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Future Internet

ENVIROFI

**The Environmental Observation Web and its Service
Applications within the Future Internet**

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D6.3.3 ENVIROFI Digital Living Lab III

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1 Glossary

The glossary of terms used in this deliverable can be found in the public document “ENVIROFI_Glossary.pdf” available at: <http://www.envirofi.eu/>

2 Abbreviations and Acronyms

Term	Explanation
AB	Advisory Board
CEN	European Committee for Standardization
DoW	Description of Work
EEA	European Environmental Agency
EGU	European Geosciences Union
ENVIROFI	The Environmental Observation Web and its Service Applications within the Future Internet
ESSI	Earth & Space Science Informatics division of the EGU
FI	Future Internet
FI-PPP	FI Public-Private Partnership
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
ICT	Information and Communication Technology
INSPIRE	Infrastructure for Spatial Information in the European Community
IoT	Internet of Things
IPR	Intellectual Property Rights
ISO	International Standardization Organization
EC-JRC	European Commission - Joint research Centre
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geospatial Consortium
OMG	Object Management Group
SOA	Service Oriented Architecture
SoaML	Service Oriented Architecture Modelling language
SDI	Spatial Data Infrastructure
SWE	Sensor Web Enablement
TC	Technical Committee
WP	Work Package

Table 1. Abbreviations and Acronyms

3 Executive Summary

The previous version of the deliverable at hand reported on the achievements in respect to a Digital Living Lab for Environmental and Geospatial Matters in the Future Internet. It built on the general concept of a (Digital) Living Laboratory (Living Lab in short) as introduced in deliverable D6.3.1. Instead of proposing the creation of a novel Living Lab for the Environmental Usage Area, we investigated how a cyclic model for open innovation could be applied in order to connect different types of innovation strategies (e.g. test beds) with the interested stakeholders and communities. In this regards, we introduced the concept of an **eInnovation Infrastructure** as a supporting framework. In addition, possible connections to Living Lab related activities within the coordination and support project for the FI-PPP (CONCORD) were already outlined, based on intense bi-literal discussions between both projects.

This deliverable (D6.3.3) is a revised and extended version of deliverable D6.3.2 outlined above. This is the last and third deliverable in a group of three (D6.3.X) to address Living Labs an open innovation issues. These are the main extensions:

- In Section 2, we present an updated view on the involved stakeholder network(s), as a continuation of an activity started under task T6.1 and updated in T6.3. We identified up to 58 stakeholders.
- In Section 3, we further refine the concept of eInnovation Infrastructure and collaboration enablers, and provide an example on how the eInnovation framework has been used in the context of the ENVIROFI pilot applications.
- In Section 4, we present an update of the required and available means to connect the environmental informatics community with the FI activities in Europe and to foster innovation.
- Interactions and discussions with existing Living Labs carried out during the last period of the project are reported on in the section of Annexes.

1 Introduction

One of the five ENVIROFI project objectives was to *'establish a Digital Living Laboratory for the ENVIROFI Stakeholders on the basis of existing expert groups in related interest communities to facilitate collaboration between the environmental ICT sector (including established SMEs, research projects, public institutions, standardization bodies, as well as citizens), the FI core platform community and other usage areas. This objective specifically targets a key concern of the Innovation Union initiative by linking ICT innovation and growth'* (ENVIROFI Consortium, 2011).

After intense discussions between ENVIROFI and CONCORD, and with contact points of several Living Laboratories in Europe, we went away from the initial proposal of establishing a novel laboratory. Instead, we see higher potential and better feasibility in connecting existing Living Laboratories, but also test beds, pilots etc., in a common framework. Analyzing the existing capabilities, we see a strong need in developing the required underlying information infrastructure for enabling innovation (eInnovation Infrastructure), on which we further elaborate on in this document.

ENVIROFI brings on board the key developers and forward looking users from environmental domain: (1) through direct participation in the project consortium; (2) through project's advisory board; and (3) through community events. The eInnovation Infrastructure should support these activities by providing the platform for required collaborations.

While WP4 interacts with the FI core platform and other usage areas, WP6 ('Collaboration with ENVIROFI Stakeholder Communities') provides a hub to the ENVIROFI Stakeholder Communities i.e. to public and private organizations as well as people. Task T6.1 presented the state of play at the beginning of ENVIROFI; task T6.2 ensures valuable short-term project results; and this task (T6.3: 'Initiation of ENVIROFI Digital Living Lab') prepares sustainability for mid-term developments.

T6.3 analyses the required and available means to connect the environmental informatics community with the FI activities in Europe and to foster collaboration. ENVIROFI thus enables the dialog between environmental community and the FI community for the benefit of both sides. At the same time, this task provides a tool to exploit additional possibilities for large scale implementations in phase 2 of the FI-PPP. Once an eInnovation Infrastructure for the Environmental Usage Area in the Future Internet is available, unlocked capacities (such as additional large scale observation networks, FI related working groups at standardization bodies and new potential partners) can be used for deploying early trials, but also real large scale applications. Following recommendations from the ENVIROFI Advisory Board, T6.3 also takes up parts of the activities from T6.1; it namely elaborates further on stakeholder networks and value chains.

We do not assume that the full infrastructure will be in place at the end of the project, but we will prepare as much as possible. In this sense, the ENVIROFI task T6.3 is not only producing documentation, but also assembles usable tools, such as wikis, portals, specific web sites, etc. While the initial version of the deliverable provided a loose collection of some of the required building blocks, this final version focuses on integration aspects. It particularly includes results from discussions with CONCORD and Living Lab representatives, which particularly have been carried out over the last part of the project.

The remainder of this document is structured as follows. Section 2 presents an update of the ENVIROFI stakeholders. In Section 3 we further refine the concept of eInnovation Infrastructure and collaboration enablers for supporting open innovation in the Environmental Usage Area, and provide an example on how the eInnovation Infrastructure has been instantiated in the context of the ENVIROFI pilot applications. In section 4 we further identify the required means to support and implement the eInnovation Infrastructure to enabling participation of the Stakeholder community in the ENVIROFI project activities and developments. In section 5 we draw conclusions and outline our plan for future work. Supporting materials provided in the annexes.

2 Stakeholder Survey

Below we present an extension to the stakeholder survey of deliverables D6.1.2 (Mazzetti et al., 2011) and D6.3.2 (Schade et al., 2012), and updated diagrams for indicating the complete set of ENVIROFI stakeholders identified up to date. Annex A provides the full list of stakeholders compiled during the project.

Updates consider novel insights from the thematic work packages (WP1 - biodiversity, WP2 – air quality and health, and WP3 – marine assets), as well as exploitation activities in WP7. The strategy during the last period of the project has been to move towards local communities and stakeholders (see geographical extent of table below) in order to support user testing and evaluation of the ENVIROFI pilots and applications. The list of stakeholders have been used for exploitation activities within WP7 and for consultation activities (public meetings, hands-on testing, etc.) as part of WP6, task T6.2.

Stakeholder	Type				Role				Geographical Extent	Theme
	Organization	Community	Enterprise	Other	User	Resource Provider	Technology Provider	Other		
Parco Nord Milano http://www.parconord.milano.it	✓				✓				Local	Ecosystems
Regione Toscana http://www.regione.toscana.it	✓				✓				Local	Transversal
Comune di Monticiano http://www.comune.monticiano.si.it	✓				✓				Local	Transversal
Unicoop Tirreno – sezione Maremma Est http://www.unicooptirreno.e-coop.it	✓				✓				Local	Transversal
Comune di Roccastrada http://www.comune.roccastrada.gr.it	✓				✓				Local	Transversal
Per Prata tra passato e Futuro http://www.pratadimaremma.it/	✓				✓	✓			Local	Ecosystems

Table 2. Profiles of additional stakeholders

In summary, at project month 22 (January 2013), 58 candidate stakeholders have been identified by a project internal consultation (see Annex A). Most of these (44) represent organizations and communities, which have multiple members from academia, the public sector and industry (Figure 1).

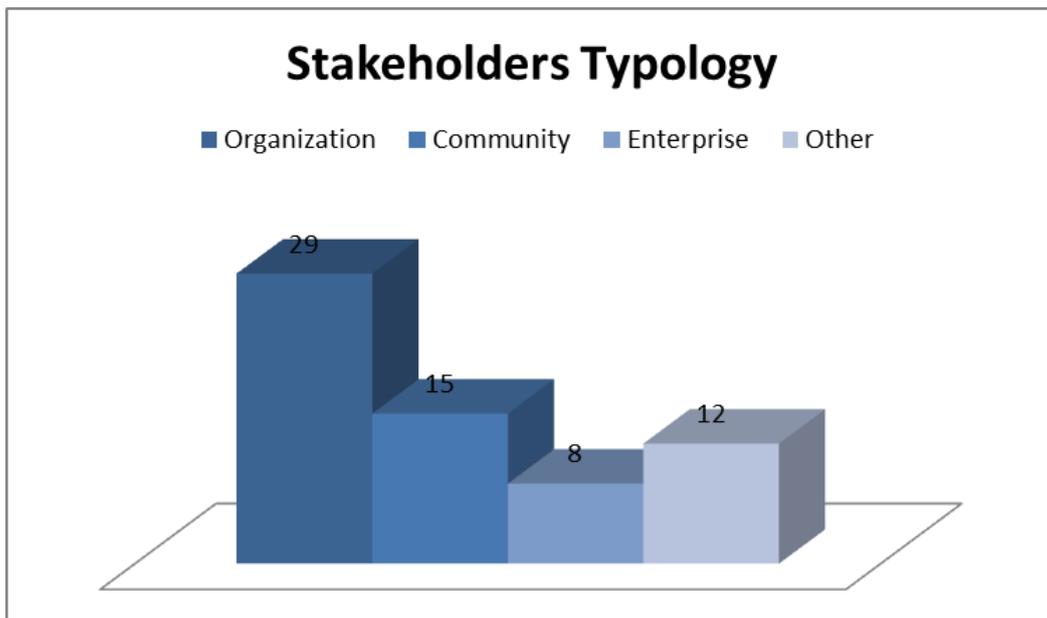


Figure 1. Typology of the ENVIROFI stakeholders.

