more extensively in the section on experimentation and results. The ArchipeLabo Rural Living Lab is functioning as a tool to locally integrate collaborative innovation approaches and economic development strategies.

2 ArchipeLabo and the Rural Innovation Environment

Starting point for the ArchipeLabo Rural Living Lab has been a situation where basic investments in technological infrastructure had been accomplished. WiMax technology was in place since 2004; also investments in a citizen web portal and intranet focused on education and health had been implemented, as well as acquisition of videoconferencing facilities. However, a strong need was felt to exploit the technology for better public service provision and to support an entrepreneurial business environment. C@R, in close interaction with regional stakeholders, provided the opportunity for the area to develop into an innovation environment and unlock the innovation potential of rural and sparsely populated municipalities. The need to collaborate received a strong push by the government as smaller municipalities were required to merge into larger units, a complex process and controversial process. The merger timeframe matched the C@R project duration 2006 – 2009; this provided new opportunities as well as problems and bottlenecks and has affected the implementation of C@R. A key factor that had to be dealt with was the role of the living lab in responding to local policy objectives in the region's changed situation.

2.1 Rural Innovation Environment

ArchipeLabo supports the development of the archipelago of Åboland/Turunmaa in Southwest Finland, comprising 20.000 islands and a complex municipal infrastructure as setting for an innovation environment.

Innovation and entrepreneurship on the islands is characterized by the fact that different sectors of professional work are strongly connected. Therefore technological applications can serve citizens, administration and entrepreneurs often in the same person. To understand how this affects application development the C@R work has emphasized a process that acknowledges the competencies and knowledge of the rural citizen in concept creation and experimentation. Scattered islands as context for collaborative work present some challenges in organising for efficient research and development for innovation. Much of the work with the local users and the local network provider has toiled with organizing the user participation and adopting tools of (open) innovation through user engagement. While most citizens' income depends on practicing a manifold range of professional activities, conducting professional and civic activities is restricted by distance (especially measured in time). Outer islands have no daily connection with more equipped urbanized centres and lack reliable services both for individuals and businesses. The two cases that were chosen for the C@R application development are Mobile Direct Sales and eDemocracy Toolbox, representing services from a business and a democracy point of view respectively.

2.2 Evolution of the ArchipeLabo Living Lab

Living lab infrastructure development, elaboration and implementation of the living lab methodology, the government led developments in the rural environment (i.e. municipalities merger) and the role of local policies were strongly interrelated. The methodology of user and stakeholder engagement implemented through the cyclic development approach and action research turned out to be crucial until the closing of the project. Living lab development went through three distinct phases: need finding and concept creation (year one), application development and experimentation (year two and partly year three), and preparation for ensuring sustainability of stakeholder involvement and the living lab business model (year three).

Throughout its evolution, ArchipeLabo has been open to innovations that were in the making and to ongoing changes in the policy and business environment. Thus, the role of the ArchipeLabo Living Lab is situated in an ongoing development of the rural innovation system to which it contributes and through which it is shaped. Table 1 lists the determinants that in our view constitute the rural innovation system to which the living lab contributes: the innovation infrastructure (ICT as well as governance), the demand for innovative services, the role of government policies (local and regional), innovation culture, and collaboration among all stakeholders (network strength).

Table 1. ArchipeLabo Rural Living Lab and rural innovation system evolution

ICT Innovation Infrastructure	
Initial situation	**Closing situation**
Wimax (4 antennas) Coverage: 45% of islands in western part of the archipelago, including 15% of population Mebben citizen portal (Education, Health) Public network company established Video conferencing equipment not in active use	Extension of network (2 new WiMAX antennas; FTTO and FTTH developed) Coverage: 65% of islands in western part of the archipelago, including 35% of population Advanced citizen services and public services (Mobiroad.fi portal for cameras and queue information for ferries; Houtskär broadband pilot
Governance Infrastructure	
Initial situation	**Closing situation**
Local municipalities delegate regional economic development to the joint development agency Board of the agency constitutes of eight mayors Constellation and governance of development function : ownership by eight municipalities of joint regional development agency; steering of strategic regional, national and international cooperation Local network provided by a public company owned by the association of municipalities for regional development. Operations are run by one of the mayors.	Changes in governance as a result of implementing government initiated merger Development functions are assumed by the newly merged municipalities, not a joint agency New challenge for governance: large municipality has longer distances Laptops for members of governing bodies and of city council purchased Shared infrastructure with city-based universities Ownership by the public company and extending its operations as remote network are under negotiation.
Demand for Innovative Services	
Initial situation	**Closing situation**
Demand is not a driver - Technical equipment available but not in use Most entrepreneurs do not have web sites Connectivity through WiMax is only recent, thus potential and benefits not yet conceived	Active vice-mayor and director for development who functions as a driver, creating demand Active participation in major projects raises awareness to ICT-enabled services and demand
Government Role	
Initial situation	**Closing situation**
Lobbying for the interests of the islands Competition for funding Information to policy makers is crucial	Lobbying for the interests of the islands Competition for funding Information to policy makers is crucial
Innovation culture and stakeholder networking	
Initial situation	**Closing situation**
Driven by key persons, adventurous entrepreneurs with ideas, implementation shows weaknesses Some user-centricity is present partly thanks to the small scale of rural contexts, and partly to ensure democratic processes Research projects of the local universities emphasize research not local development Stakeholder collaboration is project driven	User-centricity as a strategic goal, implementation still pending living lab agreement Understanding has increased on the collaborative and cyclic nature of innovation. The need to link innovation projects with entrepreneurship support is acknowledged Stakeholder collaboration governed through network agreement

2.3 Living Lab Methodology

The role of the ArchipeLabo Living Lab in its rural environment had implications on the living lab methodology. We used an approach of continuous stakeholder interaction, which fits in the over-all approach of action research and cyclic development. In our user centric focus we were supported by the leading political figure for local development. At the concrete level of specific innovations, methodologies were tailored to the demands of our use cases (eDT, MDS). Main elements of the methodological approach are the following:

- Partnership and community building based on value creation workshops (MDS) and on building a sustainable network of living labs in Southwest of Finland;
- Cyclic development approach implemented through the FormIT systems development process;
- Software prototyping techniques such as development of mock-ups and prototypes with limited and extended functionalities;
- Setting up a living lab infrastructure consisting of networking resources such as software development tools, tools for research and monitoring, student groups for testing of software applications, equipment for data capturing; project collaboration tools; and technical testbed for prototype development and architecture testing;
- User engagement tailored to the use case demands (eDT, MDS) based on selection of user groups.

Both cases, eDT and MDS, have laid emphasis on user engagement and have applied, through cycles, the sequences of action research focusing on joint innovation and problem solving: diagnosing, action planning, implementation and learning. Action research methodology has been embedded in the phasing chain of iterative cycles for living lab innovation, which starts with preparing and enabling the living lab development approach, then proceeds through stages of limited experimentation, more extensive application development and finally enters a phase of operating through a well-established business model [1]. The phase of living lab preparation includes preparing agreements at different degrees of formality, from trust between stakeholders to a formal statement of intent or contracts concerning the relationship between stakeholders and the role of the living lab in a network of partners.

Besides working on the concrete innovation cases (each case had been allotted a dedicated part of the project budget, supported by local funds), ArchipeLabo also worked on a more “strategic” cross-case level to establish sustainable living lab facilities as a rural innovation environment, based on a common research framework and on a collection of resources constituting the living lab environment.

3 Living Lab Platform and Cases

The ArchipeLabo work in terms of technical innovations has contributed to various types of results: development and testing of a common collaborative platform based on the C@R architecture, and development of collaborative applications. This section concentrates on the collaborative applications used in the eDT and MDS use cases.

3.1 Mobile Direct Sales (MDS)

The public sector investments in the WiMax network have been a way to acknowledge the need of the sparse population of the islands to have equal access to information society. However, the ability to access and the capacity to provide services go hand in hand. Based on interviews of producers and entrepreneurs involved in services for tourists, a mock-up using e-commerce was developed. The idea was to create a mobile service for farmers, producers and mobile citizens and visitors. The application enables tourists to order fresh produce available directly from the farmers by mobile application and/or fixed network. In response the producers can deliver the goods to the agreed location.

Simulated and real-live testing cycles were conducted with farmers located close to the connecting roads to ferries on different islands. The involvement of the producers, who were consulted regularly on their farms from the very early stages of the Mobile Direct Sale case, showed that they appreciated the user-centred approach and they expected speedy development. The encounters brought competing producers and ICT-entrepreneurs together. Developed MDS prototypes (sms-based transactions handling, "stock control" and web store (both for PC and mobile devices platform) on top of osCommerce Online Merchant v2.2 RC 2a) did not meet the real needs of producers. The last phase of MDS was dedicated to testing and evaluating C@R architecture, BUS, and CCS relevant to the MDS case. The aim was to find out whether in future projects the architecture could serve as basis for application development and replace the osCommerce as a platform.

The MDS application development experimentation proceeded until the stage was reached for minor testing for adjustments. This was eventually postponed for the following reasons: seasonal timing of the testing environment did not match with the other activities in the C@R platform development; real life testing including travellers needed decisions in terms of business risks distribution the expected testing in an open and uncontrolled environment such as the movement of tourists would not have yielded valid results before the above issues would be resolved. New local resources have been applied for in order to support the development of the MDS business case.

As a spin-off of MDS other product ranges and uses have been identified, for example usage linked with the timetables in collaboration with ferry services. Uses for mobile data collection to build up the living lab data base have also been tested.

3.2 eDemocracy Toolbox (eDT)

The background of the eDT case is the merger of the eight archipelago municipalities into two units, covering a larger area. The emerging eDT concept to support virtual city council meetings, was derived from a human-centric view of how the new municipal structure influences and interacts with its inhabitants. It is the mandate of a municipal authority to enable citizen to exercise their democratic rights, even in marginalized areas. Both the political leadership of the new municipality and the C@R team wanted to strongly focus on citizen. Methodology and needs merged in the eDT case.

The development cycles in eDT were defined as i) need finding and market analysis, ii) prototype development and experimentation, and iii) implementation. These cycles mark the work phases of an action research approach and also integrate new changes in governance, especially in the eDemocracy case. In the need finding phase the expected outcome was to identify the videoconferencing software that best fitted the needs of users in meetings with political as well as doing an overview of what was available in terms of hardware from previous investments. The legal features of a municipality decision making meeting were crucial for the experimentation purposes. The requirements for the procedure in council meetings are the most controlled legally at the same time as council meetings are large meetings by nature. The number of attendees with the right to present initiatives, comments, counter-comments, and votes can vary from 12 to 100, depending on the size of the municipality. The problem domain was modeled using four separate sources of information: legislative texts such as the Finnish Municipality Act 365/1995, or the guide for municipal council meetings (Finnish Association of Municipalities), a market survey on existing videoconferencing tools, observations during real life municipal council meetings in three nearby municipalities (Parainen 11.12.2007, Turku 21.1.2008 and Salo 25.2.2008), and discussions with a councilman from Nauvo and with the Mayor of Houtskär/Houtskari.

As a result of this phase four distinct needs were identified for a system to be employed in distributed municipal meetings: participants should be recognizable and available through video connection, all participants should have equal opportunities of participation, the system should support the meeting protocol, and it should be flexible enough to support different types of meetings.

Equal opportunity to participate in a meeting regardless of the technology or tools in use or distance from the physical meeting place is a subjective feeling that is influenced by the degree of understanding and experience on the meeting protocol, ICT skills and group dynamics of political conversations. The conferencing tools should support and guide the participants, especially those responsible of the protocol, and subsequently the legality of the meeting. It should allow participants to focus on the agenda instead of the technology. The ICT tools should support different types of meetings based on the level of meeting (political (council, government, board) or civil servants only), amount of participants (total amount and the amount of distributed participants), and the degree of formality involved in the meeting (strict (council, government), flexible but official (board), relaxed (civil servants only)).

The existing videoconferencing and meeting assistance solutions were evaluated against these needs. To test various videoconferencing tools available on the market an experimentation environment was established in Turku University of Applied Sciences in autumn 2007 as a part of software engineering course. The students were divided into four rooms: two with a single participant, a group of five participants in one room and the major part (13) of participants, including the chairman and the secretary, in the fourth room.

The students were assigned a role in the simulation and the role was kept the same during the complete set of tests. The meeting was repeated using six different scenarios. Each group followed the same agenda in all six meetings and they all took notes and produced a protocol of the meeting. Each participant had a defined role to play (chairman secretary, councilman) in the simulated meeting. The goal was to develop a user interface for the meeting software portal (first mock-up prototype) and find links between modules according to user roles, privileges, and process. Originally all videoconferencing software, that was found and studied in the market research, were planned to be tested using the simulated experimentation environment and the agenda included in the first prototype. However, some of the software proved to be either too demanding (required hardware, network connection, software license) or too complicated to use in a meeting following a formal procedure, that in the end only four solutions (WebEx, Videra Virtual Office, Adobe Connect Pro, GoodMood) were used to carry out the complete set of tests. All of the evaluated applications had tailoring options but at the time (2007) none had the support for distributing municipal meetings over the Internet, because of the fact that at the time it was illegal.

As a consequence, based on the findings, a decision was made to concentrate on modeling the decision making process and write implementation independent specifications and test cases for a distributed municipal meeting system.

In the prototype development phase (2008-2009) three prototypes were used for experimentation. All the prototypes were subsequently tested using the same script already defined in the first phase. The script was based on an example council meeting and it allowed testing all special features of a municipal meeting (starting and ending the meeting, stating the participants and their roles, asking and granting the permission to speak and comment, voting and election, starting and ending a topic, making a decision). The first mock-up was a PowerPoint show that presented a collection of screenshots from various existing applications built around an example council meeting. The mock-up supported two roles: chairman and councilman. The second prototype had limited functionality (no voting or election) and the chairman and councilman roles. It was designed to help the discussion between developers and users. The second and third prototypes were networked java programs used in Eclipse framework. The appearance was deliberately left crude in order to help the users to concentrate on the meeting agenda and not the application. The actual video connection was left out for the same reason – not to attract the attention away from the conduct code. The councilor role had refined features (groups, group representative, vice representative). The third prototype added the roles of secretary and civil servant together with new functionalities (voting and election). The roles of protocol scrutinizers and vote counters were not included in any of the three prototypes.

The three group of users involved presented domain and ICT specific conceptual knowledge (experts in Finnish Association of Municipalities), conceptual and practical domain specific knowledge on local level (four mayors, town lawyer), and practical domain and ICT specific knowledge (town secretary and ICT manager). The students of Turku University of Applied Sciences were used as technical testers of the prototypes. The existing commercial solutions were again evaluated against the specifications built with prototypes. As a result it was decided to end the prototype development and start building the system with the equipment and software already in use in the town of Väståboland complemented with new meeting assistant software and some upgraded devices.

The fourth prototype was an extension to existing meeting assistant software (Doplhin Interactive Presenter) that was purchased by the town of Väståboland The extension included modules that allow participation using either sms or an applet in a web page along with the regular participation using a dedicated handheld voting device. The extension was tested in a series of simulated meetings with students of Turku University of Applied Sciences. The meeting assistant application is currently in use in council meetings of the town of Väståboland. The extension is planned to be used together with a dedicated TV-based videoconferencing equipment (Tandberg). To this end we have selected to experiment with board meetings that are likely to be distributed to several locations around the islands. Every third meeting among civil servants only are planned to be carried out using an Internet based videoconferencing application (Adobe Connect Pro). The town of Väståboland has started a master user training program among civil servants and politicians in autumn 2009. The program aims to train a selection of key users on each system (meeting assistant, TV-based and Internet based videoconferencing equipment) that is used in the meetings. The master users will in turn train the other users to use the systems.

Current results and the future of eDT

Although the eDemocracy Toolbox case (eDT) is in its initial phase of usage and further development is needed for its full implementation it has already achieved significant impact in the duration of the C@R project. It has provided input into the technical and user-related requirements needed for a legal change. As a result of the first and second cycles a new bill was passed in October 2008 by the Finnish Parliament. The crucial question before the proposal of the new law was to gain sufficiently clear specifications for the validity of virtual municipal council meetings. Political lobbying and experimentation were contingent on each other. Testing with staged council meetings as well as with real usage in dedicated task force preparation meetings was done. The results formed the specifications used in the new bill and the new bill carries the name of the municipality of Åboland/Turunmaa.

In the future the meeting assistance software, videoconferencing equipment and accompanying software as well as document management and archiving system will convergence to one integrated solution that will be available through one portal. The integration process still requires further modeling of the municipal decision making system, and meetings linked to it, as well as of the citizen participation in each phase. The municipal system is undergoing changes that will have an impact on the integration process. The technology is enabling more open decision making processes, and this allows earlier and more substantial citizen participation in the process. Although based on the new bill there is legal provision for virtual council meetings, in the local constituency politically the technological changes, and their consequences, need to be accepted and formally approved as a part of the decision making procedure. The most profound change will be the change in the decision making culture and political participation culture.

The legal possibility of virtual council meetings reduces costs in the large newly merged municipality, and extends the possibility for active citizenship towards young people and towards those who wish for political active participation but for whom distance is an issue. The experience with users' engagement during the development process was positive, despite inconveniences caused by technology during the testing. The events were filmed in order to be able to revisit the meeting process with regard to further investigation on user behavior, network and equipment efficiency, and improvements in software development.

While a convincing argument from public administration point of view builds around the savings that virtual meetings will allow due to less traveling, the eDT has its strength in its human-centric initiative. The user and human focus is significant in eDT on two accounts: firstly, the participative action of citizens in the testing environment for a user-centric development and implementation lead to community building coupled with a demand-based enhanced life quality; it secures a broad citizen participation in democratic processes, including geographically marginalized areas and younger candidates interested in community work and issues of politics.

3.3 User Involvement and Experimentation

ArchipeLabo's original motivation was setting up a facility to serve local job, business, and service creation to increase the attractiveness of the area. A model for local orchestration was a recognized need. To provide new opportunities for cooperation in addition to the coordination offered in research projects by remote academic partners was part of the strategic view for economic development. This posed practical challenges of network orchestration in balancing interests. This included refining user engagement practices to win and sustain the involved entrepreneurs' commitment for tackling various perspectives beyond their immediate business needs. As a rule, entrepreneurs, and equally so local civil servants, want to focus on practical and fast outcomes. An intensive and fruitful strategic dialogue on how a multi-perspective approach can lead to benefits for the community on the long run has been conducted with the deputy mayor responsible for development. A practical approach to a strategic understanding of the user involvement was attempted. In the cases of the ArchipeLabo Living Lab this was done with personal contacts, group and individual interviews, and focus groups. The local development agency was crucial in selecting the participants that were relatively free from restrictions in inter-personal collaboration.

While in the MDS case selection was challenging due to uncontrollable variables (seasonal changes, availability of farmers, tourist flows, differences in farming and cultivating methods as well as business models) in the eDT case the process of selection of users for participation and co-creation evolved in cyclical manner, based on the phases of eDT development. The process involved need finding with the users, formulating the requirements for the users to evaluate, and repeating the process until a common understanding was reached.

In order to reach the optimal combination of users involved in each phase candidates were divided into categories based on demographic profile, related domain profile, and ICT specific knowledge. In addition, to the level of commitment as a stakeholder became relevant: influencing in, influenced by, interested, but not influencing in. The level of commitment related also to role and participation in the project taken by the user. Such variables consisted in restrictive or regulative participation, steering role in the project (not directly participating) as administrator or as part of project organization, free agent (joins or leaves the project without long term commitment).

The age of the user has influence on the general attitudes towards ICT and on the degree of interest to participate in municipal decision making. However, age was not considered an issue in the eDT development since all selected users were already involved in either the decision making process or in supporting actions and all used ICT in their profession, regardless of their age. Domain related knowledge, in the eDT case, consisted of the level of theoretical/practical knowledge of the municipal decision making process, specifically the procedures involved in council meetings. eDT users were divided into two groups: based on a political frame (politician, civil servant, citizen) and based on a legal frame (law maker, implementer or administrator, law enforcer, such as lawyer, police, judge) [2]. ICT specific knowledge consists of knowledge in connection to ICT of the domain (theoretical, practical), general ICT skills (expert, skilled, fluent, basic) and system development role during the eDT case (developer, programmer, tester (developer tests), tester (end-user tests), end-user, implementer).

Application development work has included bundling and negotiating common interests in both the eDT and the MDS case. The idea has been to create a committed core group to assist once the projects would proceed to large scale experimentation. Entrepreneurs in rural areas are in tight competition with a relatively similar choice of products to offer to the sparse population. In the small scale environment of the archipelago competition in any professional domain plays out on personal interactions and the particular gains for each. The participants were thus expected to overcome their local or personal barriers that traditionally have influenced with whom they do or do not cooperate. Therefore it has been also a function of the living lab to create awareness and favorable conditions for the local entrepreneurs to enjoy the benefits of building on a strong value chain and to envision their own role in gaining from networked approaches to service innovation.

As a whole, the C@R cases in the ArchipeLabo Living Lab have demonstrated the benefits of the human-centric approach in rural living labs to direct attention at joint efforts towards new business and service solutions by focusing on use, real life use, and demand. This has lead to some changes in service and business propositions and has affected the development of work processes. It also has tied priorities, technical implementation, timeframe, and scaling to real life priorities. Local stakeholders with the project team and developers were able to achieve a sound level of community, building on trust and room for criticism when expectations and performance were not met. This was especially the case when decisions on turning points in the process were consciously made not around the product's technical cycle, but in consideration of the users/stakeholders' feed-back. Turning points were also instances related to building joint value towards a viable business activity or service provision.

The following subchapters highlight the lessons learned from three perspectives that reflect upon the governance of the living lab and the collaborative platform that best can serve the identified issues.

3.4 Risk Taking

The revenue models that were envisioned at case level, specifically for the MDS case, required investments in marketing and in personnel for scaling up the community of producers involved in direct sales. The discussions and brainstorming with the C@R core user group of producers and potential buyers have lead to several new ideas of how to organise cooperation in product bundling, branding and logistics. The core user group established what needs to be in place to develop the MDS business case and enable the real life use of the application at large scale. In practice, this involves risk taking in approaching the market and adopting demand driven development. Risk taking was seen as a joint endeavour to be shared between the entrepreneurs and the economic development initiatives of the municipality. A public-private effort was envisioned as the best solution, including a pre-commercial cooperation aspect to it, which could diminish the risk of the SMMEs.

In the case of a successful scaling, the application would easily be expanded from direct sales into other relevant mobile services, which would bring new business for new entrepreneurs in the area. Thus, sharing risks with the public sector seemed justified in terms of local economic development. Also in terms of services and territorial marketing, the region would benefit. New service and business creation was compared to the investments in destination marketing of more traditional approaches to tourism development. There seemed to be little difference in risk taking, if service and business development through the living lab functions as improving services and attractiveness. The discussions resulted in targeting possible new funding for product development and marketing. Project funding from national sources is thus being sought, but the process is slower than expected and slower than the current business interests may allow. Funding is needed soon in order to continue with real life testing during the next tourist season and to secure a viable business model for MDS. The delay raises doubts among the producers who have already invested time (risking loss of income) for testing and concept creation.

Realities of the market, and with regard to the eDT case the regulated framework of the democratic governance and decision making processes, are contexts that demand solutions in governance and, importantly, resource allocation for a wider technical and marketing support by the municipality. While the research institutions and the universities used their role in generating new funding through proposals derived from the experimentation, platform and application development experiences, new project proposals were not easily achieved at municipal strategic level. Thus, it appears that the living lab approach requires a change in governance towards a more entrepreneurial culture in public sector development initiatives that include technology. This on the other hand produces risks that are not easily justified at political and decision making level. Furthermore, issues of distorting the market may be raised, in a rural environment where each actor weighs our benefits against their neighboring competitor.

3.5 The Perspective of User Participation

This perspective touches upon users in different roles. It includes understanding the expectations of different users with regard to participating in the experimentation activities. Also, users as end users or entrepreneurs have expectations on account of facilitation by municipal decision makers and civil servants. Flexibility and fast responses are expected and determine participation of users and entrepreneurs. In the two cases at the ArchipeLabo there was a mutual verbal agreement to a high commitment on each side, users and researchers, coupled with expectations to influence the larger picture of the business environment in the region.

The amount of time needed for coordination of public stakeholders, as well as European level coordination, affected the enthusiasm of co-creation. In addition there is the risk of looking customers that were invited to join, or political power on the side of the public participants. This lead to several discussions as to why and to what extent the expertise of the voluntary active participants was needed at such an early stage of the project, and how this affects co-creation and user-centricity.

For the civil servants involved in eDT the concern with timing resources was less of an issue, but, rather, the preoccupation that they may not be technology savvy. They showed distrust if they were not and impatience if they were familiar with technology, because of not proceeding fast enough

Competence in value chain processes and the ability to relate value creation to technology was the driving factor for user participation. Trust building was projected to the concrete benefits such competence would bring to the individual entrepreneur. However, the long term systemic changes of a living labs innovation approach would not directly track back to the specific input into the project. The input of time and resources was a hot issue for the rural entrepreneurs in the MDS case. Thus, once they realized the delay, participants revisited their strategy and did not deem the risks of the project as appropriate investment.

Among the producers as participants there was less preoccupation with technology as with receiving consultation on how technology enabled services made a case for business opportunities and increased sales. One of the producers in MDS was hesitant towards the suggestion that someone on the living lab team would come and participate in the work in the green house for observation of working processes. The response was 'Why? I thought researchers were supposed to be objective and focus on the development?' Rural users base their knowledge on practice. The above comment indicates that, as participants in the experimentation, the producers expect the researchers' team to be efficient and professional at doing science that translates into business. Participation in work with methods of testing, theoretical implications, hypothesis, outcomes evaluation, constructing new cycles, all this is time consuming while it produces only intangible results that rural users do not feel are useful for their daily concerns with energy, equipment, regulations, clustering and competition. Their role as stakeholders in the living lab team needs constant stimulation in order to enable them to foresee how the participatory living lab approach eventually benefits their interests rather than securing research funding for universities. This is a risk they are not prepared to take. Neither is human-centric and open participation considered a worthy investment per se by the local politicians, if the living lab work requires an inappropriate budget allocation from the point of view of the municipal assets for basic services.

3.6 Methodological Tools Enhancing the Human-Centred Approach

To achieve real life use and eventually commercialization of the innovation, constant negotiations concerning adjustments, costs, and resources were integrated in the technical development of the two ArchipeLabo cases. Tools for marketing communication and customer relations grew in importance as means to motivate participation and collaboration of the stakeholders in the real life environment. Involvement of a local expert and independent mediator with ties to both the producers and the municipality development functions plays a major role in experimentation in real life environments. These assumed elements of flexibility were not as such part of the actual experiments for the technical development, but they were essential for user participation. Although they may be questioned in terms of affecting the validity of the testing the approach needs to tackle the complicated real life environments of the chosen cases: in MDS, involved unbounded situations with mobile citizen and occasional visitors; in eDT, a sensitive environment of the democratic flow of decision making.

In emphasizing human-centricity ArchipeLabo aimed at collecting observations and recording methodological interventions in a dedicated research database. Through interactions between the research team and users as citizens, customers, competitors, or colleagues, ideas for improvement emerged concerning the application or the governance of local innovation. This new knowledge is relevant for understanding the real situational needs.

The ArchipeLabo put some effort into a collaborative application and data base that can take up users/stakeholders suggestions for targeted action. Ideas and knowledge can be stored and later benefit the work of developers towards follow –up project funding that can finalize commercialization Most importantly if the contribution by users/testers/ and co-creators is retained in a platform and research-infrastructure, the living lab framework enables future service incubation in support of rural development goals. A practical approach to the usage of such a collaborative research infrastructure to enhance a systematic human-centred approach was tested in connection to the MDS case. The outcomes allow ArchipeLabo to contribute to an upcoming national effort in dedicating funds towards a large scale research infrastructure platform for human-centred research mainly carried out in real-life open environments such as living labs.

4 Experimentation and Results

Experimentation conducted in MDS included selected producers whose farms are located along the main road crossing the islands and relatively close to the ferry ports. Logistically the distance between the farmers created challenges, especially the need for a larger experimentation facilitation than originally expected. Actual usage and situational context needed observation from the point of view of logistics, movement, and motivational patters, coupled with technical support. Another challenge was that the work processes of each farmer were somewhat distinct from each-other, especially due to the fact that seasonal dependency differed for open field or green house activities. Most importantly the derived business and revenue models differed. The result of experimentation was a consensus on a joint product range of fresh produce for direct sales supported by a forming a co-operative. This conclusion matched the farmers' wishes, but its process was delayed by formalities and distribution of new funding.

In eDT testing was more controlled. This allowed more frequent testing than in the MDS case. Although real life situations contained several technology related surprises and interruptions in the real life meeting procedures, the user involvement gave very positive results. eDT was less tightly knit with increasing sales than the entrepreneurs in agricultural products who are under pressure to use time efficiently with the prospects of increased profits. The IT companies as well as the civil servants and politicians involved in eDT were able to adopt to the experimentation 'mode' of the activities.

According to the C@R framework for implementing living lab experimentation the action research methodology of three months cyclic development was applied with better success in eDT than in the MDS case with its dependence on seasonal cycles of tourist flows. Managing the real life challenges of the research design and the respective tools corresponded to the level of control of the environment and the level of interdependency in the value chain network.

Evaluation of the results achieved through the experimentation cycles has ensued ways to improve action research as a methodology for user-centric living lab services which are going to be applied in the living lab in multi-actor partnerships and in-coming projects. Conducting cycles of ethnographic methods, such as audio and video data, as well as cyclic prototype testing using media documentation revealed that the analysis and learning processes need to be carefully managed as well as included in the governance structure itself with regard to longitudinal advantages of the living lab services. Interactions with users, observations and the generated data collected in different media would entail painstakingly devised analytical frameworks for analysis.

From the point of new ICT-enabled service incubation and its relevance to governance, the relations and tensions which have taken place in interactions with potential users and stakeholders, experimentations with selected users, and exchanges with other living labs need to be exposed. A detailed template was developed for capturing the data and to facilitate a systematic recording of the ethnographic material. The template and data gathered became the first script to be developed into a database infrastructure to archive and a wiki to share information. In a small scale separate project the need and user-centric functions of the living lab stakeholders' joint infra structure and data base attempted a clarification and simplification of the script, but more work is needed.

4.1 Indication of the Living Lab Potential

The evaluation of the living lab process as has been done on a continuous basis during the C@R project and has focused specifically on co-creation with users and governance of innovation for development. We have not chosen to use metrics to evaluate the experiments and the living lab potential in terms of impact and new software development. Our understanding of the process builds less upon quantitative metrics but rather on factors of integration user centric aspects in governance elements such as strategic planning, interaction within the involved actors in the living lab, facilitation of an innovation network, timing and sense of purpose, trust in the experimental interactions, interactive communication tools, and capacity building of the community.

A future analysis of the AchipeLabo is planned with funding from new national projects and will deal with behavioral change in the life of rural areas in connection to participating in innovation processes. Project proposals have been submitted both for the continuation of the eDT work and the extension of the MDS service.

The qualitative factors named above are expected to give outcomes on the quality of the experience of user-involvement, business collaboration, co-creation for RDI, collaborative learning, as well as the potential of the living lab methodology and services for the rural area.

During the C@R cases we regularly conducted interviews with the core participants who were elicited to evaluate the ongoing work and new emerging needs from the perspective of stakeholder interests. For the domain of governance towards a sustainable rural living lab we aim at proceeding into the follow-up projects by evaluating experimentation and the collaborative aspect from the perspective of potential for institutional change.

The relevance of the situational aspects delineated above lies in how they prepare the field for applying human-centricity in the local rural living lab environment. This closely knits the availability of envisioning a community's needs and the demands for strategic choices in rural development. Based on the work on the C@R facilitated cases these were easily pointed out by local citizen and businesses invited to participate, or they emerged while triggered by experimentation processes with the service technologies applications, reference architecture, or research platform, and as validation of information society and innovation policies at large.

A future analysis of the potential of living labs needs to respond to design and interpretative methodologies for arriving at outcomes in innovation services and governance, with impact on business models. The assumption for future living labs work is that rurally situated regional development which is oriented around user-centered and (action) research needs better tools to combine open innovation (management) and governance of innovative services for rural citizen and businesses. Both the MDS and eDT processes are yet continuing through spin-off projects they have generated, and more data is expected, which will allow a wider ranging evaluation and a longer term perspective analytical approach.

4.2 Relation Between Governance and Infrastructure

The plan for sustainability of the living lab builds on the concept of a supporting living lab interactions infrastructure and deriving data base. This was an understanding that emerged from the practical local living labs work. In an interview towards the end of the project one of the most active participants asked emphatically: 'Why did you need just me in the project? Tell me, what was the value of my participation?' No single information source exists yet that allows a complementary specific and unified view about the relationship between targeted domains of innovation during a project and its development activities. Several attempts had been made at living lab governance level, which are now followed by a formal, yet flexibly implemented, collaboration agreement between regional stakeholders.

What is available for the ArchipeLabo is a currently jointly orchestrated, general research infrastructure, and interaction-driven community-building service located with one of the project partners, the Turku University of Applied Sciences (TUAS). Rapid prototyping data is hosted on a general application server. For the developers, there is the typical development infrastructure such as developer server, email, and Wiki. The experimentation data is deployed on dedicated machines.

The most recent development concerning the municipal structure is the intention expressed by the deputy mayor for development to focus more on integration between departments. This may be an opportunity that allows the living lab services to generate an integrated view of the demands for services, workflows, best-practices, physical conditions, and the already existing infrastructure. Equally so, it is relevant from the angle of policy choices within the political and economic domain that dominates the rural environment: tourism, energy, resource extraction, agriculture. In the light of these core community issues a series of focus meetings on the potential of the rural living lab were organized with the stakeholders and will be continued as a result of the commitment of the cross-regional stakeholders and of the deputy mayor responsible for development and innovation.

The current joint understanding is that the best strategy for realizing the active participation of the local rural area, and thus majoring on the living lab potential is to direct efforts on the sustainability of the stakeholder community and of the living lab infrastructure. The idea is that this will provide better capabilities for timing and scaling, as well as orchestrating user involvement and the related communication processes. To this end a collaboration letter of intent as a pre-contract has been drafted to be signed by each stakeholder. The expectation is that this ensures future demonstrations of achieved outcomes, and future projects that provide a data bank of ideas, experimentation results, and expressed demand from users. The operation model thus starts off being mainly an agreement of commitment to a project driven collaboration and appropriate resources. Packaging services to create revenue may be possible at a later stage based on accumulating experiences. An improvement of the utilization of the collected data in the mostly jointly accessible living lab data base towards scalable innovative solutions will provide the value for the living labs long term business and operation model.

5 Towards a Sustainable Living Lab Business Model

The rural living lab in the Finnish archipelago has a clear objective for its operations. Research projects in the area have been traditionally plenty, but they have not functioned well for rural development. The living lab provides a way to improve this.

The ArchipeLabo stakeholders aim at a living lab 'service model' based on the above need to follow through product and service development for a longer period in order for innovative services to achieve commercialization. To this end the rural living lab stakeholders have agreed on a phased approach proceeding from a loose project-based operation model towards a business and revenue model coupled with a rural living lab service model for open innovation and user-centered approaches to development.

The ArchipeLabo service or business model in a second phase following the current agreement of intent is to provide expertise for applying human-centric research methods and serving as an incubator of services, and also to generate pre-market conditions for innovations. For a rural community this means that a rural living lab can ensure the presence of knowledge and tools required for the full (open) innovation cycle of new service ideas.

The stakeholders agree that commitment to an operational (business) model is needed if the living lab is to provide a framework and an infrastructure to persist with the user-interaction as part of the continuous process of innovation. Although currently the ArchipeLabo is a mechanism to generate new cases and new projects, there is consensus that added value for the communities, and involved businesses, emerges not just within the boundaries of a cyclic approach defined by the technological challenges of each case, rather by the context- bound local situation of use, or demand-driven processes. This will be the focus of the mutual agreement between the local multi-stakeholder consortium that has been set in motion by C@R and confirmed by a joint letter of intent.

With regard to their respective interests, the stakeholder constellation has made an effort to minimize complexity in the agreed operational model and governance of the rural living lab. The complexity derives from the fact that innovation through real life environment combines approaches driven by a different set of goals, mandates, and performance measurements for the regional development outputs. Based on the MDS and eDT cases different theoretical frameworks were exposed emphasizing human-centric methodology, innovation and business incubation. For fulfilling its function as a human-centric innovation environment the living lab currently relies on generating new project funding. However, aligning sustainability related to the innovation system with rural development rarely coincides with specific calls and their objectives.

Through C@R facilitation ArchipeLabo has initiated discussions with a large number of stakeholders representing different development functions, including research and education, included research and education, of the wider region, covering several sub-regions [3]. This results from the fact that there have been expressions of interest from other municipalities and research institutions which see the potential of the real life experimentation facilities. The governance principles of such an urban-rural living lab partnership are i) framed within this year's intention agreement to project-driven continuation of the living lab consortium, also ii) including cross-living lab collaboration, which marks iii) the start of a resolution through a thematically defined collaboration and iv) business and service model.

6 Evaluation and Conclusions

First, the human-centric living lab approach is a key competence to achieve the goals of rural development; it assures participation of users and stakeholders towards service incubation and collaborative practices. These are necessary in order for the human-centric methodology to fulfil the functions it defines for the actors in the innovation system. What this requires from each of the stakeholders or stakeholder groups has been illustrated in this chapter through the processes of the two cases developed by ArchipeLabo within the C@R project.