In terms of coverage of roles, Figure 2 represents mainly a dichotomy between users and (resource and technology) providers.

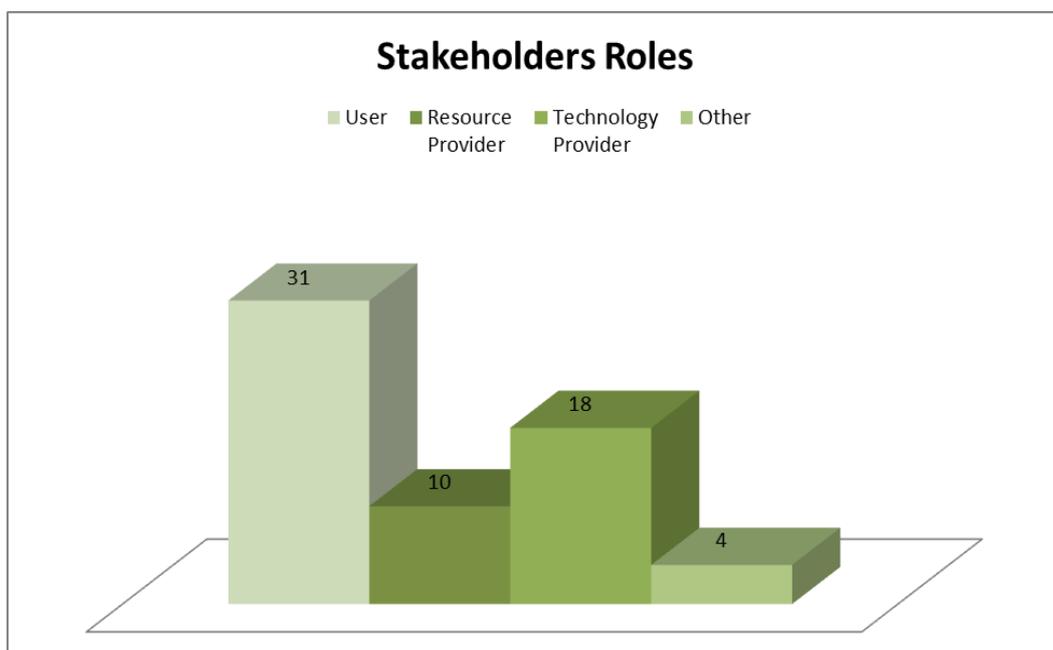


Figure 2. Roles of the ENVIROFI stakeholders

At first stages of the project, we mainly identified users from the three thematic environmental spheres that are targeted within the ENVIROFI project (biodiversity (WP1), atmosphere (WP2) and marine (WP3)). Figure 3 shows the thematic coverage of the final set of stakeholders in which traversal and

multi-thematic aspects as well as other domains such as energy gain in importance.

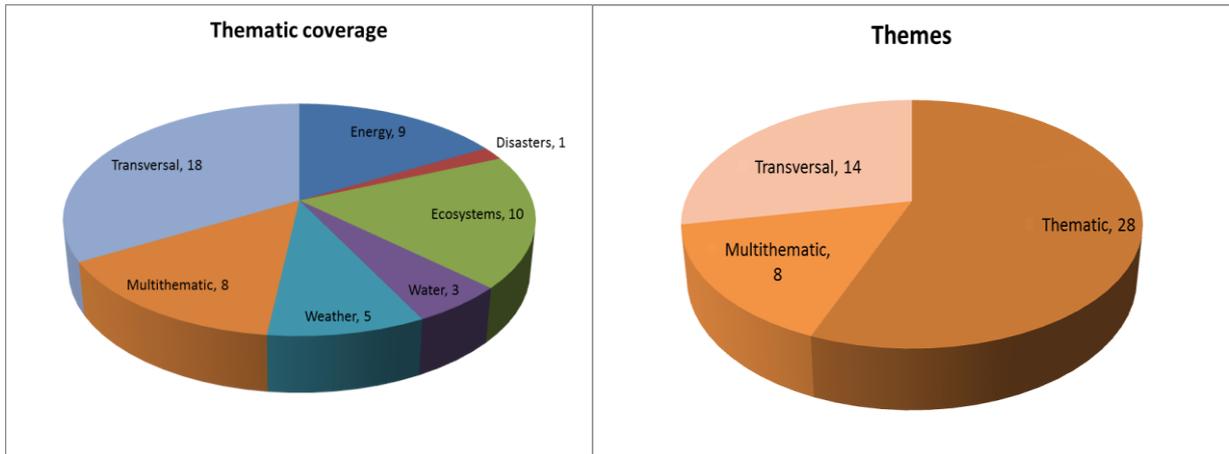


Figure 3. Left, thematic coverage addressed by the ENVIROFI stakeholders; Right, aggregated themes.

We identified most communities (18) on European level, closely followed by globally active groups (17), whereas less national initiatives (9) have been listed. Compared to the previous version we now also identified several (10) stakeholders on local level. These groups allowed us to shift to the innovation Infrastructure and community centric view (see Section 3) and to drastically increase the user role in the development and testing activities of the ENVIROFI applications.

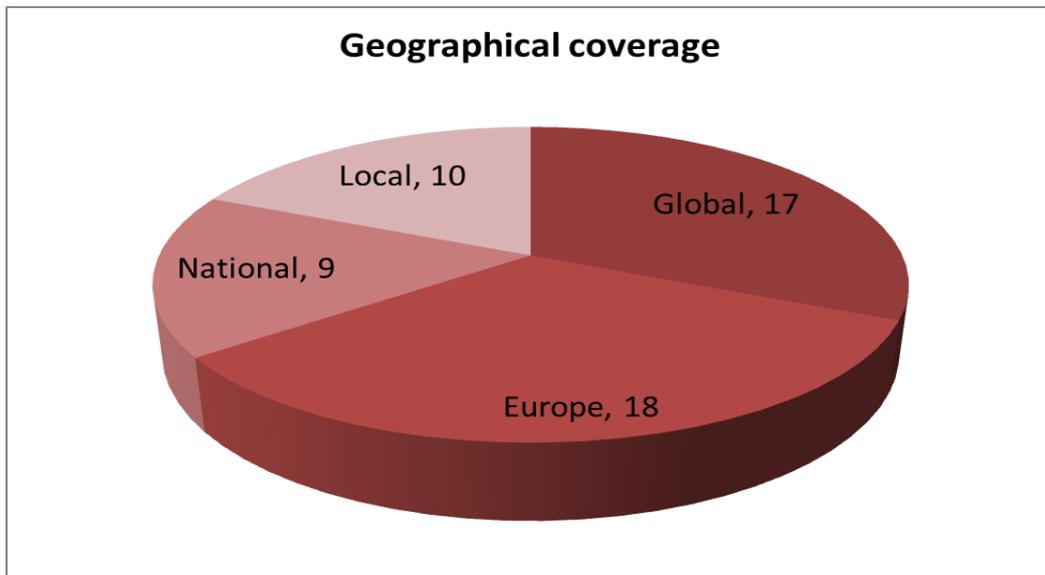


Figure 4. Geographical coverage addressed by the ENVIROFI stakeholders

3 Analysis of the elInnovation Infrastructure

This section analyses the shift in the ENVIROFI approach towards open innovation by complementing the up to now technology focused work with a community-centric view and arguing for the need of 'collaboration enablers' in the FI-PPP, as introduced in D6.3.2 (Schade et al., 2012). It further elaborates in the concept of an elInnovation Infrastructure as an appropriate framework for addressing the arising issues. We call an elInnovation Infrastructure the provision of an ecosystem of customized instantiations of collaboration enablers along with strategies for application creation, development and testing, operating closely with stakeholders in real-life experimentations. We decided to introduce the term elInnovation in line with notions such as eScience, in which cyber-infrastructures provide the means for scientists to collaborate and particularly to exchange early ideas, model workflows, and data that is required in order to support the needs of multidisciplinary collaborative research (Hey and Trefethen, 2005) and make scientific experiments reproducible (Mesirov, 2010). On the other hand, the notion of collaboration enablers are revisited and shaped in a governance methodology so as to coordinate participants in the life-cycle process of applications development. The role of involved stakeholders and relevant actors introduced earlier is briefly sketched in the realm of the ENVIROFI use cases and pilots. Decisions are argued in relation to the discussions, which took place between ENVIROFI, CONCORD and several Living Lab representatives from around Europe (see Annex B). Means for realizing the proposed infrastructure are presented in section 4, where we introduce the ENVIROFI contributions as such.

The Future Internet is addressing the interplay between the public and the private sector: innovation should be triggered primarily by an application pull, whereas a technology-push is secondary. Consequently, ENVIROFI has to encompass the socio-economic and organizational dimensions of the development: facilitate the articulation of requirements and creation of added value services; motivate 'actors' (such as SMEs, research institutions, and public organizations) to develop and market innovative services in a competitive context; and motivate the 'data owners', 'sensor network owners', 'environmental modelers' and 'citizen' to market their resources.

The elInnovation Infrastructure for Environmental and Geospatial Matters in the Future Internet shall be a main instrument for the assessment of existing Research and Development (R&D), and Innovation activities of the Environmental Usage Area. It shall build on the inputs of tasks T6.1 and T6.2, and provide a tool which helps us to streamline standardization-related work in environmental application fields, but also to plan and carry out the design, development and testing of ENVIROFI enablers in close collaboration with users, actors and stakeholders. In this regard, ENVIROFI shall develop a plan for user community building and stakeholder engagement, including the development of the elInnovation Infrastructure specifications. Furthermore, ENVIROFI shall also provide the resources for its initialization; in particular through provision of an ecosystem of services and collaboration enablers allowing open individualized experimentation and Living Labs with collective capability in monitoring the environment at high resolution spatial scales. This overall incentive is summarized in Table 3.

Initial Objective	Measurable Success Indicators (Old)	Measurable Success Indicators (New)	Targets (New)
<i>Establish a Digital Living Laboratory for Environmental ICT in Europe</i>	<ul style="list-style-type: none"> ○ Availability of Living Lab specification ○ Availability of supporting platforms (in FI portal and in environmental communities) ○ Activities in that laboratory (due to ENVIROFI internal activities, but also to external collaborations) 	<ul style="list-style-type: none"> ○ Availability of elnnovation Infrastructure Specification ○ Availability of supporting platforms (in FI portal and in environmental communities) ○ Activities and impact generated using that infrastructure (due to ENVIROFI internal activities, but also to external collaborations) 	D6.3.x ENVIROFI Digital Living Lab scheduled at: <ul style="list-style-type: none"> ○ M6: Initial Specifications ○ M14: New specifications and availability of first set of collaboration enablers (connecting to the environmental ICT domain) ○ M24: ENVIROFI use cases and first enablers connected via the elnnovation Infrastructure

Table 3. Success measures for elnnovation Infrastructure for Environmental and Geospatial Matters in the FI: a modification of D6.3.1 (Schade, Granell and Havlik, 2011), Table 2, changes highlighted in bold.

3.1 A Framework for Characterizing elnnovation Infrastructures

It is clear that innovation strategies should involve a wide range of potential stakeholders in the design, development, and testing of a product or service. Ballon et al. (2005) proposed a conceptual framework for characterizing different types of innovation strategies. First, the takeoff of a product or service onto the market is mostly bound to the degree of maturity of the technology used. Second, the aim of the open innovation strategies may range from design and development to testing platforms. For instance, prototyping strategies are mostly focused on design and early implementation of products and services, whereas test beds are centered on testing and assessing capabilities of products and services. Finally, the degree of openness refers to the level of ‘external participation’ as a product, as well as a service, goes through its life-cycle from its inception to the market. A description of the variety of open innovation programs according to the targeted audience is available in D6.3.1 (Schade, Granell and Havlik, 2011). Extreme examples are closed teams such as an in-house R&D laboratory to open innovation participation such as crowd-sourcing (Howe, 2006).

Figure 5 presents a revised version of this conceptual framework, where technology maturity and the degree of openness are on the horizontal axis, bottom and top respectively. We modified the initial graphic from Ballon et al. (2005) for illustrating what we believe is currently missing – or not matured enough – in order to seriously address the innovation space between service and product developers/providers and all potential stakeholders. Accordingly, the figure underlines the current gap in technology transfer and collaboration; it requests catalysts between R&D results and ready-to-use products in the marketplace accompanied by a major involvement of stakeholders towards marketable products and services.

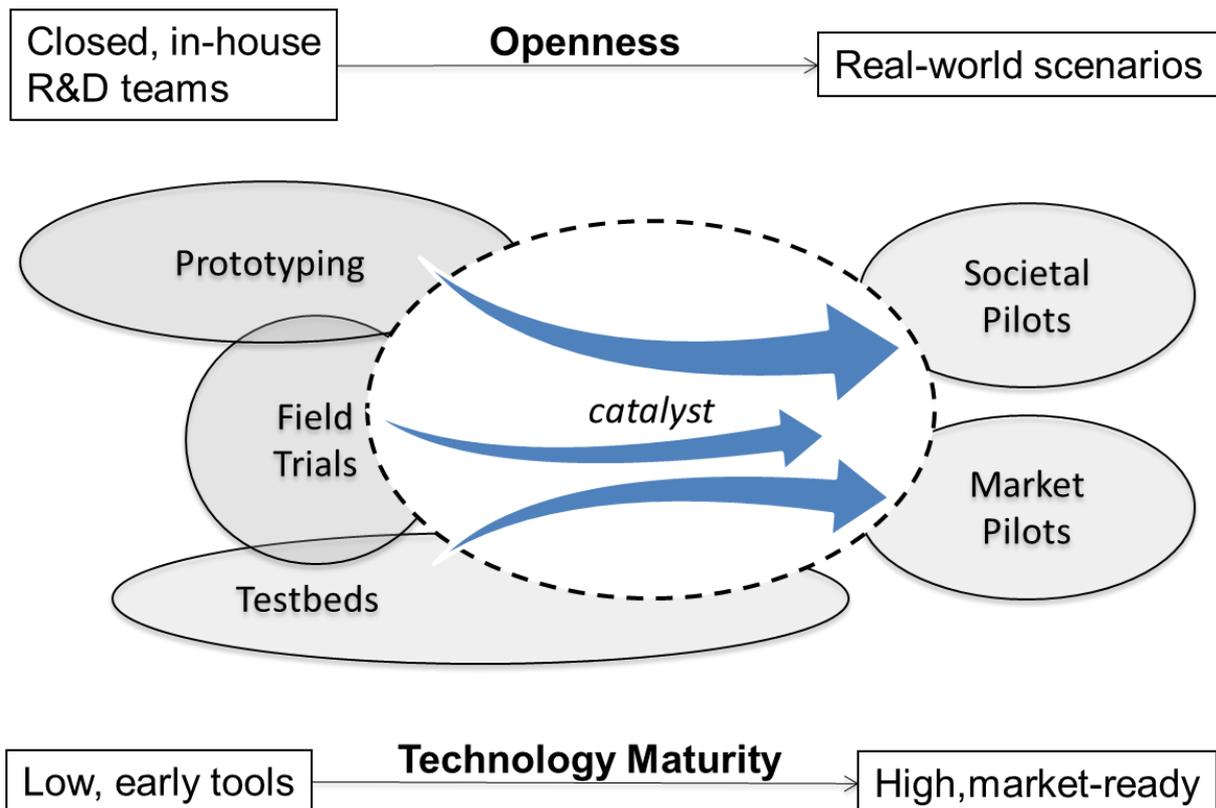


Figure 5. Existing gap to leverage R&D results to market-ready products (typology of open innovation strategies modified from Balloon et al. (2005))

Over the years, a large set of existing components for implementing geospatial and environmental applications emerged from test beds – such as OGC Web Services (OWS) or GEO/GEOSS Application Integration Pilots (AIPs) –, or from prototypes, which have been developed by research projects – e.g. under the funding of the US National Science Foundation (NSF) or the European Commission (EC). As a prominent example, the NSF EarthCube programme (earthcube.ning.com/) aims to develop a user-community-guided cyber-infrastructure to integrate geospatial data across specialties on earth systems and foster collaboration between these (science) communities. Under the EC’s FI-PPP (Future Internet Public-Private Partnership) Programme, an ecosystem of interrelated research projects are pursuing to build a series of enablers for multiple usage areas - including environment as in the case of ENVIROFI (Havlik et al., 2011) – with a strong commitment on stakeholder engagement and innovation in the long term.

As another example, the EU-funded EuroGEOSS project has contributed to the GEOSS Common Infrastructure (GCI) with concrete and valuable operational components in support of technology test beds, GEOSS AIP or even development of cross-thematic environmental applications (Vaccari et al., 2012). In the context of the INSPIRE Directive (EC, 2007), harmonised data models (INSPIRE Data Specifications) have been tested by the community, and prototypes for assessing INSPIRE Networking Services and supporting tools have been developed. Both can be seen as initial inputs for a Re-usable INSPIRE Reference Platform (ec.europa.eu/isa/actions/01-trusted-information-exchange/1-17action_en.htm), which aims to establish a reference platform and develop common component to increase interoperability among public authorities and industry in order to successfully implement an European spatial data infrastructure. Together with many others, all the above projects and initiatives pursue to provide not only components, data and service specifications, reference models, software tools together with best practices and guidelines of using them, but also existing test facilities, platforms and technical infrastructures.