Second, in the socio-economic context of the archipelago, the expectations lie in a societal relevant innovation for services. ICT-related experimentation forms only part of the process: governance, logistics and revenue models have constituted bottlenecks in proceeding from experimentation to actual commercial use in a timely manner. Thus, integrating the collaborative platform with the objectives for rural livelihood was recognized by the stakeholders as the immediate need for a functioning rural living lab that supports sustainable governance and service provision.

Third, the cases implemented in the project have strengthened the belief in the potential of rural living labs as instruments that further information society strategies at local level. ICT-enabled services increase the chance to improve and to surmount hurdles of distance and seclusion.

Fourth, the cases have also indicated that in the localized innovation environment pre-set structures need to be revisited to build up collaboration. This was successfully achieved in the eDT case. In the MDS case the process has to be continued to answer the challenges of a jointly public private service provision.

Fifth, the living lab framework applied by community stakeholders provides important services and collaborative practices needed for rapid prototyping. In the case of ArchipeLabo the collaboration agreement to be signed by the end of 2009 is the prerequisite for achieving scalability, and for new living lab projects generation. The four submitted project proposals aiming at scaling, expanding, and elaborating on the C@R cases is evidence that the living lab has achieved the conditions for functioning as a project-generator and service incubator. The level of collaboration reached leads towards sustainability of the living lab community. The renamed rural living lab, 'ArchipeLabo', will focus on two areas initiated by C@R – eDemocracy services and business incubation combining SMMEs as producers with tourism –, and in addition eHealth and agriculture projects have been identified. This will affect directly several key sectors of the life of local community and businesses.

Sixth, the impact of the living lab is shown by the ability of the rural living lab to collaborate with the urban living lab activities in the city of Turku on the mainland. The rural living lab has functioned as a seed for the collaboration, has triggered a new understanding on how to bridges the interests of the urban and rural perspectives. The Turku based universities and the Turku Science Park, are consolidating their activities for the urban living lab based on the experiences conveyed by the ArchipeLabo and on its future business model for the research centered platform. This provides a back bone for the sustainability of ArchipeLabo.

Seventh, the achieved results of rural innovation environment of the archipelago are a show case that distance and seclusion can breed an innovation environment. However, the locally situated realities of the daily life of the islands population have driven the work, but have not yet solved the issue of how to define the role and improve the efficiency of openly governed networks towards innovation and arrive at a rural empowerment activity with tangible benefits.

Thus, the software development work in rural living labs obtains a socio-political function as it is embedded into issues of user involvement and human-centric implementation for raising local well-being and competitiveness. Based on the experiences of the C@R work in the Åboland Rural Living Lab, renamed as ArchipeLabo, user and demand centric approaches are reflected in strategic governance decisions. Highest priority is given to fulfilling the promise to citizen with regard to inclusion towards improved innovative services. Equally, the result is that the community can function as a link to the innovation system at large. However, its governance is to be resolved, and before that some basic factors of the methodological approach need to be clarified, which has been one of the aims of C@R.

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Chapter 10

Frascati Living lab: An Innovation Environment to Support Business Incubation and Agriculture

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Abstract. Living labs are innovation platforms that bring together and involve all stakeholders, such as end-users, researchers, industrialists and policy makers, in early stages of the innovation process, in order to experiment breakthrough concepts and create value for both society and users. The Frascati Living Lab experiments a collaborative platform to support the development in real life scenarios, experimentation and operations of innovative applications involving incubation processes and more traditional applications in sectors such as environment, agriculture, tourism and eProfessional services. After describing the living lab methodology and platform, including the basic collaborative elements (users, services and data), we describe a pilot use case for precision farming in which the collaborative effort within the Frascati Living Lab is illustrated and discussed. Finally, results and improvements are analysed to find the best business ideas and solutions for the future of the rural environment.

Keywords: Agriculture, Incubation, Breeding ground, Business model

1 Introduction

This chapter explains the work carried out during the C@R project [1] in the context of the Frascati Living Lab, taking into account the applied methodology on identifying and engaging users and stakeholders, the different collaborations among different European projects, the performed experimentations and the achieved results but highlighting also the problems and difficulties met during the three years [2]. Frascati, a small town South-East of Rome, and its surroundings is famous because of the fine wine, but also because it is an area rich of natural and archaeological heritage. Frascati is considered not only as a rural area in close proximity to a city – Rome – which influences the small town and the surrounding country on economic, social and environmental issues; but also an area of primary production where inhabitants are getting their income from agriculture, specifically from the production of wine. As evidenced in a case study performed within the Frascati Living Lab, the urban growth of Rome has a constraining influence on vineyard and agriculture areas in the periphery overall and specifically in Frascati.

The chapter addresses processes, technologies and methodologies applied during the C@R project in the Frascati Living Lab (see [2, 3, 4, 5, 6]). It provides an overview on the Frascati area and its background following with the description of the methodology generally used by the living labs with specific focus on the Frascati Living Lab. We discuss the collaboration platform that has been designed and deployed and the collaborative applications developed for the different scenarios. A summary of performed experimentations follows including lesson learned. Finally it is discussed the opportunities to create a sustainable business model of the Frascati Living Lab in continuing to support the local and rural innovation environment.

2 Description of the Living lab

2.1 Rural Innovation Environment

Frascati is unique in Lazio and even in Italy being the most populated and still growing technological and research area. Many SMEs are dedicated to innovative sectors, offering a home to many institutional centres, including the campus of the second University of Rome Tor Vergata, the technological centre of Banca d'Italia, Italian largest Nuclear Physics Laboratory INFN, the technology centre for nuclear fusion ENEA, an important CNR site and the ESA Frascati establishment. The Lazio region considers innovation as a key-element of its regional economical development policy. It is supporting the implementation and further developments of an infrastructural system at regional level via a project called MEGALAB which represents the starting point of a distributed regional infrastructure providing high speed connectivity across major science institutions from the region (including ESA-ESRIN, CNR, ENEA, INFN and the university of Tor Vergata) with the Regional connectivity system for remote villages. These aspects shape the area as an extremely suitable location for experimenting a rural living lab dedicated to the exploitation of innovative services for, e.g., e-government, urban, environmental services, e-health, education, training, tourism, culture, and multimedia. Moreover during the last years the situation of the grape cost, which highly concerns the local farmers, required a high level of attention.

2.2 Stakeholders and their objectives

The Frascati Living Lab stakeholders can be categorised in six different main groups: ESA; Public institutions; Universities; Networks of Living labs; SMEs; Local and European Projects. In Fig. 1 these groups are displayed in the core circle. The second circle lists the principal partners of the Frascati Living Lab. On a lower level other important actors are defined (see the more outside boxes). The image contains just a snapshot of the Frascati Living Lab collaborations, since the interchange among the partners and collaborators presented a high dynamism. All the stakeholders continuously contribute to the living lab system with their own experiences, feedback about idea to be discussed and technologies to be tested, further data and knowledge (i.e. the value added component).

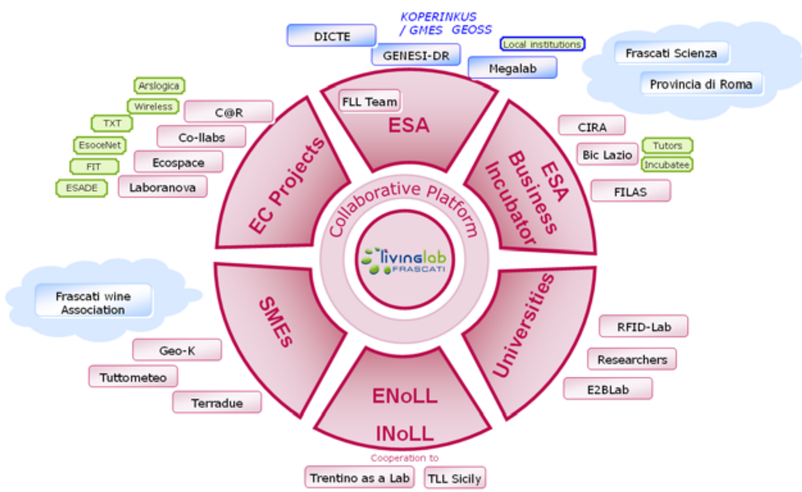

Fig. 1. Frascati Living Lab environment

Stakeholders currently involved in the Frascati Living Lab can be also distinguished into two other different groups:

- Strategic stakeholders from both the public and the private sectors (innovation agencies, companies, local/regional government, SMEs, research, etc). These comprise public institutions interested to e-governance and innovation; innovation centres such as BIC-Lazio, FILAS, Sapienza Innovazione; administrations at community, province, region level (ARSIAL, Parks agencies), science and technology centres

(CNR, universities, ENEA) and SMEs and service industry, including agriculture operators;

- Stakeholders participating in testing and experimenting: out of the strategic stakeholders a specific set of persons are selected which are involved in testing and experimenting the services and applications, as well as the data used. Those stakeholders act as a steering group interacting with the Frascati Living Lab developers, establishing "participative design and development" in technical activities and activities related to observation, learning/evaluation and training (University La Sapienza, Tuttometeo).

2.3 The Living lab and the Rural Innovation System

The Frascati Living Lab demonstrates to be a best practice for different aspects of interest for other living labs. The key point of the Frascati Living Lab is that it is proposed as an exchange and meeting platform among users, research and industry. In this sense the Frascati Living Lab acts more than a simple catalyser for the realisation of innovative process. In fact it includes a set of added values that provide uniqueness and competitiveness to the process itself. In this context the Frascati Living Lab provides key innovation features, such as:

- A competence network based on the living lab progress as itself as well as on the collaboration with other European living labs;
- An Open Architecture standard to ensure the reuse, interoperability of application developed in different contexts;
- Integration capabilities to allow a unique access to the system including Grid processing, large data repositories, etc.;
- Dissemination and networking of the Frascati Living Lab being the central point for preparation and host of meetings, conferences, workshops including people with high competences in previous mentioned sectors.

2.4 Evolution of the Living Lab

During the three year C@R project lifetime, Frascati Living Lab has followed an evolution ([2]). It started to identify different innovation scenarios, communities and stakeholder groups. The interest of the Frascati Living Lab was initially directed toward two communities related to two different scenarios: precision farming to be applied on the Frascati surroundings, and incubation scenario to enhance the possibility of success of new business companies and help these new incubates and candidates to participate on projects call. For each scenario different use cases were identified: for the incubation they referred to the support for start-up of IT companies and for enterprise development whilst for the precision farming they included the Phenology information access and the support to relations with company management bodies. During the three years the scenarios and use cases evolved rapidly taking into account the needs of the user communities and the response obtained by the stakeholders involved to participate and their possible contribution. Besides, an interesting pilot was added testing tools that have been provided in close collaboration with the ECOSPACE project. Thus a third community represented by the e-Professional scenario was added to the project. At the same time, in order to enable the communities to be supported by the project and to establish different experimentation environments, during the years additional projects, collaborations and agreements took place.

3 Methodology

3.1 Living Lab Development Approach

The methodology adopted by the Frascati Living Lab was based on the methodological framework of the C@R project. Four principal development phases were identified: Preparation, Limited experiments, Wider-scale experiments and Co-creation. During the **first phase** of preparation, areas of innovation were identified, a wide group of users and stakeholders was formed and communities were launched for future experimentation. Scenarios and use cases were identified and prepared for next phase implementation. In the **second phase** a simplified initial implementation of the analysed scenario ideas was realized. Although some developments and implementations of solutions were provided, at this point the Frascati Living Lab continued with the road map, without obtaining however a purposeful response from the final users involved into the communities. Also within the **third phase,** not all the operations indicated in the previous phases were followed: depending on the situation in which the Frascati Living Lab was involved and the stakeholders' turnover, some ideas of solution to support the initial scenarios and use cases have dynamically changed. Some tools and components shared among other living labs were integrated into the architecture although a part of that could not be validated directly from the users. The **final phase,** which indicates the last months of project experimentation and shows the co-creation of the solutions and services with the final users, was instead a continuation of the third one, because the development of solutions wasn't ready to be delivered to the final users to be tested as final product.

3.2 Cyclic Development as Living Lab Experimentation Approach

The cyclic development strategy pursued in the living lab approach, in particular regarding the involvement of the users for co-creation of tools and services, has passed several phases in which some applications or services were updated depending on the feasibility of the tools themselves and the interchange of different stakeholders. Following the main idea of the project, the developed infrastructures and tools were initially designed during the first phase of preparation taking into account the requirements proposed by the users at the first meetings (see [2], [3], [5]).

Regarding several applications evaluated as candidates to be included into the platform, a lot of work was done, although the effort was not always in line with the cycles milestones. This aspect was different in the three communities. On the precision farming, for example, the first design of the application plant life component (PLC) was initially performed with the collaboration of the users and other stakeholders that were attending the first meetings. They were mostly agronomists and partners of other projects related to rural aspects. Realization of the component has initially started with the involvement of users directly connected to the vineyard scenario, however during the development, not many tests and experimentation activities were performed due to the difficulties encountered to obtain contribution from the users itself.

3.3 User Engagement Approach and Results

As “user” we consider not only the classical end-user who takes advantages from a service or a product, but in a more general context also the stakeholders that are involved within the project, which are able to operate also as final users taking advantages from the solution provided by other stakeholders. User involvement in the Frascati Living Lab covered various aspects. First of all, a community of knowledge and interest amongst stakeholders was created, enabling participants to meet each other both to disseminate expertise and technology and to get information on activities performed by other potential partners. Stakeholders involved in this process had already been contacted and invited to collaborate to the project. To this end, periodical meetings have been organized to maintain a “high” attention and to give continue feedback to involved or interested stakeholders, to augment trust and credibility. Meetings and teleconferences were done also directly with specific parties to discuss possible new elements and opportunity to support and enhance the vineyard managements.

Although user involvement is a highly important aspect of the living lab approach it was very challenging to achieve this goal in all cycles. Starting from the first period where specific needs were analysed thanks to the initial feedback by the users, users involvement was not constant in all the communities, cycles and phases. For example, although in the incubation and e-professional the number of users is much higher than the one of the precision farming community, the results obtained from the survey for the operations and experimentations are mostly the same.

In order to establish a committed user group which could support continuously the Frascati Living Lab operations during the cyclic phases, the living lab continues to contact other research centres, local SMEs and institutions in order to find an already experimented or possible innovation idea to be realised in the living lab. This aspect is one of the important roles which a living lab must fulfil to improve the collaboration along the lines of public private partnership (PPP), thus stimulating sustainable innovation and collaboration among these actors.

3.4 The Living Lab as a User Driven Open Innovation Approach

A living lab often is considered as an innovation environment where end users participate in the innovation process. In the Frascati Living Lab this concept is moved towards involvement of stakeholders, from agronomists to pesticide business companies, from institutions to local business companies specialized in creating technologies for farmers support, like maps and GIS management. The basis for strategic development of a rural living lab is in establishing a sustainable stakeholder partnership [7]. A useful starting point is the business design concept. This concept is looking at the totality of actors and resources needed to implement the partnership and create value. Users, policy makers, companies, researchers enter into agreements on the basis of which they may engage in long-term collaboration. This concept allows us to look at a living labs innovation system from the perspective of a value system and the cooperative roles of actors, including users.

4 Collaborative Platform and Applications

4.1 Scenarios and Use Cases Explored; User and System Demands

For each of the three user communities - Incubation, e-Professional and Precision Farming – we developed one or more scenarios that were born right at the start of the project or developed during the project, thanks to the initiative and feedback from users and stakeholders as well as from the collaboration with other projects and living labs.

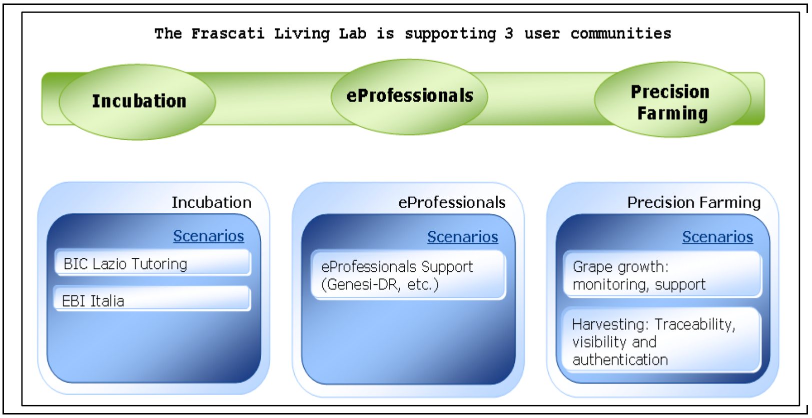

Fig. 2. User communities and user scenarios.

The incubation community is composed of research institutes, project partners, institutions, university, and users which are working together performing different actions. The community supported the Frascati Living Lab team in the co-creation of scenarios. Then the evolution of the co-creation and collaboration follows the living lab methodology already explained. Two scenarios have been defined: (1) BIC Lazio Tutoring and (2) EBI Italia. The incubation scenario is created around the process related to the daily work conducted by an incubated company that has already passed the pre-incubation phase. The main scenario needs are mainly related to collaboration, that means to have the capability to share and manage documents, discussion amongst partners and to disseminate results. The incubation scenario was elaborated and adapted taking into account the collaboration with the ECOSPACE project, in which the Frascati Living Lab is considered as a pilot living lab devoted not only to incubation community, but also to eProfessional one as well.

For the e-Professional scenario, the final users were asked to adapt the scenario according to their actual business processes to fit as much as possible with their daily activities and overall business model. In this environment research institutes, project partners and users have defined one scenario eProfessionals Support, aiming to support the user group of the Genesi-DR European project. This group is working continuously in utilizing the collaborative services provided by the Frascati Living Lab pilot and the feedback generated by the group is important for the implementation and the realisation of new tools for professional work.

In the precision farming community, the involved research institute, project partners, SMEs, university and users worked on two scenarios: (1) Grape growth: monitoring, support and (2) Harvesting: Traceability, visibility and authentication. The first scenario was modified based on experimentation results. Several internal discussions as well as feedback from a winemaker led to improvements of the scenario to represent a real use case. However due to the delay on the component supply, and the passed period for the harvesting, the second scenario was not completely tested, but the sensors have been deployed into the vineyard for possible future experimentation.

4.2 Collaboration Platform, Architecture, Components, Services

As starting point of the over-all living lab, the web portal is the first access point for users into the community. Users can register and log in into the portal to collaborate with the whole community. From the web portal it is possible to move to the other services available for the registered users. The web portal was deployed thanks to the Open Source Application Server Jboss. This Enterprise Applications server was necessary to integrate in the same architecture also the Josso component to provide a Single Sign On to assure the authentication and authorization of users. The Josso allows the users to operates among the Portal and other integrated applications - such as the Plant Life Component, the Web map service (Ka-map) - using the AAA protocol (Authentication, Authorization and Accounting). Finally the open source application server Tomcat is used for the deployment of the Frascati Living Lab portal and other applications which exploit the Java environment.

In order to better share the developed services among the other living labs, it was installed the Bus component within the platform. This component is the core of the C@R architecture because it permits to other living labs to reuse services already developed and deployed in some living lab to improve the offer of services among other users' community. Until now two components developed for the Frascati Living Lab are shared among the living labs: ACC and UPC. With this aim, every specific component can be orchestrated in order to create a more complex application; in particular the PLC component uses the ACC and UPC to make use of their service: automatic email sending and user profile.

4.3 Collaborative Applications Developed, Testing Results

The identified scenarios and use cases comprise a set of applications that has been developed to support them as well as tools to be integrated. The components developed and tested are various. Starting from the most simple and arriving to the most complicated they are:

- ACC (Asynchronous Communication Component),
- SMS_CCS (Short Message Service CCS),
- UPC (User Profile Component),
- MFC (Meteorological Forecast Component).
- WSN (Wireless Sensor Network),
- Web Map Service (Ka-Map),
- PLC (Plant Life Component),

- BSCW platform (Basic Support for Cooperative Work) with plug-ins (Marte videoconferencing, Group Blog, Upload and Notify, Team Builder). This set of tools was provided by the ECOSPACE project.

Most of them are compliant with the C@R BUS and can be reused also on other compliant living labs. For the Frascati Living Lab the PLC component identifies the core of the application for the support the farmers. In this application different components are orchestrated and integrated: the ACC to inform farmers on risk and reminder, UPC to allow each farmer to visualize only own information and data, the MFC to have meteorological forecast for own fields and the WSN to monitor fields' parameters with sensors deployed on vineyard. The SMS component was just installed into the portal to allow registered users to send SMS to other farmers and collaboration. The ka-map application implements a web map server with high resolution remote sensing images obtained by the ESA's satellites to monitoring some characteristics of the vineyard which can help the farmer to decide which actions to perform on field. Finally the BSCW application with its installed plug-ins is used for the Incubation scenario on supporting the several aspects of the incubation in which the ESA as first, and Frascati Living Lab as second, is involved. The BSCW platform is also tested in the e-professional scenario to monitor the improvement that the professionals can have in their life and work with these technologies [6].

Some particular testing phases were organized, in particular the SMS service for the meteorological forecasts which were provided users with SMS every evening for own fields. This experimentation was operated with the funding of the Frascati Grape Producers Association which was very interested on this and other solutions presented by the Frascati Living Lab. Also the Arsial - Regional Agency for Agriculture development and innovation - became interested to the experimentation and to the results, which experienced a high level of interest of local farmers. The testing phase for the fields’ monitoring with PLC received a low result due to the difficulties to involve farmers to test an electronic application.

4.4 Sharing and Reusing Technologies, Services and Components

The importance and power of the C@R services resides in the simplicity of tools and the possibility to be used in different scenarios and contexts. The Frascati Living Lab together with the collaboration of other living labs and partners has developed tools according with the main lines indicated by the project allowing the services to be shared easily (see [2, 5, 6]). The User Profile Component (PLC), developed firstly for the Frascati Living Lab, was shared with the Cudillero Living lab to improve and manage user accounts. The Asynchronous Communication Component (ACC), in charge to deliver email to the final user, was integrated into another user application developed for the Czech Living Lab: CCSOgc and CCSMapViewer. Within the Frascati portal a new simple component which is able to deliver SMS was successfully integrated. Such component presents the same basic simplicity of the ACC component and can be substituted or added to the channel of communication to warn users in specific use cases of the PLC. The SMS_CCS was developed initially for the Cudillero Living Lab and then shared with the Frascati Living Lab.

5 Living Lab Experimentation and Results

5.1 Objectives of the Living Lab Experiments

Frascati Living Lab together with the other Rural Living labs of the C@R project worked to achieve the principal goals of the project which are:

- To provide a collaborative platform for rural communities, defined in cooperation with other Collaborative Working Environment communities;
- To demonstrate the use of the same platform integrating various tools for various rural user communities;
- To promote the user centric Open Collaborative Architecture (OCA) in the industrial, new business opportunity and emerging rural sectors, demonstrating its affordability and usability;
- To develop a common methodology for rural living lab developments and assessing benefits of results;
- To support Policy Makers addressing which EU Policies are needed for Innovation and Rural Development in 2010.

Further specific objectives of the Frascati Living Lab are also to evaluate the found solutions for sore points with the involvement and feedback of users; to urge on the local policy makers to increase the attention on the farmers' problems; and to stimulate contacts among SMEs and local farmers to induce more collaboration among them and increase the technologies used on farming.

5.2 User Validation Cycles and Results

During the experimentations of the Frascati Living Lab the phases identified by the C@R project were followed with certain rate of flexibility. In particular regarding the activity of validation with the contribution of the end-users, difficulties emerged to obtain feedbacks and to implement public tests to prove the real usage and good quality of the products. The experimentations were thus done essentially into the internal team and the validation of the components above all in the precision farming respected the point of view of stakeholders involved and sometimes of the unique available active end-user.

On the Precision Farming community, the Plant Life Component passed various phases of experimentation within after the first analysis the user's feedback was relevant to refine the solution. The experimentation started with a simple agenda where the user could monitor the activity done and to do, just as a simple reminder. However during the first phase, at every meeting to present the product's changes, the farmer expressed his willing to have in a unique point integrated all together different solutions already developed and available in other applications and locations. So - to satisfied the user's request - some aspect have been changed during the works introducing also other services to monitor the vineyard in real time with the introduction of the meteorological measurements into the PLC application. This provision of new applications provided a considerable added value to the system since it supported the user with the possibility to monitor the vineyard, and also to be warned when some particular event, depending from the weather, could occur and create some damage to the vineyard.

On the eProfessional community side, experimentations and validations were done with the introduction of a procedure named Tool of the Month (ToM), which has identified some tools to be added to the collaborative platform BSCW and then tested for a month or more. The experimentation was divided into two phases: pre-launch and launch. During the pre-launch phase the team operated internal tests and when the tool seemed to be good for the public, it was presented for the evaluation by the users. The user group involved in such testing activity included a quite relevant amount of professionals involved in EC projects (Genesi-DR) but the amount of feedbacks was not as expected. Therefore additional users were gathered coming from additional environments and from the internal coordination team also.

The pilot use case for Incubation communities started to operate supporting incubated companies that already have passed the pre-incubation phase in the phase of developing a new product, using both new services and data. The scenario was composed of six main planned phases: (1) a customer commits the incubated company to develop a new product; (2) other partners and experts, with complementary competencies, may join and engage in joint development using Frascati Living Lab collaborative services (documents sharing and co-creation, development support tools, communication facilities, web portal services, etc);(3) creation of the joint proposal; (4) evaluation of the joint proposal; (5) development of the product; (6) testing the new product in the living lab (if applicable – depending on the actual nature of developed product). Unfortunately these phases were only partially applied due to some delays in the real start of the formal collaboration between ESA and BIC-Lazio. At the moment, the activities of preparation of the infrastructure have been completed and the infrastructure itself (based on BSCW) is getting used in the context of EBI-Italy incubation programme.

5.3 Examples of User Co-creation

The user of the precision farming community proposed to produce a tool to monitor the environmental and plants situation and to help him to organize all the work that needs to be done. The Frascati Living Lab responded to such expectations with the Plant Life Component (PLC) and its modifications. The farmer, which was used to test the application, provided various comments and suggestions for each new released version.

During the face-to-face meeting for the presentation of the PLC changes, some questions and remarks were advanced by the user while the services were still under development; the user raised some issues and in the same time promoted some way how to solve them. The main suggestions were around the possibility to have a unique access point to an application to manage and monitor the state of the fields. This application should have supported the farmer to take decisions remembering actions to do, showing important parameters to prevent bad crops.

A similar contribution was given by the farmers involved to test the experimentation for the SMS meteorological forecast. The users which collaborated with the developers exchanged some emails when the SMS forecast experimentation was performed. Within the emails exchange, the users explained their idea about the SMS' template to be received and at which time of the day. After some tests, the developers updated several template versions until the best solution was achieved. The forecast SMS service is at this moment active.

5.4 Evaluation of the Living Lab Experiments

The scenarios were validated directly on field that is when the final users were concretely involved, evaluating developed services, infrastructures and so on. The validation of the tools have been done with a limited number of users, such amount needs still to be increased in order to gather much more remarks and points of view. The more the users and the more the points to analyse are, the stronger and more precise the innovation of the technologies and tools in the rural system is. Another point to highlight is that the Frascati Living Lab platform provides different services but not all users made advantage of these. Very often the development and the integration were thus quite slow due to the few and generic feedbacks obtained.

The collaboration with BIC-Lazio led to the EBI Italy initiative where new incubatees are taking support from the experience and space technology of ESA and from the business competences of BIC-Lazio. They are bringing new ideas and establishing new business networks taking advantage from the collaboration platform provided by Frascati Living Lab. At the moment six new born companies with technologies spanning from fluido-dynamic solutions to Geospatial data management, wireless communication, environmental data processing and other are on the road to develop innovative solutions and further to face the market environment. The number of new companies to be incubated is planned to increase at least up to ten into the 2009 and to continue with new entries in the next years.

6 Future Sustainability

6.1 Living Lab Benefiting the Rural Environment

During the period in which the Frascati Living Lab has experimented new technologies and facilities for the rural environment, several aspects and results were achieved in general. The main categories indicating impact on rural development are: impact on the rural innovation system, impact on current rural policies, business and entrepreneurship impacts, social and individual wellbeing impacts, and impact on internationalisation. For each of these points the Frascati Living Lab has operated to improve the local business and to take new opportunities for the local area ([6]).

The first innovation brought to the communities is the utilization of collaboration tools, very important to share info about every business rural area. In the vineyard, which is the main aspect of the Precision Farming community, it is very important for the farmer to know the actual situation of his field, and to have the possibility to be warned in real-time about any possible risk to cope with. All these information are always available for the user and the business take advantages from this, first because there are a lower use of pesticide, which means low money and second because it contributes to provide a more genuine product.

Regarding the e-Professional, the tools provided to enhance the productivity met some resistance in using them for the first time. We have to keep in mind that even for technical people time is needed to accept new tools that potentially can change radically their habits. So, often, although previously requested, not all the features provided in this timeframe from the Frascati Living Lab have been systematically used: sometimes classical email is still preferred to more updated and integrated alternative services.

6.2 Business Model of the Living Lab

The Frascati Living Lab community members (public organizations, thematic associations and SMEs) contribute their working time, software and services towards the development of the Frascati Living Lab. For example, ESA allocates post-doc research fellowships of two years to be used towards the strengthening of the Frascati Living Lab and its services.

Individual researchers employed by various organizations also contribute a part of their work for the Frascati Living Lab.

Additional funding is envisioned to be received from other R&D projects. It has been established an agreement with the MEGALAB regional project which is dedicated to a fast connection network. It envisages adopting the Frascati Living Lab as a collaborative platform for supporting small enterprises with the experimented e-professional tools and the GRID service available. The same GRID architecture and collaboration platform are in phase of decision to be used by another project which started recently: MedLab (Mediterranean Living lab).

Another important opportunity which can support the Frascati Living Lab on continuing to extend its work already done on the Precision Farming community is given by a regional call where a SME has just applied. This call regards the technological transfer from Regional Scientific Research Centres to regional SMEs. In this context a new agreement was established with the department of the Tuscia University near Viterbo in Regione Lazio to create a new team in order to design further functionalities and enhance the already structured platform of the Frascati Living Lab. All the services are thought to be very useful and exploited by the whole farmer's community in Regione Lazio and not only.

6.3 Sustainability of the Living Lab

Once the Frascati Living Lab has been able to further develop its service offerings it is likely that organizations will be paying for the services to cover the operational costs [7]. Frascati Living Lab developers foresee that in order to be sustainable it needs to be able to offer a consistent platform of collaboration services to support small enterprises (incubatees or already established businesses). This platform can represent a "digital business ecosystem" which would provide technologies and services that target real business needs.

Regarding the funding possibilities in the not-so-near future, private sponsorships are already being sought. The operation of Frascati Living Lab shall in the future be turned over to a new organization (public or private). For this, as already experimented within the CERN, the Frascati Living Lab has already presented a proposal to convert a simple living lab into an Open Living Lab which is legally qualified to accept private sponsorships. It is seen that the Frascati Living Lab needs to be recognized as a legal entity. In this context the living lab will have a financial sponsorship from interested ICT Industries and local Institutions, to provide fellowship to young researchers for experimenting Space application using emerging ICT technologies. The Frascati Living Lab has already had a good response from the INTEL Industry, well disposed to get involved into this solution, which has already provided hardware solution for the aim: four high level machines on which are installed the GRID platform used to run the job for the GRID processing.

6.4 Outlook

As explained above, the Frascati Living Lab is also considered to be a particular type of living lab, where ideas are born, developed and realised emerging from a stakeholder community. This “breeding ground” character is one of the principal strength points on which the Frascati Living Lab mostly works and is embedded in the region. The networks of Italian and European living labs are very close to the Frascati environment and continuously exchanges of points of view are discussed. A strong collaboration with the stakeholders and partners brings even more new perspectives and opportunity to be exploited. This collaboration is also expressed on co-operations for proposals to be presented both at local (regional, national) or European calls. The items of such collaboration are basically following the experimentation on precision farming environment on which the Frascati Living Lab has worked.

7 Conclusions

7.1 Living Lab Results and Methodologies

As previously stated the process of requirements capturing / gathering was quite complex, due to difficulties to involve end users and to communicate them the nature, spirit and objectives of the living lab. There was a long process on deciding which methodologies to use: questionnaire, use cases, scenarios, interviews, meeting, and so on because of different natures and development status of different living labs. In Frascati Living Lab it has been chosen to use tailored questionnaire, scenarios, meetings and storytelling. To specify concrete requirements has been a delicate task. It frequently happens in fact that the user - answering to a particular question - unconsciously identifies and focuses on a specific potential solution of his concrete needs.

7.2 Innovations Generated in the Living Lab

As regard the first aspect, the quality of life can take great benefits by mean of specific collaboration tools: on precision farming, the working activities receive a substantial support by mean of remote monitoring which avoid the continued presence of the farmer on the vineyard. The collaboration aspect also shared by the incubation and e-professional communities where the collaboration tools provide the possibility to work remotely and to meet people in video conference without the necessity of travelling, simplifying not only the quality of work but also improving the quality of life due to better working ambient and less critical aspect on organising meeting, sharing documentation and doing all the operations necessary for the work. Innovation, however, needs time and a remarkable start-up effort, thus schedules needs to be continuously re-planned according to changing in user needs and availability: the choice of a dynamic environment as the living lab just emphasizes this aspect. Moreover the importance of a correctly dimensioned ICT infrastructure in a rural area is relevant since it represents a great support to introduce innovation into the communities and thus to reduce the effort to bring the new technologies and let the people take benefits from them.

7.3 Impacts of the Living Lab Work

The impacts of the tools developed and provided with the living lab innovation are important and useful for the life and work into the rural area. In our case, the tools are a directly response to the users needs and their utilization brought a relevant added value for the wine growing and not only. Moreover, as regard the tool development process, the main concept of co-creation and collaboration among stakeholders has been reflected into the implementation of functionality and services integration. This led to customised and integrated tools that do not solve only specific problems or support single activity of workers but assemble contributions coming from different sources to support directly the user "as a whole".

The BSCW platform provided by ECOSPACE has been adopted in all the three communities: it increased the quality of collaboration and influenced the over-all productivity (time savings, work efficiency), although these data at the moment are not quantifiable.

The application of the Frascati Living Lab to the precision farming community created a first relevant bridge between two opposite faces that – in a some unusual way - coexist inside the involved territory: on one side the agriculture activity (specifically winery) that is performed in very traditional way and that is suffering from aging of farmer and progressive cropped field area reduction due to urbanism, on the other side the massive and concentrated presence in the land of high technological research centers. Such collaboration brought local people and farmers to take consciousness about the possibilities offered from the research on the territory and to reduce the resistance to apply innovation. This is specifically witnessed with the participation of local farmers to specific organisations that are moving to play for technology in the wine producing (Frascati Grape Producers Association, Consorzio Tutela Denominazione Frascati etc.) as well as with their availability to participate as partners in proposed European projects, also supporting from the beginning of the writing of proposals and using the specific tools offered by Frascati Living Lab (for example, the shared workspace platform BSCW).

7.4 Lessons Learned

During the project we experienced a rather slow process on testing and also some difficulties to involve further users. On the other side the methodology introduced by the living labs showed a lot of improvements in term of innovation and brought a new type of collaboration on the business process. What we found is also that a need of increase of the collaboration among users and stakeholders is evident in order to avoid any misunderstanding and to accelerate the process.

This new type of collaboration explored during the project period - which involved users into the most part of the phases of the business process - sometimes revels the restive aspect of people involved, toward the changing. However the process of changing mind and habits of persons and motivating them to use collaborative tools is not fast and linear.

Anyway, the line followed by the Frascati Living Lab within the project brought to keep in life the huge number of collaborations born during the project or not. This aspect was a typically feature of the living lab in which even more collaborations and co-operations are established as a continuous "breeding ground" in which the idea are discussed and promoted.

It has to be considered that the massive involvement of stakeholders in relation to the limited number of simple end users can represent a limiting factor inside the living lab management since they can move the implementation toward a technology-push point of view rather than maintain the user-centric approach. Moreover the open environment of the living lab framework and the consequent dynamic and irregular participation of the stakeholders requires in fact attention to maintain the level of the agreed collaboration. Changes and additional opportunities occurring during the timeframe although potentially powerful needs to be controlled to not interfere into the regular development of already running activities.

As conclusion it can be said that the concept of a living lab in which users, stakeholders and developers collaborate to achieve a final aim, appeared to be a good practice to be applied in the Frascati area and a relevant opportunity of business. This is mainly due to the offered opportunity to operate closer each other, limit the spent efforts and reach the identified solution in a minor time. Moreover achieved solutions are able to represent a real response to the needs of communities.

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Chapter 11

Assessment of Results and Impacts of the C@R Rural Living Labs

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Abstract. This chapter presents a methodological framework elaborated in C@R to evaluate the results of living labs and their impacts on the rural areas where they have been developed. It is discussed how this framework has been used to evaluate the rural living labs. The results achieved in the living labs are summarized and the impacts of these results on the rural environment are analyzed. We present recommendations related to the role of living labs as engines of innovation, driving rural development. Finally, we discuss lessons learnt regarding the way to measure and assess the results and impacts of living labs.

Keywords: Living Labs, Evaluation, Impacts, Results, Monitoring, Added-value.