These building blocks are complemented by an increasing number of Virtual Globes, which pave the

way towards a new generation of Digital Earth applications (Craglia et al., 2012) (Schade and Granell, in press), as well as increasing capabilities for geo-social networking (Chang and Li, 2013), geo-coding and geo-tagging mechanisms for environmental applications (Craglia, Ostermann, and Spinsanti, 2012) (Crooks et al., 2013). All in all it can be summarized as ‘toolboxes’ or enablers, which ensure a technology push towards geospatial and environmental applications. They enable several types of important user interactions, including personalization, community building, content creation and sharing, and a rich set of user experience components. In summary, the above leaves us with two questions regarding Figure 5: (1) how might we govern the overall process and the connections among these heterogeneous building blocks and (2) who or what should approach the required catalysts to boost technology transfer and stakeholders collaboration? We elaborate on both in sections 3.1.1 and 3.1.2 respectively.

3.1.1 Generic Governance Methodology

A sound, flexible methodology is required to help us to shape the desired infrastructure on the premises of the open innovation, and to materialize our planned objectives, aims, and expectations with respect to the elnnoaiton Infrastructure for Environmental and Geospatial Matters in the Future Internet. We are then looking for a governance methodology to establish well-defined methods to coordinate and inter-relate involved participants together with development and open innovation strategies in place (e.g. prototyping, test beds). As the methodology of choice, we decided to follow an approach suggested within the Apollon project (www.apollo-pilot.eu), which has also been adopted by the European Network of Living Labs (ENoLL, www.openlivinglabs.eu) and the CONCORD project (www.fi-ppp.eu/about-us/projects/concord/). The approach is based on the Cyclic Innovation Model (CIM) (Berkhout, 2000) (Berkhout and van der Diun, 2007). In doing so, the benefits are several. In a short-term, our elnnoaiton Infrastructure efforts shall be in line with the Living Lab view in the CONCORD project and thereby with the FI-PPP programme as a whole. In a mid- and long-term period, as elnnoaiton Infrastructure for Environmental and Geospatial Matters in the Future Internet should be shaped according to the CIM methodology, this will notable increase the likelihood to endure the infrastructure (or at least parts of it) after the ENVIROFI project ends. Notably, the lifting of CIM from a pure Living Lab focus to the wider concept of an elnnoaiton infrastructure for supporting open innovation strategies for application creation, development and testing, along with close collaboration with stakeholders in real-life experimentations did not require mature modifications.

The most important feature of the CIM methodology (Figure 6) is that the different phases towards innovation are not a one-way pipeline but a circle: innovations build on innovations (feedback), ideas create new concepts, successes create new challenges, and failures create new insights (Berkhout, 2000) (Berkhout and van der Diun, 2007). The CIM methodology proposes an innovation model composed of dynamic processes, which evolve according to environment and context changes, along with four phases: Scanning the Environment (market exploration), Ideas Creation (innovation), Research and Development, and Deployment. This means that the four phases influence each other. As a result, relations between innovation and creativeness (Idea and Concept Creation), science and technology (Research and Development), industry (Deployment) and market (Scanning the Environment) are reflected in the model, which leads to creative, open, and interactive innovation processes.

The first two phases (Scanning the Environment and Idea Concept and Creation) were dealt in the previous version of this deliverable (Schade et al., 2012). The Research and Development phase is suggested to some extent in this deliverable. The ENVIROFI project mainly addresses the first three of these phases. The Deployment phase, follow-up on R&D that will eventually lead to highly scalable implementations of environmental enablers and to large scale implementations in close collaboration with industry actors, is foreseen for projects in the phase 2 and 3 of the FI-PPP programme.

In figure 6 we center on the particular case of the R&D phase that’s actually characterized by an AGILE approach to design, develop, and test products and services. We revisit this concept later.

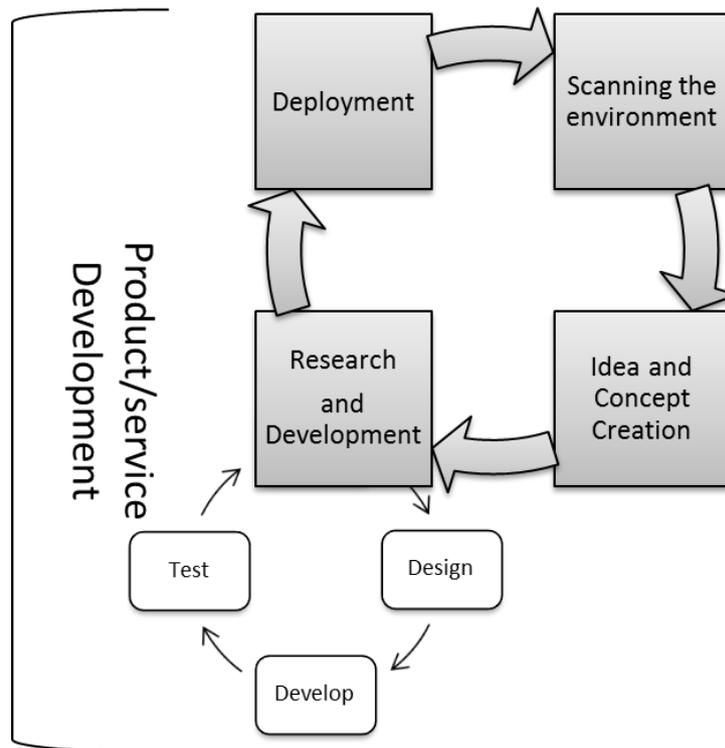


Figure 6. Cyclic Innovation Model plus AGILE development in the ENVIROFI scope

The Apollon approach suggests extending the CIM methodology for the creation of user-driven innovation networks (Living Labs in their case). Each of the CIM phases (see Figure 6 above) follows a cyclic model made up of four steps as illustrated below (Figure 7):

- **Connect:** This step is concerning with the initial, minimum infrastructure to enable collaboration, etc. to start each CIM phase. An important aspect at this step is the definition of the intended users and audience to delimit and anticipate the needed resources, scope, and impact of the Living Lab at each CIM phase. For instance in the case of the eInnovation Infrastructure that is prepared within ENVIROFI, the target audience for the phase “Idea and Concept Creation” (section 4.2.1) may be different from those in the “Development” phase (section 4.4.1). Furthermore, trying to answer to following questions is a good exercise: do we prefer to engage a lot of people, even without knowledge or expertise in the Environmental Usage Area, or a smaller, more selective team? Do we find incremental or disruptive ideas? Do we want to establish a trusted network of partners or just to attract people interested in such themes?
- **Plan and engage:** the definition of the boundaries in terms of Intellectual Property Rights (IPR) management and formal agreements among the involved stakeholders, as well as the definition of use cases and best practices. In the case of the eInnovation Infrastructure for Environmental and Geospatial Matters in the Future Internet, this step may include the initial consortium and collaboration agreements, as pointed out in section 4.1.2. Some questions in this step are: Who plays the role of coordinator? Who acts as facilitator? How information and conversions are channeled through the network of stakeholders?
- **Support and govern:** As each CIM phase is related to different aspects in an open innovation program, such as market, science, innovation, technology, and industry, the supporting tools, services, and infrastructure to carry out each phase may be distinct. Definition of milestones and assurance of active communication among stakeholders are common tasks of this step. Some examples of supporting services are listed in section 4.2.3.
- **Manage and track:** This step includes an assessment of the expected impact and expectations of the outcomes of each CIM phases, according to the initial goals and scope set in the Connect step. Again, in the case of the eInnovation Infrastructure for Environmental and Geospatial

Matters in the Future Internet, this step may include different actions, depending on the CIM phase, as briefly illustrated in sections 4.1.4 and 4.2.4.

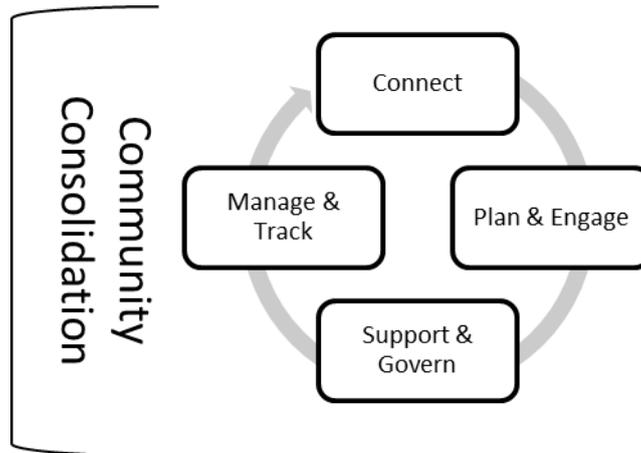


Figure 7. Extended Cyclic Innovation model for User-driven innovation networks (after Apollon Project)

The aim of the generic governance methodology is then to accommodate the core CIM methodology to the specific scenario of the setup of specific pilots/tests. In other words, each CIM phase in Figure 6 suffers a ‘specific tuning’ through the application of the four cyclic steps in Figure 7. Notably, each step may (and most likely will) include different methods and supporting services as they aim at different outcomes and because different people are involved. The extended CIM methodology in Figure 7 is aimed to support stakeholder engagement and community building. Figure 8 represents a step further and reflects in the product development in conjunction to community consolidation and engagement. The combination of phases for product development in close collaboration with stakeholders allows the promotion of open innovation and the launch of products or services to the market once the appropriate level of maturity is reached.