1 Introduction

User driven innovation principles are based on the idea that technology providers possess a deep knowledge on the technology possibilities and solutions, while the users possess the knowledge about needs and operation environment restrictions. This information is sticky and can therefore not be transferred easily between the users and technology providers. In order to provide an integrated approach to user driven innovation, the living lab approach has emerged; within C@R, a living lab approach has been developed dedicated to rural development [1, 2, 3, 4]. Demonstrating a strong interest in living labs, the European Network of Living Labs has been created, nowadays including 129 living labs in different environments such as rural development, e-health, ambient assisted living, ICT for disabled people [5]. The European Commission has recognized the effectiveness of open and user driven innovation principles and has recommended to use this approach in the ICT research projects related to ICT for healthcare, digital libraries and content and ICT for independent living for the 2009-2010 period [6, 7, 8]. Nevertheless, what is the most appropriate way to measure and analyze results and impacts of living lab activities, and what exactly are these impacts, in the case of C@R, on business innovation, the rural innovation system, and on rural socio-economic development, are questions that still require more in-depth analysis. This chapter aims to answer these questions based on our work in the C@R project. For this purpose, in the next sections we focus on the following topics:

- What is the state of the art on the methods for evaluating innovation ecosystems and its adaptation to user innovation approaches.
- What could be a useful framework for measuring and evaluation of the results and impacts of the rural living labs considered in the C@R project.
- What are the results and impacts achieved in the C@R living labs, using the measuring and evaluation framework previously stated.
- What are the lessons learnt in applying the C@R evaluation framework.

2 Issues in Measuring Innovation Performance

In order to define a pragmatic approach for evaluating the results of C@R rural living labs it is necessary to first analyze the current state of the art on methods for innovation ecosystems evaluation and measurement. In this way, this section discusses generic approach for evaluating innovation initiatives and other already existing approaches more oriented to rural living labs. Two fundamentally different types of measures for innovation are distinguished: the organizational level and the country or region level.

2.1 Measuring Innovation at Country and Region Level

At this level, measures of innovation are focusing on a country or region competitive advantage through innovation. The Oslo Manual, developed jointly by EUROSTAT and the OECD, is part of a continuously evolving family of manuals devoted to the measurement and interpretation of data relating to science, technology and innovation. This includes manuals, guidelines and handbooks covering R&D (Frascati Manual), globalization indicators, patents, the information society and human resources in S&T statistics (Canberra Manual). The Oslo Manual provides guidelines for collecting and interpreting innovation data in an internationally comparable manner. These standards are used for example in the European Community Innovation Scoreboards. The purpose of this annual scoreboard is to have seven dimensions grouped in three blocks that bring together a set of related indicators to give a balanced assessment of the innovation performance in each country. The blocks and dimensions included are [9]:

- Enablers captures the main drivers of innovation that are external to the organization as human resources and financial support.
- Organization Activities captures innovation efforts that firms undertake recognizing the fundamental importance of organizations‘ activities in the innovation process: organization investments, linkages and entrepreneurship and throughputs.
- Outputs capture the specific outputs of organizations activities as: innovators (the number of organizations that have introduced innovations onto the market or within their organizations) and economic effects.

The main barriers that prevent the usage of this way of measuring innovations generated by living labs are the following:

- The indicators required are macroeconomic and comes from large statistic databases [9], for example EUROSTAT, World Bank, Thomson Reuters and Gallup. Normally, these databases contain figures at national level, but living labs are innovation ecosystems created at regional or municipal level, so it is very expensive in terms of effort and costs to obtain figures at the required level of granularity.
- Categories like organizations investments, throughput and socio-economic effects can be considered only once the living lab has implemented successfully a self-sustainability model that normally happens more than five years after the inception of the living lab. During the lifetime of the C@R project it therefore will be very difficult to measure results and impacts of the living labs.

2.2 Innovation Measurement at the Organizational Level

Measuring innovation at the organizational level relates to individuals, team-level assessments, private companies from the smallest to the largest [10]. Today, there is no established general way to measure organizational innovation [11, 12]. Corporate measurements are generally structured around balanced scorecards which cover several aspects of innovation such as business measures related to finances, innovation process efficiency, employees' contribution and motivation, as well benefits for customers [13]. The procedures used to measure and assess the innovation activities at organizational level permit to compare the fulfillment of objectives stated in the organization’s innovation policy. These procedures usually include the documentation of results of the innovation initiatives, and control and measurement of the results obtained [13].

The most difficult issue to control and measure of the results obtained is related to quantifying the innovation results [13]. One of the most widely used methods of assessing innovation is to distinguish between the outputs and inputs of the innovative activity [13, 15]. Ultimately, the key output measure is the success of the organization [13, 15]. Organizational performance can be determined by profits, revenue growth, share performance, market capitalization or productivity amongst other indicators [16]. However, all these indicators have drawbacks and can be caused by factors other than the level of innovativeness [15]. An alternative measure of innovative output is to create the variables for the number of new or improved products produced, percentage of sales from new or improved products generated, patents or trademarks created [13].

The level of innovation expenditure has been the most extensively used indicator for the level of innovative effort [10]. The advantages of the input measures are that it is a relatively well understood term and it provide a money (euro or dollar) figure for the use in subsequent analysis [17]. However, it is not well stated the way to calculate this figure due to the existence of different definitions of innovation and different sources of costs that have to be considered depending on the organization or the type of innovation to be measured and analyzed [11, 12].

2.3 Measuring and Evaluating Innovation in Rural Living Labs

In the scope of this paper, it is essential to highlight that rural living labs are innovation oriented organizations that have several different characteristics with regards traditional innovation organizations. rural living labs are ecosystems where the research and innovation activities are directed and guided by the needs and restrictions of the social communities participating in the living lab setting [1, 18]. In this sense, a appropriate way to measure and analyze the results achieved by the rural living lab activity should include several elements of the traditional innovation measurement and evaluation. These elements include the blocks and dimension of the innovation measurement at country and regional level and the procedures considered for measuring innovation at organizational level. However, other specific requirements for measuring innovation in social entrepreneurships should be considered too. These requirements drive the definition of additional aspects that have to be considered for evaluating rural living labs:

- Creation of rural living labs is a long-term process. It is essential to address the evaluation of the potential social impact of the innovation projects in the rural environment, in order to avoid a lack of social returns of investments.
- Living lab organizers should be able to measure living labs results against the diverse goals they set for themselves, using simple and inexpensive measures tailored to the particular circumstances.

- In order to evaluate living lab results, it is essential to include mechanisms for tracking processes and results across phases of organizational development and growth.
- Living lab practitioners have benefited in forming networks for mutual learning and support. An example is the European Network of Living labs [5]. Living lab organizers solicit detailed feedback about the living lab ability to support these networks and provide other useful services to the living lab members.
- The transfer of the living lab approach to other organizations in the same region is an important criterion for success. Concretely, one of the evidences for success of the rural living labs is their ability to deliver wide-scale innovative services providing social benefits in a leveraged and sustainable way.

Within the context of C@R rural living labs, an important goal is to catalyze innovation and change rapidly on as massive a scale as possible. The measures that matter most should be practical indicators that can be tracked and acted on in real time to disseminate and transfer ideas or build strong organizations that can reach more people more cost-effectively. Taken into consideration all the issues presented in the previous discussion, the C@R project has defined and implemented a practical approach for measuring and evaluating C@R rural living labs results and impacts.

3 Methodology for Rural Living Labs Impact Assessment

Considering the characteristics of a rural living lab highlighted before, we have developed a framework for measuring and evaluating the results and impacts of the C@R rural living labs (see also [3, 4]). This framework focuses on the following impact assessment objectives:

- How rural living labs, through generating innovations during the living lab activities, have created economic and social value for living lab users. Here, the living lab is seen as organizer of innovation projects, which generate value.
- How rural living labs act as efficient and effective innovation environments, enabling organizational learning and stimulating open and user driven innovation. The living lab approach also affects the rural "system of innovation".
- How the impact of the rural living lab on the wider socio-economic development can be determined. Living lab activities and results will influence the community and rural environment where the rural living lab is established. As the living lab approach acts to enhance the rural innovation system it will affect the rural socio-economic system.

These assessment objectives should be distinguished; at the same time they are mutually interrelated. Rural development impacts will be very difficult to observe during the project lifetime. However we may observe "weak signals" concerning such impacts, for example interest of companies to establish economic activities in rural areas due to an enhanced innovation infrastructure. An enhanced rural innovation system due to introduction of living labs may positively affect rural development and socio-economic conditions. We aim to understand how rural living labs influence their rural and regional environments becoming boosters of rural and regional development, and we will identify the rural and regional policies that are implemented due to the rural living lab activity. The evaluation framework to achieve the previously mentioned objectives is presented in Figure 1.

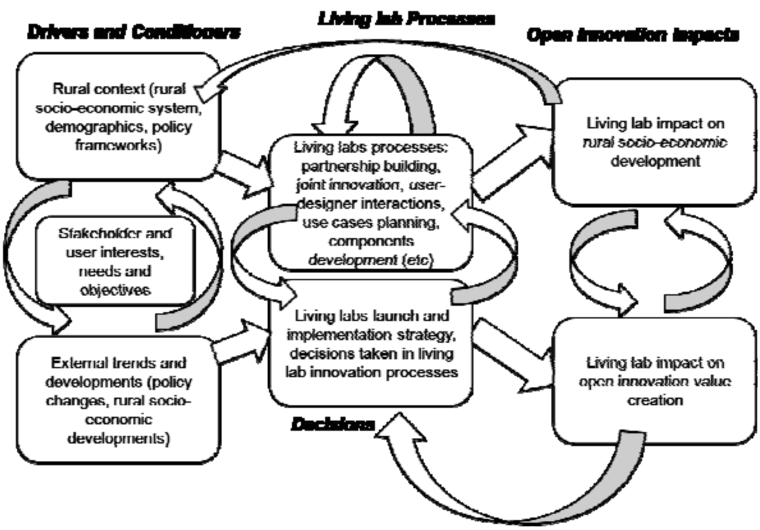

Fig. 1. Monitoring framework as implemented in the C@R living labs [3]

The evaluation framework consists of three main elements represented as columns. Living lab impacts and results are related to living lab processes and to drivers and conditioners, in order to facilitate interpretation and assessment. First, represented in the left column, it is necessary to study the drivers and conditioners of the innovation activity managed by the rural living lab. The elements that have to be considered in order to study properly the conditioners and drivers are:

- Living lab rural context. It is necessary to identify the resources that are brought together to carry out the innovation activities considered in the scope of the living lab. Rural living lab resources include: network infrastructure, experimentation resources and tools, know-how, funds, user and business support base etc. Additional rural context elements include innovation policy frameworks and rural socio-economic characteristics such as demography and employment.
- User interests and needs. It is necessary to identify the strategic objectives formulated for each rural living lab and the innovation

initiatives addressed to achieve them. Moreover, it is necessary to identify the short-term objectives considered for each innovation objectives. These elements are essential to measure and/or assess the progress and results achieved as consequence of rural living labs activities.

- External drivers and developments. This category is related to identifying and describing the living lab external context and trends driving living lab developments (e.g. funding available, strategic partners business needs, rural policy changes). Specific information to gather in the scope of this category is: main facts on industrial constituency: SME's and large companies involved in rural development of the related environment; situation of business networking relations; description of market key players and dynamics (presence of advanced users, constituting a demanding market; presence of innovative companies etc); relevant policies regarding innovation and rural development, relevant policies regarding public-private partnership for innovation and rural development; innovation instruments, budgets / subsidies available to the living lab.

Second, represented in the center, it is necessary to study the processes and decisions related to implementing and operating the innovation initiatives in rural living lab experimentation cycles. Third, represented in the right column, we identify the results and impacts of the living lab innovation initiatives. Results are outputs that can be measured and interpreted in terms of progress against the short-term and strategic objectives as agreed for the living lab.

Table 1. Indicators for living lab results and impacts

Level	Results	Impacts
Value for users	Economic benefits of CWE innovations e.g. for fishery (Cudillero), farmers (Homákháti)	Enhanced competitiveness of sectors Employment generation impacts
Innovation environment	Decreasing time from idea to innovation Ease of building innovation networks Ease of innovation project development Number of innovations generated Uptake and adoption of innovations	Attractiveness for stakeholders to initiate new innovation initiatives Attractiveness to enterprises to initiate innovation initiatives
Rural development	Open innovation infrastructure Entrepreneurship activities New business creation Public-private partnership	Economic sector impacts (above): competitiveness, employment New innovation initiatives Enhanced business attractiveness of the rural environment

As regards impacts we are using the categorization introduced above, distinguishing between living labs value creation for users (in C@R these are mainly people working in economic sectors such as fishery, farming), living labs as efficient and effective innovation environment, and living labs impact on rural development. Table 1 presents a summary framework for indicators to measure results and assess impacts. As many of these indicators are qualitative, it must be relied on joint assessments based on judgments from all stakeholders involved.

4 Results and Impacts of C@R Living Labs

The monitoring framework has been implemented in all living labs on basis of the cyclic approach of C@R, and followed a three-monthly assessment and reporting approach. A summary of the achievements, impacts and benefits is presented below.

4.1 Frascati Living Lab

The Frascati Living Lab activity has both worked on establishing a generic regional community of innovation and worked on innovative CWE platforms and technologies for specific target sectors. It has well succeeded in bringing together a community of stakeholders in the region of Lazio and became part of the Italian Network of Living Labs which it initiated. The community is interested in innovation based on the resources brought together (platforms, know-how, business interest) and how that could create benefits. The community has entered a process of discussing the strategy and needs of Frascati Living Lab, and also developed innovation ideas, in particular in the selected innovation domains of precision farming, business incubation support and eProfessionals. As such it has well acted as a "breeding ground" of business ideas.

The collaborative workspace has supported the Frascati Community at a general level of providing an infrastructure for sharing documents and hosting projects. It has been more important for a core group within ESA to support idea generation and project development; this group participated to testing and validation activities.

Regarding the precision farming activity, technologies and components have been tested internally but not experimented and used in practical situations. The benefits of the services are in itself relatively evident, and have been demonstrated in scenario-type of situations. Some of the components have the potential to be reused and shared with other projects as they are C@R architecture compliant.

As wider-scale users involvement has not succeeded, the different projects might not be considered as "true" living lab projects in its methodological sense, however they have contributed to enhancing the Frascati Living Lab community and positioning in the Italian living lab network. Projects, community and living lab environment will be expected to co-evolve in the future, thus mutually strengthening the innovation environment.

Table 2. Impact Evaluation of Frascati Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Building up a community of stakeholders in Lazio region as a basis for "breeding ground"	Making available technical and organizational resources e.g. from past projects for living lab innovation Establish collaboration with other projects (ECOSPACE)	Development of components for precision farming system and incubation support Partial implementation of C@R architecture
Living lab concept implemented	Agreements among stakeholders as basis for collaboration	Elements of a technical platform (under construction) Arrangements for open innovation	Elements of living lab project methodology Limited user engagement and involvement
Benefits generated for stakeholders	The innovation community has been useful for Lazio stakeholders to develop new business relations and innovative ideas	Opportunity to meet stakeholders and jointly develop ideas and projects	Demonstration of the potential use of components in practical situations
Key factors determining outcome	Awareness of importance of collaborative innovation (+) Availability of key research centers and infrastructure in Lazio region (+)	Availability of a living lab portal and workspace (+) Difficulty to manage and maintain the community (-)	Lacking ability to engage user groups (-) Difficulty to apply living lab methodology in a consistent manner (-)

In summary (Table 2), important elements for a future living lab innovation environment and project methodology have been established, in particular its position in the regional innovation system. Although it has not yet reached the phase of being able to generate and implement living lab projects using living lab methodologies, the Frascati Living Lab has gained interesting experience during its development process, and is well positioned to grow towards such a full-fledged living lab. A clear and committed living lab strategy and increasing the capability to attract user communities will be necessary to exploit the promising results achieved so far.

4.2 Sekhukhune Living Lab

Sekhukhune Living Lab has worked on creating a rural community oriented to create impact on operational excellence of small and micro enterprises. The Sekhukhune innovation community is characterized by the participation of stakeholders composed of SAP Research, CSIR/Meraka institute, Infopreneurs, Spaza Shops owners and retailers providing the products sell by Spaza shops. Sekhukhune Living Lab has evolved through the C@R project. First, early engagements have been established with CSIR/Meraka and the established infrastructure for Infopreneur business. Second, extensive effort on requirement analysis have been spent applying an iterative and incremental approach using prototypes and limited application development. Third, fully functional software had to be developed ready for real life roll-out. Finally, user roll-out has been completed achieved by the 24x7 live operation of the applications provided for a period of nine months.

Two different innovation scenarios have been considered: logistics brokering enabling the synchronization between rural public transport demand and offering; and a virtual buying cooperative enabling collaborative procurement amongst small convenience stores, so called Spaza shops. The live operation has shown that regular change management and end user interaction is most important for the sustainability of the business and technology models. The key impacts of the specific results of Sekhukhune Living Lab at project level are:

- The developed innovations have been accepted by the local people.
- The goal of reducing transactional costs has hit its target.
- The income of the very small and micro enterprises increased during the last nine months of real life experimentation.
- The first step into the goal of bridging the 2nd and the 1st economy has been successfully done.
- The extension of the product and service portfolio for Infopreneurs has proven to be viable providing additional income.

Table 3. Impact Evaluation of Sekhukhune Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Building up a community of stakeholders for open innovation willing to cooperate in future innovation initiatives	Creation of a open user driven infrastructure enabling the implementation of innovation processes	Development and roll-out of collaborative procurement application Partial implementation of C@R architecture
Living lab concept implemented	Agreements among stakeholders as basis for collaboration for the scenarios considered in C@R	Evolution of the living lab innovation infrastructure from initial agreements and preparation to user-led co-creation and wide scale roll-out	Effective User engagement and involvement Effective application of user driven open innovation principles
Benefits generated for stakeholders	The innovation community has been useful for stakeholders to develop new business relations and innovative ideas		High acceptance of application developed, reduction of transactional costs, increase of income of Spaza Shops and contribution to bridge 1st and 2nd economy
Key factors determining outcome	Willingness to cooperate of Community of Practitioners and other stakeholders (+) Lack of active support and alignment at policy level (-)	Effective ways for managing the community of stakeholders (+) Lack of communications and ICT infrastructures for sustainable innovation (-)	Ability to engage and involve group of users (+) Ability to manage and implement user driven open innovation (+)

Important elements for a future living lab innovation environment and project methodology well tailored to the Sekhukhune context have been established. The Sekhukhune Living Lab has implemented a single project based on open and user driven innovation principles, and this very well could be the starting point of constituting a sustainable innovation organization. The stakeholder community is willing to repeat the experience.

4.3 Homakháti Living Lab

Homákhati Small Area Living Lab (Table 4) has been able to bring together a community of stakeholders in different sectors such as agriculture, tourism, energy and ICT (farmers, the farming cooperative, Szeged university, municipalities, living lab organisation, ICT companies), to jointly work on innovation projects. The living lab plays an important role to establish an ecosystem and itself was established as an organisation playing a role as facilitator and coordinator, supporting large and small projects development. A basis has been created for establishing a longer term viable and sustainable living lab, based on different funding sources and services. As such, Homákhati belongs to the most advanced living labs within C@R. Focus of the living lab work has been the creation of an Agricultural Collaborative Working Environment where four different, relatively simple, applications have been developed covering different collaborative situations, for example orders and offers matching, prediction-based pricing, and collaborative logistics.