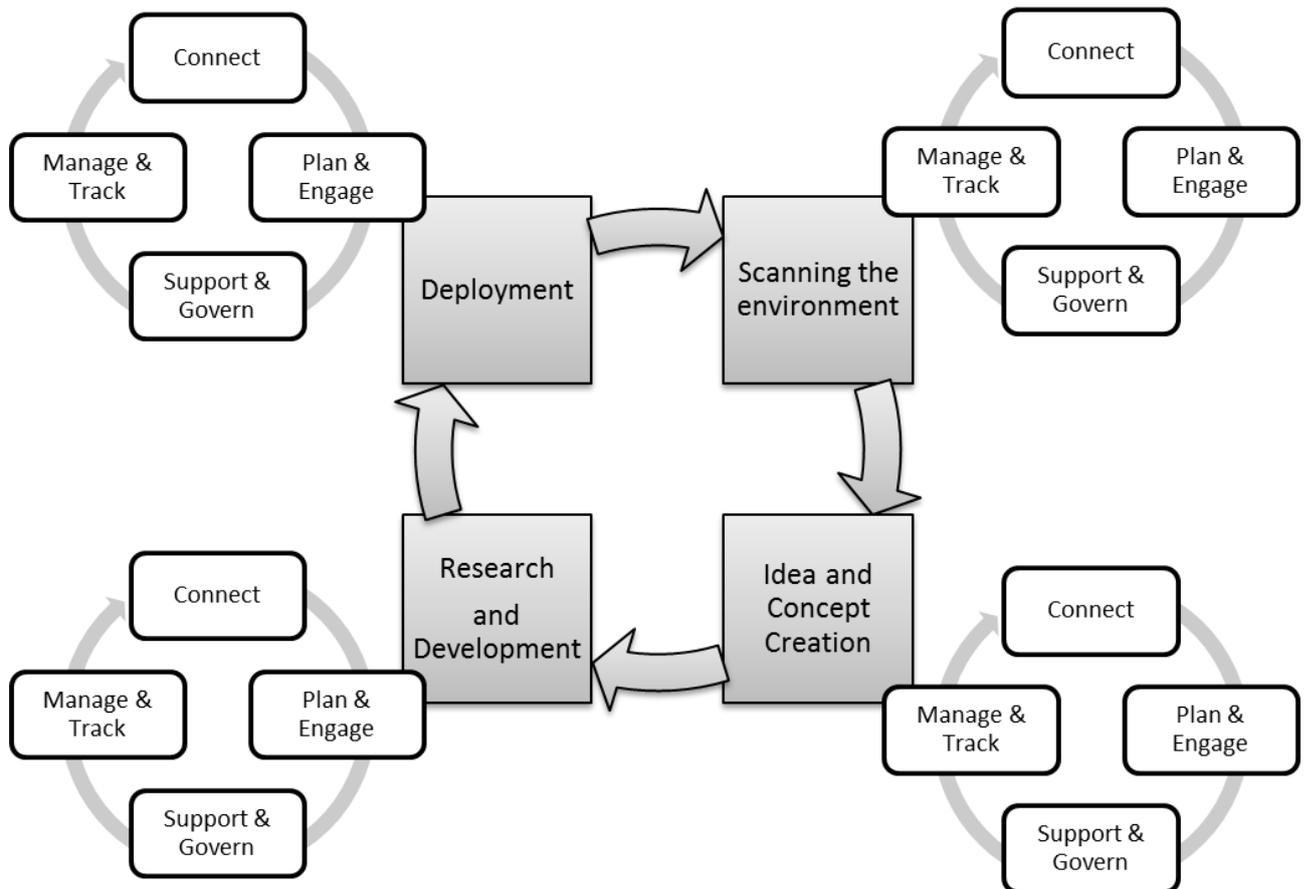


Figure 8. Extended Cyclic Innovation model for customer-driven product development (after Schade and Granell (in press))

Furthermore, this methodology is aimed to put stakeholders and technical staff and developers working together from the early stages of a product or service. In principle, this methodology can be deployed at all stages of the framework introduced above (Figure 5), i.e. to realize prototypes, test beds, but also market and social pilots. In respect to the goal of ENVIROFI project, we will particularly focus on the use of this methodology for approaching the required catalyst between less mature and closed developments and open markets as follows.

3.1.2 Living Laboratories

Ballon et al. (2005) already suggested a possible mechanism for implementing the required facilitator for open innovation and co-creation: Living Labs. Over the last decade this concept has been promoted as one promising way to address the above challenges, i.e. transforming available inputs (prototype software components and various technology or design focused testing facilities) with the desired outcome (mature and innovative products with strong market take up). They incorporate the requested catalyst and also – at least in parts – social and market pilots.

The term Living Lab as such is difficult to define (Ballon et al. 2005, Bergvall-Kåreborn and Ståhlbröst 2009, Levén and Holmström 2012). The main defining characteristics may be summarized as follows:

- A Living Lab enables conducting experiments in familiar and real-world contexts. Experimental settings resemble as closely as possible real-life situations and embrace the uncontrollable dynamics of everyday life. If you plan to introduce a next generation mobile device, for example, give it to people on the street.
- A Living Lab provides an experimentation environment for co-creation in close collaboration with (end) users. This means that users openly and actively participate in all stages of a product

development (e.g. ideas, design, development, testing), and not only in last phases. For example, ask users for their impressions and suggestions for the user interface of your new mobile device.

- Opposed to (fully-open) crowd-sourcing (Howe 2006), a Living Lab follows an open innovation strategy where there are restrictions on the targeted participating audience. For example, give a few dozens or hundreds of your mobile devices to selected people.
- A Living lab can be seen as an open innovation ecosystem. By promoting co-creation, community dynamics and real life contexts, innovation processes may emerge to create new opportunities and capture unique ideas from a set of stakeholders who have valuable knowledge for shaping specific problems, and social and technological needs. New generations (teenagers) have certainly different desires than elderly people – not only considering mobile devices.

The European Network of Living Labs (ENoLL) provides many more details about the overall concept and hosts searchable contact information for more than 300 Living Labs within Europe, China and Africa. Details about possible more specific governance models for Living Labs are illustratively described in (MEDLAB, 2011).

While all the above findings can be equally applied to any application domain, we will in the next section further elaborate on the specific of ENVIROFI project and eventually required adaptations when applying the Living Lab approach in this context. In relation to existing investigations on governance for Digital Earth applications – as for example developed in the context of EarthCube and the Digital Earth Living Lab (Schade and Granell, in press) – we seek a common governance methodology that allows us to particularly inter-connect and increase cooperation and collaboration with stakeholders in the creation, development and deployment of ENVIROFI applications and (ii) to in general trigger innovation for environmental applications in the realm of Future Internet technologies.

3.1.3 Shaping an elnnovation Infrastructure

In this section, we put together the pieces described previously, i.e. the generic governance methodology (Section 3.1.1) and the notion of Living Labs (Section 3.1.2), in order to shape an elnnovation Infrastructure that aims to promote stakeholder engagement and to address sustainable development and growth, i.e. to boost market transitions and socio-economic benefit in relation to environmental applications. We promote this approach for implementing the catalyst requested above (Figure 5), particularly for closing the gap in user-contributed validation, reflections of desirable solutions and market needs, as well as development of innovative environmental applications.

Figure 9 summarizes the resulting elnnovation Infrastructure based on the initial sketch of Figure 5. It is worth to mention first that Figure 9 only illustrates the Research and Development phase of the CIM methodology (section 3.1.1), since this is the focus of the present deliverable. Previous phases such as the Ideas and Concept Creation may certainly rely on the stakeholder community. Product developers, companies and organizations may draw on ideas, opinions and feedbacks that may lie outside their own boundaries from the very early stages of the development process (Schade, Granell and Havlink, 2011).

In the case of Research and Development phase, currently available inputs – research prototypes, results from field trials and technical components from out of test beds (lower-left part of the figure) – serve as the seeds for a designing, development and testing approach following the generic governance methodology described above (Section 3.1.1). The catalysts factor is illustrated by the successive Living Labs interactions (lower-central part) towards the lower-right of the figure which should be matured environmental applications close to market release. Schade and Granell (in press) discussed in detail the interplay of Living Labs and Open Innovation in the development of Digital Earth applications, which may be easily translated into the environmental field.

Consistent with the AGILE approach, the Living Lab approach relies on iterations of shorter product development cycles characterized by the stakeholder involvement (upper part of the figure). However, rather than starting from the classical user requirement analysis, this approach offers opportunities for more creative thinking and doing, timely feedback and rapid interactions between technologists and stakeholders (e.g. government agencies, scientists, SMEs) who will be involved in the development of an application or service. The upper part of the figure illustrates stakeholders and communities (a cloud

of circles). In a generic sense, such communities, which might be an ad hoc and dynamic group of people) are not independent, but interconnected and sometimes even contain each other. Such communities would not only embrace research projects, such as the FI-PPP projects, but also crisis mappers, test beds, environmental associations, and thematic expert groups of any kind. The increased openness of a product (service, application, etc.) is accompanied by the amount and variety of stakeholders who participate in each step of the development process.

In this scenario, **collaboration enablers** (we omitted this additional graphic element in order to not overload the figure 9) are then needed to connect, plan, support and manage collaboration with and between stakeholder communities as well as with product developers. That's the reason why the AGILE approach to design-develop-test of Figure 6 becomes now co-design, co-develop, and co-test. Living labs are seen as catalysts to connect product development with stakeholders and communities so as to promote innovation, technology transfer, and marketable products and services.

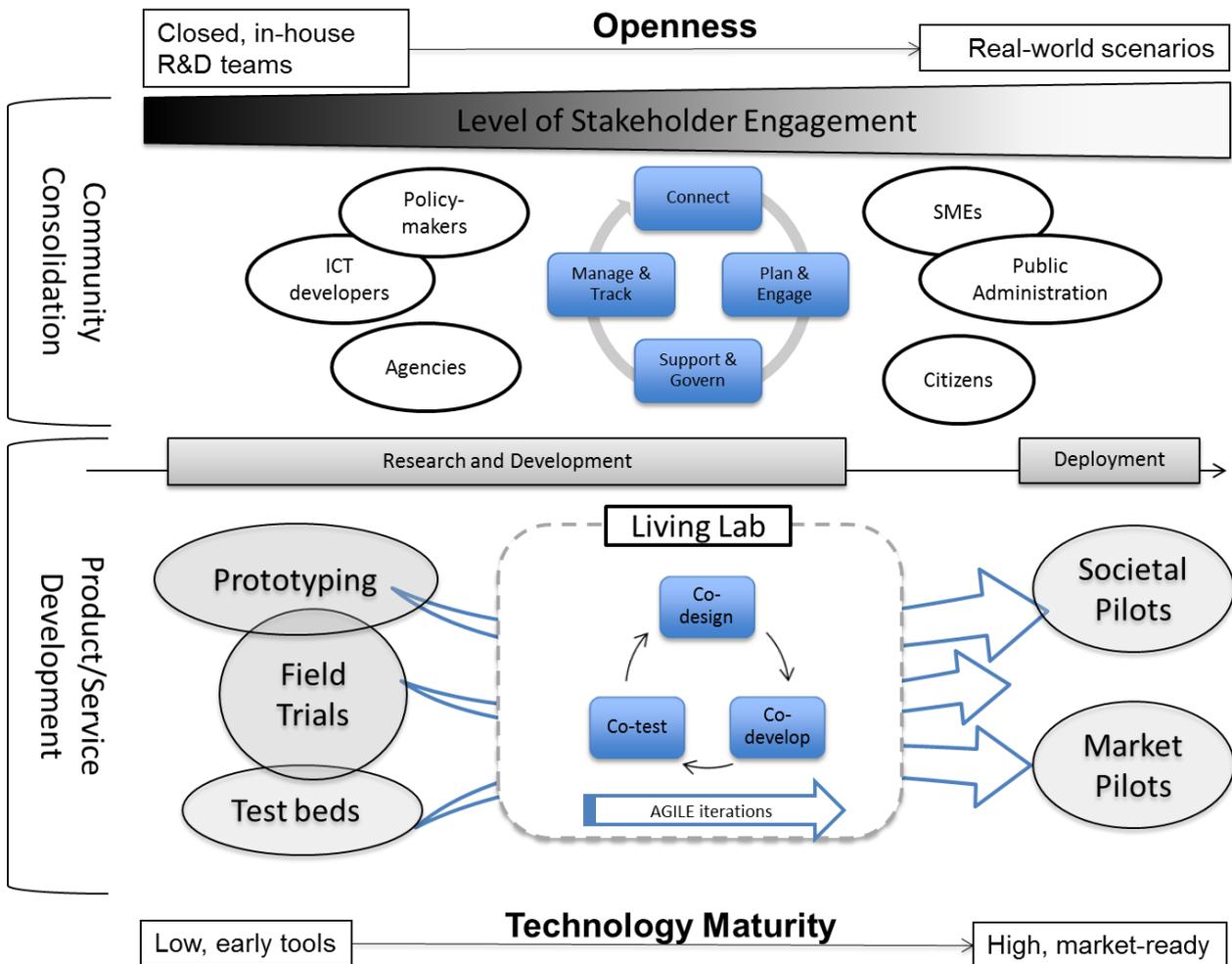


Figure 9. Living Labs as catalysts for realizing elnnovation Infrastructures

3.2 Instantiation of elnnovation Infrastructure for the ENVIROFI applications

So far, ENVIROFI and most FI-PPP projects focused on a technology-oriented view, which could be summarized as initial prototypes and results from field trials and test beds, as well as technical enablers developed in early phases, illustrated in the lower-left part of the Figure 9. In this section we instantiate the elnnovation Infrastructure depicted in Figure 9 to the ENVIROFI context in accordance with the target M24 in Table 3, namely “ENVIROFI use cases and first enablers connected via the elnnovation

Infrastructure". Here we provide an example for the ENVIROFI "Biodiversity Survey Application" as further detailed in deliverables D1.3.2 (Schleidt et al., 2012). Our focus is not on the technical details of the application development, but on the shift from a technology-centric to a community-centric view. For us, this conceptual shift is fundamental for the further progressing in respect to innovation and the preparation on large-scale pilots in phase 2 and 3 of FI-PPPP. However, rather than centering on the implementation of particular enablers and components, interactions with associated stakeholders, the application of open innovation strategies and collaboration enablers are the focus here and, in general, how all of this fits into the eInnovation Infrastructure framework. As follow-up of the intense discussions within the Environmental Community (see also D6.2.2 (Schade et al., 2012)), further details on recent consultations with living labs and stakeholders carried out during the last period of the ENVIROFI project will be described in the next section.

3.2.1 The ENVIROFI Biodiversity Survey Application

The ENVIROFI applications are one of the major results of the ENVIROFI project. Remarkable applications are the Biodiversity Survey Application (BIO App), the Personal Environmental Information System (PEIS), and the Marine Asset decision Support Tool (MAST). PEIS, an outcome of WP2, is a mobile application enabling users to monitor information on the state of atmosphere and related hazards from their own particular perspective. MAST, as a result from WP3, is a web portal that mashes together a number of freely available information and data feeds to monitor operational weather conditions in Galway Bay, Ireland. Here, we take as example the BIO App developed in the context of WP1 to illustrate how the AGILE approach to application development has been smoothly interwoven with diverse communities of stakeholders.

The Bio App is aimed to support the preservation of biodiversity. It focuses on the use of Future Internet technology for survey, analysis, quality assurance, persistence and dissemination of biodiversity data. This enables users from a wide variety of backgrounds to (i) access data on interesting biodiversity occurrences recorded directly at their current location, (ii) provide data on biodiversity occurrences they are currently observing, and (iii) provide feedback on the correctness of existing biodiversity occurrence records in the system. In order to allow data provisioning by users, they may either add information to existing entries on individual plants or animals, or provide information on specimen currently not contained within the system. While the data models and ontologies adopted by the ENVIROFI project allow us to handle any species, in the context of the prototype testing activities it was decided to reduce the scope of the app to trees. This was done with the specific aim of allowing testing by users who are not biodiversity experts, and to simplify the possibility of providing multiple annotations on the same specimen.

As an example of the first aspect of the BIO App, users may ask for interesting aspects of biodiversity in their immediate surrounds. The BIO App provides users with a map centred on their current location with all individual occurrence records (e.g. trees in the vicinity) available for this area (left part of Figure 10). Additionally, users may obtain detailed information on the individual plant or animal occurrence records by clicking on the symbols on the map. This includes information on the species of the individual plant or animal, various further observations as well as measurements and an image of each specimen (right part of Figure 10).