Most of the applications developed are now being used on a daily basis. The applications were in itself relatively simple but their use was driving change in the current way of working. For example, the orders and offers application changed the procurement process, whereas the yield prediction application actually no longer focused on prediction but provides the tools for analyzing information collected by the farmers, thus stimulating them to engage in collaboration. Living labs work also impacted the local community, as trust relations have grown over the project and end users were coming up with more and more ideas about new applications. Finally, the living lab has evolved into an innovation ecosystem which has grown over time, attracting more and more private and public partners. It is already visible that this will result into appropriate business model concepts that will enhance the sustainability of the living lab. A company was founded for representing the living laboratory. The H-Lab Nonprofit Ltd. was formed in September 2009. Currently there are two half time employees for this company a half time executive director and a software developer for providing support for the applications. The owners of the company are a spin-off company of the employees of the University the Aensys Ltd. and a company owned by the municipality the Homokkert Nonprofit Ltd.

Homákhati Living Lab has been able to organize a user community around the living lab project to enhance the Agricultural Collaborative Working Environment. Winning the trust of stakeholders, and engaging “local champions” to take a leading role, were important strategies. Traditional approaches have been used to engage users in working with the developers, but they resulted in applications that have been integrated into the users’ working environment. The living lab is currently exploring new business models that should establish the sustainability and viability of the living lab as an ecosystem and facility.

Table 4. Impact Evaluation of Homákhati Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Built up a community of stakeholders in the region Involved local champions to lead innovation	Has worked on a business model for sustainable collaboration	Agricultural Collaborative Working environment Platform development based on architecture
Living lab concept implemented	Community building on basis of trust Willingness to invest (Szeged university)	Living lab technical infrastructure evolved, led by USG	Effective, practical approach to user engagement realised based on mixed methods
Benefits generated for stakeholders	Regional development perspective, collaboration private and public parties	Clear potential for future projects based on technical infrastructure (platform) and business model	Direct benefit of collaborative applications / ACWE for users
Key factors determining outcome	Ability to build up local, committed community (+) Ability to identify and engage local champions (+)	Living lab technical infrastructure (+) Commitment of supporting partners USG (+)	Cyclic development approach (+) Ability to engage users in testing (+) Practical approach matching demands of users (+)

4.4 Czech Living Lab

The Czech Living Lab (Table 5) has been built upon the activities of the WIRELESSINFO consortium. This is a collaborative R&D environment in which several organizations work together to build and implement projects. Projects are commissioned by different parties, acting as “users”, e.g. government departments, and implemented through project teams, formed from the consortium parties. The applications for territorial planning, forest owners support and sensors have not yet been tested and validated in large-scale practice. Therefore it is difficult to assess the real value, impacts and benefits of the work done beyond the acceptation of project results by the Czech Living Lab consortium.

The Czech Living Lab is different from other living labs in the sense that it has operated more as an environment for joint research and development, working on the basis of commissioned projects, than as a user driven living lab environment.

Table 5. Impact Evaluation of Czech Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Building a consortium of parties willing to engage in joint research and development	Technical facilities, platform, component developed by the consortium enable to carry out future innovation projects.	Development of scenario-based projects (territorial planning, forest owners support, sensors)
Living lab concept implemented	Joint research and development consortium. Open innovation environment. Partial involvement of experts within the project consortia.	Technical infrastructure as one of the resources for future living lab work. Missing are arrangements for user engagement.	No clear living lab projects but joint research and development projects
Benefits generated for stakeholders	No clearly visible benefits at the rural development level	Environment to establish project consortia Open innovation environment	Benefits for commissioning and participating organizations
Key factors determining outcome	Strategy of joint research and development hinders a rural living lab approach (-)	No clear strategy to build resources for living lab innovation environment (-) Open innovation environment favorable for building project consortia (+)	Lacking ability to engage user groups (-) Difficulty to apply living lab concepts (-)

4.5 Cudillero Living Lab

The Cudillero Living Lab activity (Table 6) has worked on establishing a generic regional community of innovation and on innovative Software Collaboration Tools and related technologies for fisheries sector. The strategic objective stated for Cudillero Living Lab at the very early stage was related to the preservation of traditional fisheries activity in Cudillero. In order to achieve this aim, the innovation initiative launched was the feasibility study and creation of an origin label for hake hook by hand catch in Cudillero coastal zone.

Table 6. Impact Evaluation of Cudillero Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Building up a community of stakeholders Integration in Cudillero Local Action Group and inclusion in its strategic plan.	Initiatives for deploying WIMAX connectivity, enhancing innovation capabilities in the zone Extension to other areas in Cudillero	Software Collaboration Tools for fisheries sector, concretely ICT tools for managing hake origin label. Full implementation of C@R architecture
Living lab concept implemented	Agreements among stakeholders as basis for collaboration	Elements of a technical platform (under construction) Arrangements for open innovation	Elements of living lab project methodology Effective user engagement and involvement
Benefits generated for stakeholders	The innovation community has been useful for Lazio stakeholders to develop new innovative ideas	Opportunity to meet stakeholders and jointly develop more ideas and projects (also other sectors) Cudillero LAG is implementing the approach in other projects	The Regional fishing Directorate is financing the activities of wide scale roll-out of the technological solution provided by Cudillero Living Lab (funded by EFF)
Key factors determining outcome	Support of the idea and concept from all stakeholders (+) Availability of key research centers and infrastructure in the region (+)	Incorporation of more stakeholders during the process of creation of Cudillero LL and policy level support (+) Unavailability of ICT infrastructures for innovation (-)	Difficulties to engage user groups at the very early stage (-) Willingness to collaborate from policy stakeholders at policy levels (+)

The living lab has well succeeded in bringing together a community of stakeholders related to Cudillero Harbour Market. Firstly, a small group of stakeholders was created. This group was composed of the representative of the regional government, the director of the fisher guild, the municipality representative and a few fishers collaborating with TRAGSA, technology providers and research organizations.

In order to introduce the origin certificate in the production, Cudillero Rural Living Lab works on the fleet GPS tracking, sending data on real time from the fishing grounds to the auction The establishment of a traceability system in Cudillero "Virgen del Carmen" fishermen's association is considered the first step to change radically the business processes in Cudillero fish market. Guaranteeing the traceability from the fishing grounds and making their production data accessible to buyers and consumers through the Internet, the fishermen association would start working towards the e-commerce and the direct sale.

The Regional fishing Directorate is already financing the activities of wide scale roll-out of the technological solution provided by Cudillero Living Lab using resources from the European Fishery Fund (EFF 2007 - 2013). These value-added services to the production are expected to attract producers and wholesalers to trade in Cudillero. Other benefit obtained from Cudillero Living Lab activity is the introduction of broadband connectivity and Internet access to the Cudillero coastal zone. The Regional government is also financing the deployment of a WIMAX deployment in Cudillero municipality. This is an open field for new developments for the sake of innovating in Cudillero Rural Living Lab. Moreover, the activity related to Cudillero Living Lab has contributed contributing to create the Spanish Network of Social Spaces for Research and Innovation. Cudillero Local Action group is now implementing the approach in other projects (Pilot Projects funded by Spanish Ministry of natural, rural and coastal environment).

4.6 Åboland Living Lab ArchipeLago

The Åboland Living Lab activity has worked on establishing a generic regional community of innovation and worked on innovative collaborative technologies for specific target sectors. It has well succeeded in bringing together a community of stakeholders in the region of Åboland. In the specific domains mentioned, small stakeholder groups have been targeted who have been engaged in specifying requirements in order to support the development and testing of Mobile Direct Sales and eDemocracy scenarios.

In the mobile direct sales scenario, the end-user participation have been related to the idea and scenario generation, home prototypes testing visits, outdoor environment (selling points), and green-houses. Regarding this scenario, no final wide scale user roll out has been achieved. In the eDT case in order for any development to proceed through real life testing the team depended on how the political processes were advancing. There were identified several restrictions that impede the normal evolution of the development of this scenario, such as the law regulations preventing the celebration of remote council and the continuous and sudden changes of procedures to manage a meeting council due to the confidentiality of the issues to be discussed.

Impacts as summarized in Table 7 are mainly results in terms of regional development and involvement of stakeholders. The cooperation that has been facilitated by C@R has engaged different types of stakeholders who have determined roles and activities of the living lab.

Table 7. Impact Evaluation of Åboland Living Lab.

Impact level Impact profile	Impact on region	Innovation environment	Innovation projects benefits
Key achievements	Building up a community of stakeholders in Åboland region as a basis for "breeding ground"	Making available technical and organizational resources A sustainability and business model has been drafted.	Development of components for eDemocracy toolkit and mobile direct sales
Living lab concept implemented	Agreements among stakeholders as basis for collaboration	Elements of a technical platform for user driven innovation Several regional arrangements for open innovation	Elements of living lab project methodology Important user participation in the mobile direct sales scenario and limited user engagement for the eDemocracy tools due to the limited community of councils representatives contacted
Benefits generated for stakeholders	The innovation community has been useful for Åboland stakeholders to develop new business relations and innovative ideas	Opportunity to meet stakeholders and jointly develop ideas and projects	Demonstration of the potential use of components in practical situations
Key factors determining outcome	Awareness of importance of collaborative innovation (+) Availability of ICT infrastructure and innovation related competences in the actual Living Lab constituency (+)	Availability of a DB for managing end-users participation (+) Different types of policies, funding mechanisms and strategic stakeholders to be involved that have different interests (-)	Lacking ability to roll out the services and solutions created (-) Difficulty to apply living lab methodology in whole innovation management lifecycle (-)

A change in legislation was made possible as the outcome of the dialogue with the government in conjunction with prototype testing. Government recommendations on the criteria for a change of law with regard to virtual council meetings were based on collaboration between the different civil servants of municipalities preceding the town of Väståboland concerning the different procedures in meeting processes. Legislative outcome is the change in the Finnish Municipality Act (365/1995) that, starting from 1.1.2009, allows participation to council and board meetings using videoconferencing.

Elements for a living lab innovation environment and project methodology have been established. The Åboland Living Lab has been working to create a sustainable innovation facility, but the results have been restricted to the implementation of two scenarios with good examples of end-user engagement especially in the initial phase. A more clear and committed living lab strategy and increasing the capability to attract user communities will be necessary to exploit the results achieved so far.

5 Lessons Learned

5.1 Determinants of C@R Rural Living Labs Results and Impacts

Based on the presentation of current results of C@R living labs, this section presents the main factors that contributed to achieving these C@R living lab results. First, it is relevant to highlight that the research and innovation activity in open environments is catalyzed by the conjunction of different factors that constitute the main pillars that support the living lab activity. These pillars are:

- Societal Communities. This pillar represents the societal groups demanding the research and innovation efforts and, moreover, they will be the main users of the results obtained in the research and innovation process. These groups must define the needs to be solved, the requirements of the technological solutions to research, including the main restrictions that must be considered for an efficient use of the technological innovations in real environments.
- Industry and Market Actors. This pillar is constituted by all the economical agents in the living lab environment that have the intention to boost the economy activity by means of the commercialization of products and services based on the results obtained during the research and innovation process.
- Research Community: This pillar includes all kind of agents whose main activity is concentrated in the basic and applied research activates

catalyzers of the creation of new technologies that can be transformed and applied in the living labs to solve the problems and satisfy the needs proposed by the societal communities represented in the living labs.
- Infrastructures for research and innovation: The basic idea of the living lab approach consists of moving the technological research activity from controlled laboratories at research centers to open environments that provides the real conditions where the new ICT technologies must operate. For this reason, living labs must also provide ICT infrastructures to carry out the activities included in the research and innovation process.
- Political Support: This pillar represents the political representatives and the active policies that are boosting directly the research and innovation activity or those policies and representatives that are directed to solve the problems of the societal communities launching research and innovation areas.

Moreover, it is necessary to identify how external conditioners can contribute to maximize the impacts of the results obtained or prevent the wide-scale exploitation of the results obtained. External context and the events originated outside the living lab influence directly or indirectly in the activities, results and impacts of the living lab approach. Most relevant externalities that have been occurred during the operation of C@R rural living labs are described below.
- The alignment of local and regional rural development policies is impacting positively in several living labs as an instrument facilitating the innovation activity. For example, several living labs are contributing to launch ICT innovation initiatives accompanying the rural development policies implemented in Local Action Groups.
- However, there are political related externalities that impede or difficult the living lab activities and to overcome these difficulties consumes a great amount of resources and efforts. Examples of this type of externalities have been produced in Åboland, Soria and Cudillero living labs. In these three cases, the living labs are directed and boosted by local and regional governments, but in elections period, several decisions important to the living labs activities has been postponed after the finalization of election process so, in those three cases, the living labs effective activity has been delayed. Moreover, the work to overcome the situation has been very hard because the people involved in the living lab has changed, so the user involvement process had to be re-initiated, requiring some re-work.
- The existence of contradictory laws regarding the use of innovation results and virtual collaborative work prevents some of the innovation initiatives launched by the living labs. Examples of this type of externalities are presented in Åboland Living Lab. Concretely, one of the scenarios considered here is related to the integration and deployment of an e-Democracy tool (eDT). Currently, Åboland region has laws limiting the application of these tools to celebrate official municipality meetings.

However, as a new development, experimenting on using these tools has been allowed.

- In some cases we observed resistance to the changes that were due to the new principles and paradigms introduced by the living labs.
- The living lab paradigm proposes a change in the conception of the research and innovation process where the user information and participation in the process has more value and the researchers position has changed due to they are not leading the process.
- On the users' side, we have found several cases of difficulties related to the lack of experience in the participation in the innovation process.
- On the researchers side, we have found that several groups have the interest of develop several type of technologies without a previous demand on the users side.
- Lack of alignment with the economic and market sector causes that the introduced innovations are not used and exploited in the long term. Lack of good communications infrastructure to use effectively and take advantages from the technologies and applications obtained as a consequence of the living lab activity.

A key for rural living labs' success is the balanced combination of an appropriate rural living lab membership considering the five pillars presented above, a system-changing idea, and a scalable organization.

5.2 Lessons Learned from Assessment of Results and Impacts

A first observation is that among C@R living labs that are performing evaluations, the purpose of the evaluation, the techniques used, and the degree of rigor vary widely. Some evaluate the process of implementing the rural living lab to assess whether it is being delivered as planned. Others try also track the program outputs, such as the economical value of the results obtained or number of people served. Still others attempt to track short-term outcomes, such as the changes produced in circumstances or behavior over one to three years. Normally, evaluation within rural living labs tends to be more often about testing a pilot program or validating an specific technological solution, and less often about tracking the growth or potential for growth of an intervention or idea. Regarding the evaluation of rural living labs as innovation ecosystems, the focus should be shifted. This change of focus has obvious consequences for the role of evaluation. Effective approaches to evaluate rural living labs should take into account the leadership qualities of the organization managing the living lab; the financial sustainability, managerial strength, and growth rates of the living lab organization; or whether the idea itself is being adopted in other regions.

The rural living lab evaluation process should start since the living lab inception, because the existence of the required components (an appropriate membership, a system-changing idea, and a scalable organization) often can be evaluated based on evidence available at the very early stage of the rural living lab creation.

The most common form of rural living lab evaluation is tracking progress of each innovation initiative (project) considered against a set of specific goals that are developed collaboratively among the rural living labs. An initiative is usually considered successful even if it does not meet its original goals, however, normally the parties exhibit a ready willingness to change direction as events unfold. Nevertheless, it is relevant to highlight that this necessitates a close working relationship between the stakeholders so the rural living lab manager can make a subjective determination about whether a change of direction is evidence of a failed project or a successful adaptation to unforeseen circumstances.

The implementation of the assessment framework in C@R project has been done by periodic reports to obtain the required information. The reports ask detailed questions about all aspects of the rural living lab progress, including a set of questions around organizational development.

In order to determine the impact of rural living labs, several attempts to identify indicators to determine the social return of the innovation processes lunch have been undertaken. However, it is difficult to define quantitative indicators because in many cases the figures obtained are relevant in terms of societal impact after a very long period (five years from living lab creation). It seems to be a very long period in terms of innovation management but it is not so long in the period of the development and growth of societal communities.

Moreover, it has been difficult to obtain a set of indicators that enable the benchmarking of experiences between C@R living labs due to the large variety of realities. Moreover, those who focus on the earliest stages do not necessarily expect the rural living lab to produce wide-scale usage of new products or services created or to bring an idea that is fully developed. In other cases, managers had a clear shift in focus from supporting the rural living lab as an innovation organization, to building scale, efficiency, and sustainability in the organization as it matures in later stages of the life cycle. Among those funders who are most focused on organizational development, we found a strong tendency to emphasize measures of organizational capacity and growth over the end-impact on beneficiaries.

Although all rural living lab practitioners acknowledged the benefits of networking, a few representatives of end-user communities observed that these gatherings can be very time-consuming. Nevertheless, when the networking brings tangible benefits, such as new funding opportunities, the benefits were viewed as much substantial as when the gathering was intended only for Social Entrepreneurs to learn from and support each other.

6 Conclusions

The aim of this chapter was to discuss appropriate methods to measure and analyze the results achieved in the C@R rural living labs and to understand the impacts of these results on society development and innovation policies. We started to investigate whether the current approaches for innovation measurement might be useful for this purpose. Measurement of innovation performance at the political level is based on the recommendations provided by the Oslo, Frascati and Canberra manuals. We conclude that these approaches are not appropriate to measuring and assessing rural living labs because they work with macroeconomic indicators, without providing meaningful information for a valid assessment of rural living lab effectiveness. Innovation measurement at the organizational level provides recommendations of the procedures to identify innovation results and quantify them in terms of added value measures. The indicators used to quantify innovation results are usually outputs indicators that permit the determination of revenue growth, share performance, market capitalization or productivity increases due to the results of innovation activities. This type of measurement framework does not provide an approach that is suitable to analyzing the results achieved by the rural living labs.

Therefore we have developed a (semi-)qualitative monitoring and assessment framework in order to monitor living lab processes and to assess the results of the C@R living labs and their impacts. Thus we aimed to better understand the processes and decisions that are causing these results and impacts. While this approach also constituted a learning mechanism for the living labs, there is certainly much scope to improve on this approach.

C@R rural living labs are close to the concept of Social Spaces for Research and Innovation (SSRI), which is related to the modernization of traditional sectors such as sale of agriculture products, fishery and tourism. Considering the results obtained in C@R living labs, their main impact seems to be related to creating an innovation infrastructure for social communities, based on community building, organizational agreements, human knowledge and resources, and technological facilities to support innovation and collaboration, such as collaboration tools to enable community building and social innovation in a rural environment. Further impacts include the increasing business performance related to the collaborative applications created in the living labs (cost, time savings), the enhancement of entrepreneurship and business creation. and improvement of individual and social quality of life.