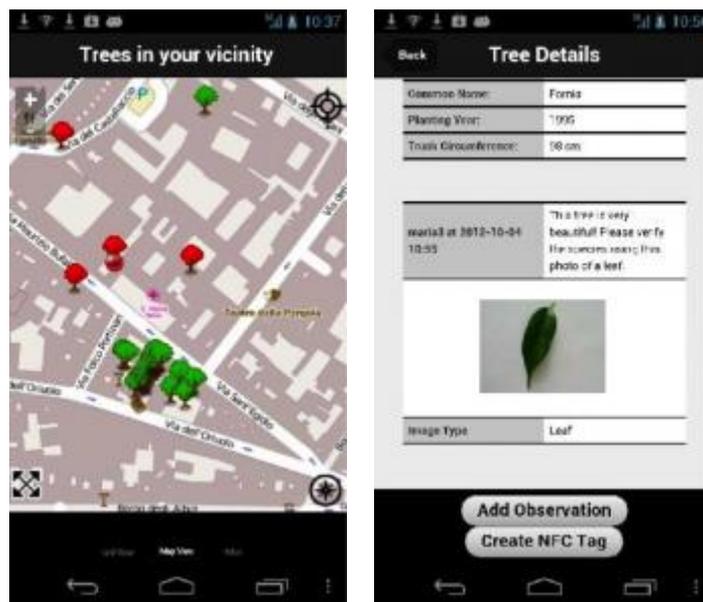


Figure 10. Examples of the BIO App (see related deliverables from WP1)

The previous tool description fits into the AGILE application development phases (low part of figure 9) in which developers through iterative cycles are able to increasingly improve the final application. Here we focus on the upper part of figure 9 to see how stakeholders and interested participants have influence on the BIO App development. In this regard, we adapted different open innovation strategies to connect and engage stakeholders in the co-designing, co-development, and co-testing of the BIO App: (1) organizing brainstorming sessions involving “experts” in the biodiversity thematic area, (2) through open calls on the Web (crowd participation), and (3) through the use of public meetings and test-beds for collecting requirements and feedbacks from actual end-user in real contexts. For this purpose we relied on the experience of Living Laboratories, which are open innovation ecosystems with a strong focus on a specific network of end users, since it offers opportunities for more creative thinking and interactions between technologists and users.

The first type of engagement activities –brainstorming sessions with experts–, were conducted during the first period of the ENVIROFI project, and reported in past deliverables of WP1, in the case of the biodiversity pilots. These activities were mostly internal to the project. However, we also searched for advice, views, and opinions from a board of external experts (Advisory Board) through a set of three Advisory Board meetings held over the project (see annexes in D6.2.2 (Schade et al., 2012) and in D6.2.3 (Granell et al., 2013)). All in all, it provided a coherent and complete view of the functional requirements for the Bio App from a selected group of experts both internal and external to the project.

The second type engagement of activities –open calls on the web (crowd participation)–, have been carried out during the last period of the project. We did an open call to the environmental community in general but particularly targeted to the Region of Tuscany to get feedback, questions, issues, or comments addressed to the ENVIROFI project team. Curious citizens were able to download the BIO App, assessed it in their local settings and provided feedback via email. For doing so, we set up a dedicated web page (e.g., the biodiversity pilot of ‘citizens in Tuscany’ at www.envirofi.eu/citizens.aspx) containing all required information to install and run the application. The page was updated on an approximately monthly basis, to share progress in terms of new releases of the app, as well as to document relevant public meetings.

The third type of engagement activities – public meetings and test bed with stakeholders–, have been much more intensive over the last period of the project. In the case of the biodiversity pilots in general, around 60 stakeholders have been contacted (full stakeholder list in Annex A) highlighting the wide array of stakeholders involved in the project from experts and professionals (e.g. environmental guides), to amateurs and curious citizens, to services (e.g. managers of tourism boards) and departments of

public administrations (e.g. municipalities). Not all of them have actively participated in the BIO App development. However, we managed to stimulate the participation of stakeholders and attract experts and non-experts alike by organizing an intensive series of public meetings (further details will be reported on in the pilot evaluation and testing deliverable of WP1), which were combined with hands-on sessions. Meeting participants were able to test the application and provide directly real feedback and suggestions for next functionalities and steps to the ENVIROFI project team. Meeting participants provided helpful comments and feedback since tests were realized in their local environments and places. Another effort made in the context of WP1 was to provide specific opportunities for a direct liaison between the research and development team and the general public.

A couple of examples may clarify the nature of such public meetings. In October 2012, an ENVIROFI workshop was held in Torniella, southern Tuscany. In addition to the typical agenda of discussions and elaborations on various project tasks and issues, the meeting was extended with a two-hour open event in the community centre of Torniella. In that same month (October 2012) a different approach for stakeholder engagement was taken. An ENVIROFI event was collocated as part of a big event called *Festa dei saperi e dei sapori dell'Alta Val di Merse*, in Monticiano. In this case, the strategy was completely opposed to the one of the previous event. Food was the hook factor and the BIO app was just an additional activity to really motivated visitors to the Local Food Fair. Finally, a full stakeholder workshop was held in Florence in January 2013, taking advantage of the comfortable logistics of this location and the presence in this city of the home offices of various authorities, it was possible for the full ENVIROFI team to interact with the general public, and to provide an overall overview of the different usage areas (not just WP1).

That is, in-house lab experimentations became into real-life experimentations by engaging users in different settings and scales. In general, such results, both online and off-line, were directly fed into the development process exemplified by the flow co-design, co-develop, and co-test in Figure 9. By engaging citizens in the biodiversity survey process, we can not only utilise the users' interest in nature to glean new relevant data about the state of biodiversity in the world around us, but we can also improve the users' understanding of biodiversity as well as fostering their interest by providing a way to make a change. In the end public, non-virtual community meetings were proven yet to be an efficient way to engage stakeholders and citizens and motivate them.

3.2.2 Collaboration enablers

Following the community-centric view just introduced above, we feel an under-representation of components, which facilitate communication within communities, but even more important the collaboration between communities, which will be a central requirement for open innovation (Chesbrough, 2003). As introduced earlier, we call these components "collaboration enablers".

We currently see only some services supporting collaboration within communities, but especially between communities. The FI-PPP already provides:

- FI-Ware fusion-forge for interacting between Usage Area projects and FI-Ware on technical matters.
- FI-Ware chapter on 'Business Framework', which reports on available collaboration enablers within the FI-PPP, including the market place.
- INFINITY repository of infrastructures XiPi (www.xipi.eu).
- CONCORD (soft) services for connecting to Living Laboratories and test sides.

However, these collaboration enablers can support only parts of the required bi-directional collaboration between stakeholder communities in and outside the FI-PPP. For example, we see a need for:

- Monitoring of user testing.
- Feedback mechanisms from users to Usage Area projects, not only at testing stage but also at early stages such as collecting new needs and requirements.
- Platform for offering enablers for (open) community testing.

- Fostering long-term community-level engagement and retention by using record-keeping enablers for determining relative contribution from participants.
- Public meetings and dissemination events
- Hands-on meetings
- Crowd participation through open calls on the Web

Note: We are well aware that many of these enablers have to be provided specifically focused on a user community, e.g. Usage Area, and that testing of those always have to be done in relatively closed settings.

4 Methods for implementing the elnnovation Infrastructure

Discussions between ENVIROFI and CONCORD (especially with ENoLL and IBBT) helped to align the approach suggested ENVIROFI with the on-going discussions at FI-PPP level. This deliverable contains advanced results of these discussions and will in future be used to raise major questions, using the structure that is imposed by the general framework. Updates of this section will be provided where appropriate. Naturally, at this stage of the FI-PPP Programme, the earlier sub-sections of this chapter include more information than the latter ones. As the third and last version of this deliverable, we have extended this section with new actions from May 2012 to March 2013, apart from the activities already carried out during the first part of the project.

4.1 Scanning the Environment

It is one main objective of ENVIROFI to provide community-consolidated Future Internet requirements and enabler specifications for the Environmental Usage Area. Supporting conceptual prototypes and a socio-economic analysis of the expected impacts is requested in addition. Focusing on the environmental observation web and facilitated applications (Havlik et al., 2011), the work is defined in a way that may have major implication on the future generation of environmental information infrastructures (Digital Earth). Accordingly, public and private organizations, as well as people, have to be involved from the beginning. This includes the provision of reference material together with a sketch of the desired ENVIROFI architecture.

The environment for establishing the above has already been scanned during the proposal preparation and in the first month of the ENVIROFI project. Particularly task T6.1 provided major contributions in terms of general stakeholders and available technical components (see also deliverables D6.1.1 (Mazzetti et al., 2011) and D6.1.2 (Mazzetti et al., 2011)). Activities are now continued as part of tasks T6.2 and T6.3.

4.1.1 Connect

The FI-PPP project consortia and especially the ENVIROFI partners are destined to be early adopters and testers of the intended elnnovation Infrastructure. In addition, stakeholders of the various domains of environmental informatics have been identified (Mazzetti et al., 2011). Section 2 of this document already provides an update. Intense connections to the FI-PPP are established via WP4 and WP7, while the strong connection to the environmental and environmental informatics sector is primarily taken care of by WP6 (task T6.2). The latest report is available as ENVIROFI deliverable D6.2.2 (Schade et al., 2012).

The intensification of such connections naturally would increase and be progressing into phases 2 and 3 of the FI-PPP.