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Chapter 12

Living Labs and Rural Development: Towards a Policy Agenda

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Abstract. This chapter addresses the issue how the C@R project on rural living labs has contributed to developing a policy agenda for innovation and rural development. The chapter also presents recommendations to be considered in future policy agendas regarding the benefits of rural living labs as engines of innovation and rural development in Europe. The formulation of recommendations for policy-makers at the European Commission level is carried out through a scenario-based framework that considers the complexity of the socio-technical environment in which rural living labs act to stimulate rural development.

Keywords: Living Labs, Rural Development, Impacts, Policy, Scenarios, Complexity.

1 Introduction

This chapter aims to provide an analysis of the role of the rural living labs concept to influence and enrich innovation and development policies in rural areas. This analysis is based on the results achieved in implementing the living labs concept in various settings in Europe and South-Africa, and in particular on analyzing the first impacts that could be observed on development and innovation policies in these rural settings. The analysis proceeds through identifying key innovation and rural development policy areas that are to be taken into account, and analyzing how the results that have been achieved in implementing the C@R living labs are contributing to the effective implementation of these policies. The analysis mainly focuses on the policy implications of how living labs contribute to 1) creation of a sustainable and open innovation ecosystem and to 2) the business and technological innovations affecting the rural socio-economic system.

This chapter also aims at providing recommendations for policy-makers at the European Commission level on the process of promoting rural living labs as engines of innovation driven rural development. In order to support the policy recommendations, two alternative scenarios of possible outcomes in a ten year time frame were developed. These processes mostly aim at showing that rural living labs are embedded in complex systems in which an array of social agents interact in an unpredictable manner. Thus, the construction of scenarios provides an engaging way of going through the issue of innovation driven rural development. The presented scenarios do not aim to show most likely futures, but to provide examples of factors that influence rural populations and how the actions of local and external agents will influence these futures. This enables informed discussions and draws attention of those accompanying rural living labs' work to the key drivers of rural development.

2 Rural Living Labs and Policy Implementation

The rural living labs have achieved most of their objectives related to developing and validating collaborative applications targeting the functionalities that were found important by their users in the particular rural environments. The living labs methodological approach also introduced a change in the traditional way of innovation as it engaged the end-uses and stakeholders. Nevertheless, the impacts of these results did not have the expected level in all of the living labs and it might still be too early to judge the success. We may analyze these impacts in relation to their contribution to implementing policies focusing on innovation and rural development. The rural living labs activities in C@R have been designed to contribute to the implementation, at a limited scale, of policies for rural development and innovation. It is important to remark that regarding rural development policies there is a common European guideline, and each country has translated this guideline to its own situation. This circumstance supposes that it is possible to analyze this type of impact in an homogeneous way in the rural living lab settings of C@R. Nevertheless, there is no unique regulation for harmonizing the innovation related policies at European levels. Even, there are several different policies at national and regional levels. This circumstance supposes that it is very difficult to analyze the policy impacts of rural living labs in an homogeneous way.

2.1 Rural Development Policies and Contributions of Rural Living Labs

The European Policy for Rural Development for period between 2007 and 2013 has the following main objectives: To make rural areas a more attractive place to invest and work; to promote knowledge and innovation for growth; to create more and better jobs in rural areas; to promote a sustainable use of natural resources; to improve governance in rural areas; and to ensure synergy with cohesion policy. European and national rural development strategies and programs, since the beginning of 2007, are centered around four so-called axes:

1. Improving the competitiveness of the agricultural and forestry sector;
2. Improving the environment and the countryside;
3. Quality of life in rural areas and diversification of the rural economy;
4. Leader+, an initiative to help rural actors consider the long term potential of their local region.

Under Axis 1 on improving competitiveness of the agricultural and forestry sector, a range of measures targets human and physical capital in the agriculture, food and forestry sectors (promoting knowledge transfer and innovation) and quality production. In this respect, the rural living labs contributed to encouraging the take-up and diffusion of information and communications technologies and to foster dynamic entrepreneurship in rural areas. Specific examples on these results are:

- Re-boosting the fisheries sector in Cudillero, more specifically related to the hake hook by hand, by introducing a quality and origin label for this product that is very much appreciated in Spanish markets.
- Facilitation of innovation and access to research and development (R&D) by the lunch of public and privately funded projects (Homokháti)
- Encouraging the take-up and diffusion of information and communications technologies due to availability of wide bandwidth communications access (based on WiMAX or Wireless Mesh Networks) in Cudillero or Homokháti.
- Fostering dynamic entrepreneurship. ESA Business Incubator (EBI-Italy) has been strengthened by the Frascati Living Lab. This living lab, enabled by a community collaborative workspace, acts as an informal breeding ground of new business ideas. In the Åboland living lab we observe the involvement of entrepreneurs in commercial exploitation of mobile direct sales application. Other living labs demonstrate new possibilities of businesses in different sectors under the umbrella of new markets regulation (i.e. mycological sector licensing in Soria). We also found several examples related to business related cost and/or time savings, i.e. piggybacking on existing business backbones in the Sekhukhune living lab environment.

Axis 2 provides measures to protect and enhance natural resources, as well as preserving high nature value farming and forestry systems and cultural landscapes in Europe's rural areas. The results achieved in several living labs related to collaborative decision-making process related to land management in rural areas are contributing to preserve the farmed landscape and forests and to promote territorial balance. A specific example concerning these impacts is the creation and deployment of collaborative tools for decision-making related to territorial and landscape management in the Czech living lab.

Axis 3 helps to develop local infrastructure and human capital in rural areas to improve the conditions for growth and job creation in all sectors and the diversification of economic activities. The C@R living labs activities and results are contributing to several key action areas considered in this group of policies, concretely putting the heart back into villages. Integrated initiatives combining diversification, business creation, investment in cultural heritage, infrastructure for local services and renovation are contributing to the improvement of both economic prospects and quality of life. Specific examples on these impacts are:

- Integrated initiatives for businesses creation, integration and diversification. In Sekhukhune living lab there is an example related to cost and/or time savings due to the integration of first and second economy businesses in rural areas such as piggybacking on existing business backbones.
- Integrated initiatives for increasing the quality of life in rural areas. In Åboland, as municipalities cover huge areas, the deployment of the eDemocracy Tool will contribute to reduce the travels to meet the council, increasing the wellbeing of its members and saving cost and time associated to these meetings.

Axis 4, based on the Leader experience, introduces opportunities for innovative governance through locally based, bottom-up approaches to rural development. Effective mechanisms and organizations are available dedicated to implement living lab policies across Europe. Concretely, Local Action Groups (LAGs), are organizations existing across Europe to implement Leader+ policies. These Local Action Groups bring together all the social and economical organizations in a rural area interested to boost rural development. As a consequence of the current global situation, Local Action Groups are demanding to launch sustainable and durable innovation initiatives related to ICT in order to modernize and diversify the current rural businesses and services. As Cudillero living lab has demonstrated, the integration of the living labs innovation approach into the activities of already existing Local Action Groups is a very appropriate strategy to:

- Align rural development with innovation initiatives implemented by living labs.
- Assure the living labs' sustainability and persistence beyond a specific project, i.e. C@R
- Amplify the added value and impact of the research and development results.

- Increase the return of public and private investments in rural development and innovation.

The C@R living labs are enhancing possibilities for innovative governance through locally based, bottom-up approaches to rural development. More specifically, living labs are contributing to this set of rural development policies by building local partnership capacity, animating and promoting skills acquisition, aiming to help mobilize local potential, promoting private-public partnership and improving local governance. Specific examples of rural living lab contributions in C@R are:

- Living labs have demonstrated their capability to implement innovation mechanisms in Local Action Group activities. A good example is Cudillero living lab. As a consequence of integrating the living lab in Local Action Group activities, mechanisms to enlarge this Local Action Group as a Coastal Action Group are now being considered.
- The activities to implement Mobile Direct Sales and the eDemocracy tools in Åboland living lab have stimulated the collaboration of this living lab with policy makers responsible for regional development plans and economic development mechanisms in the region.
- All living labs considered in C@R provide good examples on promoting cooperation and innovation between several stakeholders in the local settings where living labs have been established.
- Implementation and deployment of the eDemocracy Tool in Åboland and the collaborative tool for forest and territorial management in the Czech living lab are good examples on how living labs contribute to improvement of local governance.

2.2 Contribution to Implementing Innovation Policies

The current innovation policies at European, national or regional level can be grouped in two categories:

- Framework Policies encompass several aspects of financial conditions, education policy, and product- and labour-market regulation.
- R&D Specific Policies include direct public financial support for private R&D, either through grants or the tax system, the funding of public research institutions, and measures to improve linkages with the private sector.

Rural living labs within C@R are contributing to the implementation of several European, national and regional innovation policies:

- Encouragement of intra-regional collaboration in building and operating knowledge infrastructure (e.g. technological centers) and in promoting innovation clusters. In Frascati, interlinkages of the living lab and MEGALAB regional broadband projects have been established.

- Fostering entrepreneurship by the creation of a software cluster in Homokháti.
- Creation of stronger linkages between university research and industry in the Homokháti, Frascati and Czech living labs.
- Improvement of ICT infrastructure availability and capacity due to enhanced attractiveness of the rural area attributed to living labs.
- Availability of wide bandwidth communications access (based on WiMAX) enhances rural area attractiveness
- Strengthen international collaboration by the integration of all C@R living labs in the European Network of Living Labs.

2.3 Achieving a Sustainable Scaling-up of C@R Results

At this moment, C@R living labs have not yet been able to provide concrete evidence demonstrating a wide-scale impact on rural development and innovation policies implementation. Establishing a rural living lab is a long term process, well beyond the duration of C@R project, and the main benefits of the socio-economic innovation processes generated by the project most probably will be observed in the mid to long term.

If rural living labs are to become an effective holistic approach to rural development, the results of C@R and those that will be produced in the future need to be scaled-up. Scaling-up leads to “more quality benefits to more people over a wider geographic area more quickly, more equitably and more lastingly” [7]. Scaling-up can occur both vertically and horizontally. Vertical processes involve expansion from the level of grassroots organizations to national institutions and policies. Horizontal processes refer to geographical spread or replication on a larger scale, from hundreds to thousands or millions of people.

Rural and urban communities, local decision-makers, policy-makers, and public and private organizations have successfully developed and shared C@R project results that directly benefit rural communities. Scaling-up of C@R results can help to improve well-being and provide sustainable and appropriate benefits to over 140 million people who live in rural areas of Europe.

The concept of sustainability in the context of C@R rural living labs refers to the ability to achieve and maintain the innovations of C@R through certain processes, functions and productivity into the future, beyond the life of the project itself. Sustainability includes a number of dimensions, including the evolving needs and requirements characteristics of a user-centric approach beyond the lifetime of any given project, with the implication of having to consider an increasing level of complexity. This complexity goes from project pilots which involve few members of the rural community in one sector of the economy (usually agriculture) and few social actors to the C@R rural living labs which include all members of the rural community, all social actors, all sectors of the local economy, and at a yet higher level constituting the “Social Space for Research and Innovation”

(SSRI) which involves all rural communities in a region or country, and encompass many policy domains and political levels.

One of the results of the C@R project has been the development of a complexity theory-based approach for assessing the impact of innovation-based development programmes specifically aimed at rural communities. Some of the factors that influence the well-being of populations and rural living labs results are exemplified in Figure 1.

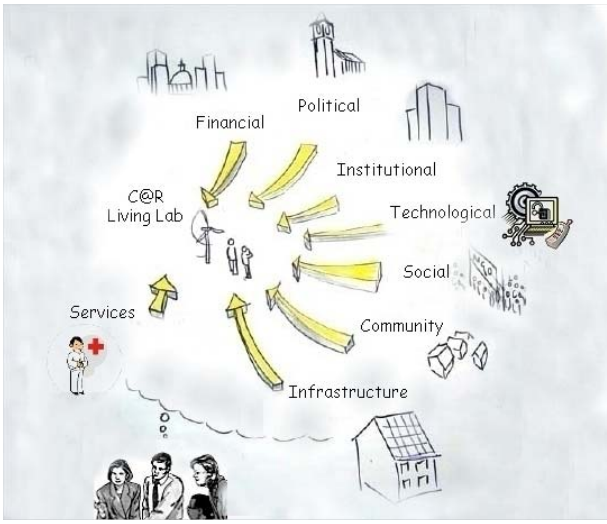

Fig. 1. Example of factors influencing populations' well-being and rural living lab results

An inbuilt impact assessment methodology based on this approach can be used in the future to identify the social agents and institutional and policy innovations that can ensure the systemic and sustained use (scaling-up) of C@R results to improve the livelihoods of rural citizens. The aim of the methodology is to provide a platform for a collective effort in identifying the whole structure and the driving forces that influence the dynamics of the development process (technology, infrastructure, policies, population skills, markets,...) and what conditions its success. As Clark points out [2, 3] even if the single elements of an innovation system are strong the system as a whole may be weak. The key property of a system of innovation is not so much its component parts, or nodes, but rather how it performs ad a dynamic whole. Once this overall performance is understood, the identification of the up-scaling opportunities (in particular horizontal up-scaling possibilities on system transfer and adaptability) becomes easier.

3 Recommendations for Policy Makers

The section presents policy recommendations regarding the use of rural living labs as engines of innovation and rural development in Europe. The formulation of recommendations for policy-makers at the European Commission level is done through a framework that considers the complexity [5], [12] of the socio-technical systems in which rural living labs act to foster rural development. This framework takes into account the several dimensions of populations' livelihoods, so that the actions that are undertaken in rural environments consider all the necessary assets for a life with quality in rural areas [9]. This work results in the identification of drivers that improve rural populations' well-being and in the social agents that influence each of these drivers. The drivers are rolled out in two opposite scenario narratives, named (1) rural living labs relevance in a better rural world (best scenario) and (2) rural communities extinction (worst scenario). The two scenarios, together with the drivers that have been identified along the scenario building process, allow the construction of preliminary policy recommendations, namely:

- promote the regional rural development strategies in member countries;
- have a well known and well promoted rural economic development policy that integrates all the existing instruments;
- establish a framework for the creation of rural living labs
- assure the formation of multidisciplinary partners in the setting up of new rural living labs.

3.1 Methodological Approach for Defining Policy Recommendations

Scenario building is a methodological approach for addressing development and policy issues used for exploring possible futures of complex systems [1], [6]. Scenarios are an important tool for learning and informing decision-makers in situations of high uncertainty. Used properly, they can help people think more systematically about the different circumstances they may encounter in the future and the implications of those future possibilities for decision-making in the present. There is no standard methodology for scenario development, but it is important to include all key stakeholders and social actors in the scenario-development exercise.

Scenario building starts by using existing knowledge to determine the processes that are responsible for structural change into two broad domains: (1) things we believe we know something about; and (2) elements we consider uncertain or unknowable. The first component, known as trends, can be used to develop robust models of the future based on existing knowledge, recognizing that our world possesses considerable momentum and continuity. The second component, considered as uncertainties, involves driving forces like the market of a certain product, or oil prices, which are not understood well enough to be able to say how these drivers will evolve and interact with other components of the system, and therefore, they produce unpredictable outcomes. These make it very difficult to explore the impacts of any particular intervention or policy.

The first step is to define, through iterations, the components and boundaries of the systems, and then identify and characterize the driving forces. The interactions among driving forces are then characterized based on evidence and framed in a systems analysis structure into a set of diagnostic hypotheses. From these initial hypotheses, deductions are made as to what to expect as far as the future outcomes or results of the dynamic interaction among system components. These hypothesized outcomes are then subjected to tests and further observations. These tests or further observations are carried out to either confirm or modify these initial hypotheses. Occasionally new data may lead to a new hypothesis not considered in the initial set of interacting driving forces. Once validated, the scenarios can be used to explore the impacts of interventions on the evolution of the system. This process is represented in Figure 2.

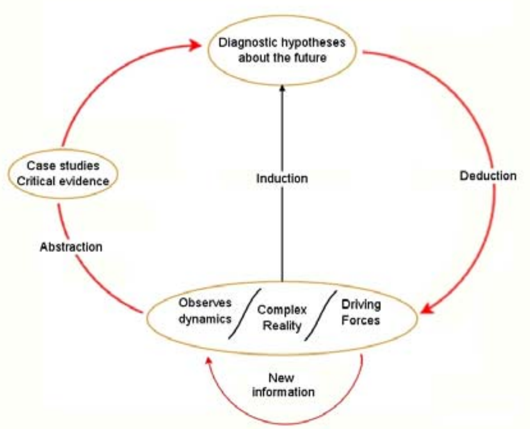

Fig. 2. The process of scenario building

In the C@R project, scenarios were built by involving living lab leaders and C@R partners in general. The coordinating team of this activity gathered information from existing project reports, and from an analysis of the general European rural context. This allowed the identification of a set of drivers from which the coordinating team built preliminary scenarios. The decision about this first step was taken during a workshop that involved a group of C@R partners. The preliminary drivers were presented and discussed with partners in a working group during a project meeting. In this meeting it was also agreed that each partner would provide a snapshot (case study) of their rural living lab with a focus on the expected evolution of the existing livelihoods and social networks in the region.

Identification of drivers and provision of case studies enabled the creation of two narratives of opposite scenarios. The idea behind these narratives was not so much to present likely scenarios, but to identify as many conditions as possible for the success of rural living labs on one hand, and as many threats as possible that could result in the failure of European rural development on the other hand. From these narratives it was possible to withdraw a set of actions to be performed by the different identified actors in the European rural social networks that could promote the success of rural living labs or prevent against the threats of failure. Some of these actions need support and/or understanding from European Commission policy makers. This need for support was translated into recommendations. Once this was done the resulting report was circulated by the partners for comments. The workflow upon which the team agreed is represented in Fig. 3.

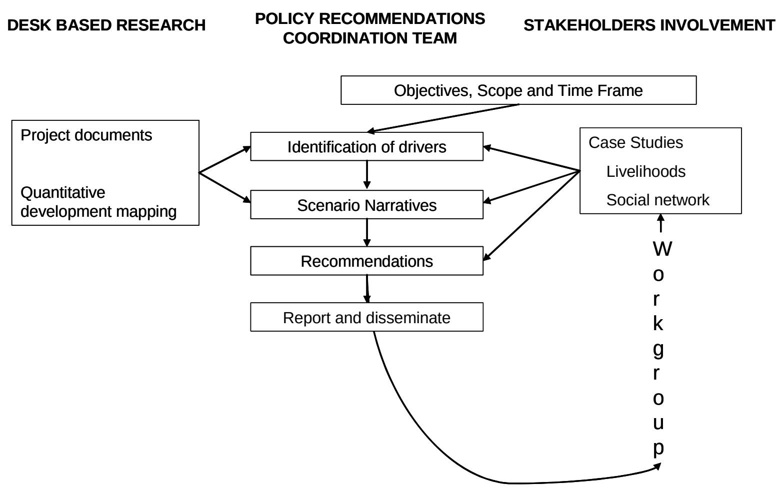

Fig. 3. C@R undertaken in C@R to build policy recommendations

The evolution of this highly unpredictable system and the agents that interact in it must be closely monitored by policy-makers. Policy-makers must pay special attention to the most vulnerable livelihoods and to the vulnerabilities within the region's livelihoods, so as to find the most adequate policies and programmes that minimize these vulnerabilities when the system itself is not addressing them [4, 12].

3.2 Scenario Narratives

The narratives in this section demonstrate the considered drivers in two opposite scenarios: a best and worst case scenario. Best and worst case scenarios without the classification of drivers by degree of impact did not look to be likely outcomes and did not create bias when reading them, but stimulated the discussion amongst policy recommendations team members about the drivers that they wanted to see considered with more emphasis and in different combinations of positive and negative outcomes.

Scenario 1: Rural living livelihoods relevance in a better rural world

The first scenario described here is one where rural living labs have had extensive success across the rural population of Europe. The narrative of this scenario explores the interactions among drivers and livelihood assets of rural populations, and the key mechanisms that would need to be in place to overcome barriers to rural living labs playing a key role in an innovation-based economy. The strong cohesiveness of the major economic sectors, brought by the expansion of rural living labs in the European Union Territory, enables the agents to align in a structured strategy of cooperation. CSOs and research institutions build strategic plans for the sectors that are validated by the stakeholders. An action plan for the development of ICT and other innovative interventions is set up. Well structured plans that represent the vision of each sector for the medium-/long-term future are presented to local policy-makers that engage with the CSOs in the rural living labs activities. These are followed by careful and continuously monitored implementation which allows prompt adjustments to the objectives and actions of the plan when necessary.

Local politicians recognize the value and the potential of the rural living labs, participating in financing some activities and providing the enabling environment for such living labs to expand. They allow living lab partners to work freely, as long as they commit to the set objectives and do not capture for themselves the living labs' created value. They are aware that the results are not immediate, but promote and communicate the actions that are being undertaken in a powerful convincing way that engages citizens.

The rural living labs include individuals working in all economic sectors and from all social classes and can even assist in the emergence of new economic sectors in the region. The number of partners and of areas of work continuously enlarges. This means that it involves a critical mass, composed by the public sector, universities and diverse agents from the private sector. This cluster is able to address different areas and share multidisciplinary knowledge and experiences in a constructive way.

The rural living labs' network becomes virtually self sustainable in the provision of information that is necessary for informed decision-making. Different partners working on different layers (national, regional, local) collect, systematize and provide information for decision-making that other partners use to build intervention strategies and decide on activities and the relevance and role of the different social actors. Strongly supported by sound information, living lab development strategies are seen as guidelines by policy-makers. The large group of players starts to have a common voice in the region and to be able to influence policy.

This means that in rural areas people start to be aware of the concept and the role of a rural living lab, and also of what it offers, through examples, models and advocacy. Additionally, local associations are provided with good resources and hire competent professionals that bring innovative actions into the economic sectors. Training programmes with different sources of finance are directed to activities related to the living labs' work. These new awareness and skills also bring new perspectives on how collaboration and innovation can be part of a rural society, contributing to a change in mindsets.

The recognition of the rural living labs' work is also enabled as the living labs evolve into institutions, legal entities that are able to make contracts, consortia, share profits and with a physical presence in the society, an open door for anyone who is interested in knowing more about it and participating. This legal entity has a strategy and defined roles for the different players in society. Local authorities, CSOs and research institutions build these strategies for rural living labs and promote the integration of the use of the development tools provided by the European Commission. Axis one and three in the Common Agricultural Policy (CAP), Leader, European Regional Development Fund and European Social Fund (ESF) are used to finance rural living lab activities as well as to provide information about the populations, train the populations, and to promote other activities that are essential for the development of the rural living labs. When trying to engage new partners, there are specific proposals, when new partners search the rural living labs there is a framework and a regional strategy in which they fit.

Advocacy efforts work toward the transfer of new born ICT and innovations in general. Rural living labs link up to and take advantage of the existing national rural networks adapting work that is being done in other parts of the country, even out of rural living lab influence. Commercial marketing and collaboration approaches are used to up-scale the use of rural living lab results. Networks supported by platforms for knowledge and technical solution sharing are used by the network of rural living labs and managed and promoted by marketing professionals financed by this network. Besides technical descriptions, there is also focus on commercial description and briefs on lessons learned and success stories. This ensures that the developments are understood by a wide audience and that rural living labs are more protected from intellectual property loss (no technical descriptions). Start-ups aiming at long-term sustainability make efforts to make the new products and services viable.

Local authorities also actively participate in the rural living labs in the projects that involve the public sector (governance, education, health). E-governance progresses, brought by rural living lab innovations allow extensive public participation. An increasingly well educated population participates in open forums on local development and people find the leverage that is needed to influence policy-making. Citizens understand the aims of policies and feel their needs are being attended.

Rural areas, partially through the efforts of rural living labs on identifying and supporting local sustainable lifestyles, are able to provide education and health care, and diversify the offer in jobs, available services and products, and leisure activities, driven by populations' needs. Connections to urban centers are fast and affordable. Simultaneously traditional activities that are part of the identity of local populations are promoted and incorporated in a modernized society. Some of them are even part of new business opportunities.

The strong trend of an ageing European population is targeted by long-term integrated strategies at European, national and regional levels. Rural living labs recognize their role in creating jobs and alternative livelihoods for everyone, but also for those who will have to work beyond the age of 65 given the reform of the European pension systems. The partners engage in creating and stimulating new activities that keep people productive for a longer time, while still securing good living standards. Part of the education courses focus on training for jobs with local markets and on entrepreneurship.

Public and private entities assure the existence of the necessary infrastructures for all this to happen. Whenever the market is not doing so well, local authorities assure that all communities have the necessary infrastructures (mobile network reception, broadband internet services, roads, schools, health centers and leisure facilities) at an accessible price.

Rural living labs have developed good tools for natural resources monitoring and trends on the use of natural resources and the consequences these may have are identified. Links to policy-makers and private investors help to find solutions that make new sustainable use of the available natural resources and prevent incidents usually related to land use change (fires, floods, landscape deterioration).

In the availability of a stimulating political environment and appropriate human resources, local industries are additionally reinforced by the rural living labs that engage in research in the fields of these local industries (existing or potential). These actions are continuously promoted by European Commission policies. Transport systems are organized and agents cooperate to improve efficiency through economies of scale and good logistics. As a result, in addition to building security in local production and assuring a good degree of self-sufficiency, populations become proud of local products.

The valorization of locally produced goods and services transforms rural economies that were once dependent on a sole particular industry/sector and have now managed to diversify their production. Rural living labs have participated with support to businesses at the level of strategy building, business plans, marketability, enabling joint cheaper credit, human resources management and technology implementation.

Scenario 2: Rural livelihoods extinction

This scenario presents a future perspective of rural Europe over a period of ten years without the benefit of rural living labs. Overall, the scenario presents a significant decline in the overall well-being of rural populations who find themselves less equipped to cope with the adverse impacts of major driving forces of structural change. The main argument that reinforces this scenario of declining sustainability in the quality of life for rural Europe is that current economic forces have been driving this trend for the last decade, where rural populations are being marginalized from the benefits of economic progress brought by advances in new technologies and have lost political leverage over social dynamics that are driven by large corporate and financial powers. This has left rural populations in the sidelines of the complex political life of European countries and sets up a vicious cycle where rural citizens have limited access to relevant knowledge regarding complex economic, social and environmental issues, which limits their ability to impact the policy- and decision-making process, leading to further isolation and declining quality of life.

The electoral calendar makes long-term projects not seem attractive and rural living labs give way to unstructured measures with short-term impact. The political constraints multiply and national and regional policies differ in aims and ideology. Rural living labs do not present any strategic plan that makes their action understood. The aims, potential and form of the organization of a rural living lab are not shared by local entities. Populations do not see a strategy or a structured common approach to rural development in the existing policies and feel that their true needs are not being addressed. Eventual positive results are captured by a few economic agents or major corporations and the related activities are no longer run by the living lab partners or, in other cases, the rural living labs are formed by groups of interest and old friendships and do not create a true spirit of collaboration or represent the whole society. The activities, even if undertaken in partnership, are mostly developed under an individualistic approach for short-term gains for each partner. There is no focal point with the aim of working to bring agents together and keep the collaboration environment. Rather than a new business capable of being self-sustainable, projects rely on long-term public-private partnerships becoming dependent on public policy more than capable of influencing it.

Local populations, including CSOs, are weak, not representative of the sectors of society and have a culture of competing for resources rather than optimizing their use. In this frame, the ICT are developed according to the skills and interests of the research institutions or to general guidelines from the European Union or large multinational conglomerates. Users do not adopt them in their daily routine.

This happens as rural living lab vocation is exclusively ICT development. There are no partners with skills on business support and therefore turning innovative initiatives into business is left for each individual partner. In regions with costly credit and lack of entrepreneurship and self-employment culture, business creation will be in the hands of a few enriched agents that will do little to diversify the local economy and job choices, also so needed for the diversification of lifestyles.

Additionally, bureaucracy continues to be one of the major factors hampering the dynamism of rural areas. Constant trips to urban centers for the most basic public services drive people away from the countryside, leaving some towns deserted and turning others into highly urban environments. Access to basic infrastructures is limited or expensive. Fundamental developments based on web services and mobile communications are not possible. Rural living lab agents feel frustrated and lose momentum.

The ICT tools that are being developed take too long to be internalized in the populations' livelihoods due to lack of training, advocacy and prioritization of needs. Investing in ICT in rural areas becomes a long-term investment that is only interesting while there is public funding, as the payback period is too long. As populations are not aware or do not understand the benefits of a structure that does not have a clear role, a strategy, or enough proximity to them, they keep their interest exclusively on traditional activities. When this interest is lost, they leave the rural area.

The lack of regional coordination gives an advantage to multinational companies to dominate the labour markets. These look for cheap labour and create few jobs in rural areas. When cheap labour can no longer be found, companies move to more competitive markets. Governments are left with the choice of paying unemployment subsidies or making the work laws more flexible. Flexible work laws prove to be only medium-term solutions that cause great social instability and large multinational companies eventually leave.

The only alternative local source of income, tourism, finds too must competition from all the nearby rural places and environmental concerns and restrictions hamper the development of this activity. Rural living labs are faced with a poorly educated and aged work force, specialized in specific simple tasks and with no capital. The innovative work is virtually impossible. In this picture, those without power and whom the rural living labs should serve do not have access to it and are not even aware of its existence and work.

The environmental frame is not brilliant either. Rural living labs are focused on other activities with more immediate economic results and ignore the trends in the use of natural resources in the region. Although populations are not economically so dependent on these resources anymore, some environmental consequences of natural resources mismanagement will affect the performance of local businesses (e.g. tourism) and the well-being of populations (e.g. loss of cultural identity, change in landscape, natural hazards).

In addition, impacts of climate change are hard to cope with for rural populations. Governments and the European Commission impose high transportation fees that make export goods less competitive. Imported goods, especially food, become more expensive. Local agricultural systems are not prepared for this and they are producing crops that are no longer competitive and that do not respond to local market needs.

Given this picture, aged and impoverished people living on remittances, search for the cheapest products. Developing countries start producing high quality goods (such as wine) with much lower costs and the large companies that took possession of the countryside produce only export products. This and the dependency on subsidies in a sector that still dominates rural economy, agriculture, means that the European rural communities have little opportunities to innovate.

Given the stagnation of local economies, the commerce and services sectors do not modernize. The services and goods available no longer serve the young populations which are now educated and want modern lifestyles. Businesses do not find the required services and are forced to take constant trips to urban centers, with the inherent costs and loss of productivity. Rural living labs lack innovative businesses in which their action can be of good help. Young populations have moved out and there is no suitable work force left. However, the few schools in the region are considered to be of a lower standard than those in the urban centers. These pupils are often later marginalized by potential employers causing problems of social exclusion in the near urban centers. On the other hand, the immigrants that eventually arrive are given the jobs the young people did not want, which comprise mainly manual and unskilled jobs. They are not properly integrated and are stopped from climbing the social ladder. The environment for innovation in these rural areas is poor and rural living labs cannot thrive. Scattered impoverished populations bring politicians to adopt cost saving measures that lead to many health centers being closed in rural areas. Medical doctors do not take appointments in these areas at all.

Rather than being truly innovative the rural living labs become the lifebuoy of some struggling sectors in unsustainable rural societies.

3.3 Towards Policy Recommendations

Our policy recommendations have their origin, as described before, in a set of identified needed actions for the different actors in the European rural scene. These actions concern different topics that affect the society: public administration, economic policy, social action, technology development, environmental planning, methodological approaches. Each action indicated what type of agent should be responsible for its concrete definition, planning execution and monitoring. The categories in which the agents are divided are very general, given that the work had a focus on the European level. These categories were national governments, regional/local administration, research institutes, civil society organizations (including local action groups). From this spectrum of actions and agents it is clear that turning the rural living labs into more multidisciplinary structures is vital for their sustainability. In terms of recommendations for policy-makers at the European Commission level, they mostly focused on the need to support living lab initiatives in which the rural living lab is integrated in the life of the rural society, by having a physical structure (an office where citizens can participate with ideas and find rural living lab managers), by having living lab strategies that are embedded in the local development strategies and are able to integrate de different aspects and programmes of the European development policies, by consisting of multidisciplinary teams with human resources outside of the technology research field that are able to identify and cover the actions that are required to maintain an innovative society. We propose the following list of actions and recommendations that has been obtained as consequence of the work done in C@R project [8].

Engage rural living labs in the establishment of strategies for their sustainability and for actions in support of rural development

As stated throughout the chapter, rural development has an ineluctably local dimension that depends on the existing livelihoods, social networks, available resources and the way all these are combined and interlinked in each region. Rural living labs should develop strategies and action plans for short- and long-term sustainability based on their regions' characteristics. Rural living lab strategies for fostering innovation and use of technology must take into consideration a set of aspects:

- The boundaries in which they act and strategic and operational objectives of the Rural living labs, addressing both short- and long-term sustainability.
- The main existing livelihoods (the strengths and mostly the weaknesses that challenge these livelihoods sustainability), lifestyles tendencies and natural resource management challenges within the area of influence.
- The necessary knowledge and actions upon (when possible) markets, society and infrastructures, given that they are the support to the sustainability of the innovative initiatives that occur at the rural living labs.
- The identification of the social networks, the role the different agents and how they interact (actually and potentially) with each other.
- The necessary integration of the rural development instruments that are available.

Effectively communicate the need for the integration of existing instruments aimed at rural development policies

Rural living labs have as a function to act upon the same objectives as the rural development policies of the European Union (competitiveness, diversification of rural economies, environmental preservation, populations' welfare, etc.). Thus Rural living labs should be able to articulate with the existing rural development financial instruments (e.g. European Agricultural Fund for Rural Development) and, moreover, make them clear and advocate their use in long-term initiatives next to the populations. For example, the use of the funds that are available both in the European Agricultural Fund for Rural Development and the ESF should be advocated by rural living labs. This would support rural living lab activities in facilitating the emergence of innovative economic activities, in creating a spirit of entrepreneurship or in dealing with the innovations in the existing sectors. Rural living labs should once again, not only play an important role in innovating but in bringing all the agents and instruments together in a strategy that makes the results of innovation successful.

Establish a framework for the creation of rural living labs

Rural living labs are not the same as "common" living labs. They have to deal with complex challenges of demography, territorial management and inter-territorial competitiveness. If they do not address these issues, they will not be keeping their primary stakeholders (rural populations). By not sustaining populations that provide the necessary human resources for innovation, their work will not be enabled.

Hence, the formation of rural living labs should be done within an established framework that ensures that the new partnership will look at the system in which it acts as a whole and considers the complexity of working towards sustainable development. The support to rural living labs must assure that the partners presenting the proposal are able to identify the regional needs and the factors of hindrance in addressing these needs (e.g. lack of infrastructures, information needs, populations' skills, level of education and behavior).

This would probably require a multilayered approach to rural living labs in which some agents would focus on information collection and systematization, whilst others would use that information for demand driven innovation. A group working on business support and access to credit, advocacy, audience targeting, marketing and dissemination, and effective use of networks would also do much for the up-scaling and thus sustainability of results. This group would support SMEs and start-ups focused on obtaining short- and medium-term sustainability from rural living lab results. This team could be hosted in a rural living lab office with an open door for any stakeholder (Local Action Groups or any other legal entity, could host the rural living lab headquarters and act as focal point for partners and stakeholders).

Ensure an interdisciplinary framework for partnerships in the setting up of and scaling-up of rural living labs

Understanding the system in which rural living labs act, monitor results and up-scale innovative initiatives requires multidisciplinary teams. Rural living labs need an eclectic critical mass among their partner institutions in order to thrive. As portrayed in the scenario narratives, Rural living labs are in a context in which it is necessary to deal with issues such as emigration/immigration, ageing population, competition from urban lifestyles, provision of leisure activities, climate change, markets and attracting new and qualified populations. Only multidisciplinary teams will be able to identify, address and adapt the rural living lab strategy to the communities' needs and find ways to up-scale the use of rural living lab innovations, making them economically sustainable. It is possible that partial public funding will always be needed, even if only through the participation of public entities in the rural living lab partners' community (e.g. universities, public administration, Local Action Groups). Rural development is about bringing the living standards for rural populations close to those in urban centers (even if in different ways), it is about keeping landscape, environment (e.g. the abandonment of grazing fields is the reason for many of the fires that consume European rural areas in the summer) and cultural heritage. It is a service done by rural communities to the global society and should be supported accordingly. Part of this support passes by a continued action of monitoring and adaptation to the changes in local populations and in the rural living labs' internal and external environments.

4 Conclusions

This chapter discussed the impact of rural living labs activities within C@R on rural development and innovation policies, and elaborated policy recommendations aiming for scaling-up the results in order to achieve a wider-scale impact. Several conclusions can be drawn based on an analysis of impacts of current C@R rural living labs:

- The analysis proved difficult to find comparable quantitative data about each living lab region. However, the use of quantitative data could be very beneficial. The development of good databases and information systems on development issues could be part of rural living lab work.
- When evaluating impact of development actions full well-being accounts of the populations are often not considered. Economic indicators (income, job creation) are usually the only indicators being considered. Success of living labs in relation to rural development must be capable of capturing and monitoring broader indicators of well-being, including qualitative ones.
- At this moment, C@R living labs have not provided relevant figures on that indicators and evidences demonstrating objective figures of a wide-scale impact on rural development and innovation policies. If rural living labs are to become a holistic approach to rural development, the results of C@R and those that will be produced in the future by rural living labs need to be scaled-up.

The formulation of recommendations for policy-makers at the European Commission level was based on the development of scenarios that consider the drivers and complexity of the systems in which rural development takes place and thus Rural living labs act. Important but still preliminary policy recommendations are related to:

- promoting the regional rural development strategies in member countries;
- developing a well known and well promoted rural economic development policy that integrates all the existing instruments;
- establishing a framework for the creation of rural living labs; and
- assuring the formation of multidisciplinary partnerships in setting up new rural living labs.

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