4.1.2 Set Boundaries and Engage

Boundary conditions have been already set within the FI-PPP Programme and internally within the ENVIROFI project. Achievements include:

- The Signatures of the consortium and collaboration agreements.
- The establishment of project and programme mailing lists etc.
- The engagement of project consortium members in terms as defined in the ENVIROFI Description of Work (DoW) (ENVIROFI Consortium, 2011).
- The contributions of all project partners to task T6.1, especially to the stakeholder and technical components surveys (Havlik et al., 2011).
- The continuation of the above in the context of task T6.3, where this deliverable provides the final results in project month 24.
- The ENVIROFI scenarios set a focus in terms of content (to terrestrial biodiversity, atmospheric

conditions and pollen, and marine assets).

4.1.3 Support and Govern

Support and governance structures are mainly topic to tasks T6.1 ('ENVIROFI Stakeholder Analysis: Communities, Architectures and Technologies') and T6.2 ('Preparation, Execution and Reporting of Community Consultations'). However, decisions on appropriate tools still had to be taken. For ENVIROFI, following tools have been used for scanning the open innovation and Living Lab environment:

- ENVIROFI Stakeholder and Components Wiki (<http://wiki.envirofi.eu/>), not publically available at the time of writing this document)
- ENVIROFI Web page (<http://www.envirofi.eu/>), which is currently extended with specific pages for the stakeholder and testing communities under the scenario work packages (WP1, WP2 and WP3).
- ENVIROFI Twitter account (<http://twitter.com/ENVIROFI>)
- Future Sensor Web and its Applications group on the INSPIRE Forum (<http://inspire-forum.jrc.ec.europa.eu/pg/groups/9265/the-future-sensor-web/>)
- Environmental Information Infrastructures and Platforms (ENVIP) portal (<http://www.envip.eu>)
- FI-PPP web page (<http://www.fi-ppp.eu/>, offered by CONCORD)
- FIA and general FI web pages (<http://www.future-internet.eu/>, for some reason weakly linked with the FI-PPP one)
- ENVIROFI Advisory Board Wiki (http://ab-wiki.envirofi.eu/index.php/Main_Page)
- CONCORD Wiki for capturing the results of bi-literal discussions between CONCORD and ENVIROFI in an open setting.
- DWG FI-PPP wiki (<http://dwg-fi-ppp.wikispaces.com/home>) for capturing the result of the Dissemination Working Group activities at FI-PPP level.

4.1.4 Manage and Track

The coordination of required actions in centralized in WP6. Whereas task T6.2 is the main carrier for managing and tracing stakeholder engagement, task T6.3 provides the required tools. Related risks have been defined and tracked (ENVIROFI Consortium, 2011). The discussions with CONCORD became one of the major contributions over the last months. Tracking is supported by the CONCORD project in form of their Wiki (see also below).

4.2 Idea and Concept Creation

The evolution of a Future Internet infrastructure goes in line with the emergence of open, secure and trusted service platforms for building networked applications, and the arising cyber infrastructures in various science domains. Such an infrastructure can be leveraged through user-centered open innovation schemes.

The eInnovation Infrastructure for Environmental and Geospatial Matters in the Future Internet (Section 3) provides the urgently required grounds for a collaborative development approach. It may help to relieve eGovernment for environment from its infancy. Contributions will continue after the end of the project (Schade and Granell, in press). This includes the agreement on common/representative scenarios, as well as discussions of (i) FI requirements and Digital Earth (DE) applications (ii) environmental enablers for the FI and DE, (iii) ENVIROFI conceptual prototypes, and (iv) socio-

economic impacts.

In respect to the environmental informatics sector, this activity started and is in progress (in terms of task T6.2); a first stakeholder workshop and advisory board meeting, which both took place in early October 2011, a second round (where the community-centric-view has first been presented) was held in mid April 2012 (Schade et al., 2012). The final project events took place in Dublin in March 2013 and are further described in deliverable 6.2.3 (Granell et al, 2013).

4.2.1 Connect

The needs of the usage areas represented within FI-PPP cannot be fully represented by the respective Usage Area projects. The usage area projects therefore have to rely on additional inputs and feedback from their respective stakeholders communities. For these reasons, WP6 establishes and coordinates the collaboration with the ENVIROFI Stakeholder Communities, which includes environmental agencies up to national and European level, standardization bodies and related international initiatives, SMEs working in the earth observation, environmental and geospatial sector, as well as local authorities and end-users (See Section 2). Activities for establishing relevant communities have been undertaken over the project. For example, EC-JRC and the European Environmental Agency (EEA) organized a workshop on 'The Future Sensor Web and Its Applications' in late January 2010, in which core areas for innovation have been identified. It was concluded, that many issues of the observation web can be addressed by existing research results. The effort to lift available prototypes to innovative scalable and robust products/services is the real challenge. Additionally, SINTEF and JRC co-organized the two Environmental Information Systems and Services Infrastructures and Platforms (ENVIP) workshops, which brought together current FP7 research projects dealing with environmental content and services. The participants agreed to proceed with the community building; a third workshop is planned for August 2012. CEN/TC287 follows similar efforts in order to maintain research results and to facilitate related standardization processes. ENVIROFI is now in liaison with CEN/TC287 and already contributed to a technical report on spatial data infrastructures (SDI). Similarly, revisions of the SDI reference models of OGC and ISO have been initiated.

Main stakeholders include:

- *Citizens* of a particular social, political, or national community;
- *Environmental agencies* on sub-national, national and European level;
- *Public authorities* of national and regional and other level;
- *Industries* from the primary, secondary and service sector; and
- *Standardization organizations* providing the umbrella for establishing standard procedures.

4.2.2 Set Boundaries and Engage

ENVIROFI shall establish the connections between the involved communities. Instead of building new expert groups, the project shall establish an environmental connector to the Future Internet, as well as a Future Internet hub for the environmental sector. In terms of standardization, the latter shall be used to contribute to the advancement of the 10 year old service model ISO 19119 of ISO/TC211 and accordingly contribute to an updated OGC reference model. Both shall take the Future Internet development into account and allow for the best integration possible. ENVIROFI standardizations shall help to lay the basis of the Digital Living Lab for Environmental and Geospatial Matters in the Future Internet. They shall allow for collaboration with geospatial and environmental standardization bodies (ISO, CEN, OGC etc.) and provide access to experimentation infrastructures and technology, preparing for both an environmental and a geospatial enabling of the Future Internet. Related end users from the public and private sectors shall become involved.

The ENVIROFI Advisory Board (AB) reflects the targeted audience. Advisory board has been selected and formally invited to participate on three meetings over the project (Granell et al., 2013). The above also holds for wider communities, as we invited stakeholder representatives to a couple of ENVIROFI consultation workshops, and the final ENVIROFI conference Day in Dublin (Granell et al., 2013).

Future engagement beyond the ENVIROFI project might be reached by launching open competitions

e.g. together with OGC test beds, GEOSS Architecture Implementation Pilots. Particularly the discussion on the Internet of Things (IoT) at OGC, to which ENVIROFI also invited FI-Ware to give a presentation, provided a good step forward. An according working group at OGC is under way now and ENVIROFI is represented.

Beyond that, several Living Laboratories across Europe in order to investigate possible trials for the Environmental Usage Area and to start to define connections between the identified communities and stakeholder networks.

4.2.3 Support and Govern

For this stage, the eInnovation Infrastructure requires means for connecting the FI with the Environmental Informatics communities and vice versa. This section outlines the basic needs, available capabilities and an analysis of the missing pieces. It provides the basis for potential collaboration enablers to support an eInnovation Infrastructure for Environmental and Geospatial Matters in the Future Internet:

- ENVIROFI Stakeholder and Components Wiki (<http://wiki.envirofi.eu/>, not publically available)
- ENVIROFI Web page (<http://www.envirofi.eu/>)
- ENVIROFI Twitter account (<http://twitter.com/ENVIROFI>)
- Environmental Information Infrastructures and Platforms (ENVIP) portal (<http://www.envip.eu>)
- FI-PPP web page (<http://www.fi-ppp.eu/>, offered by CONCORD)
- FIA and general FI web pages (<http://www.future-internet.eu/>, for some reason weakly linked with the FI-PPP one)
- ENoLL Web page (<http://www.openlivinglabs.eu/>)
- Incoming tools from the Apollon project (<http://www.apollon-pilot.eu/>)
- FI-Ware Applications/Services Ecosystem and Delivery Framework (http://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php/Applications/Services_Ecosystem_and_Delivery_Framework)
- OGC web page (<http://www.opengeospatial.org/>) and portal (<http://portal.opengeospatial.org/>)
- OGC IoT and SWE pages (<http://www.ogcnetwork.net/node/1802>).
- GEOSS front-ends (<http://www.earthobservations.org/geoss.shtml>)
- INSPIRE web page (<http://inspire.jrc.ec.europa.eu/>)
- INSPIRE portal (<http://www.inspire-geoportal.eu/index.cfm>)
- INSPIRE forum (<http://inspire-forum.jrc.ec.europa.eu/>)

As far as concrete supporting techniques are concerned, and on top of the techniques already mentioned in deliverable D6.2.2 (Schade et al., 2012), we initiated activity within CONCORD to report on available collaboration enablers within the FI-PPP.

4.2.4 Manage and Track

Management and tracking will largely depend on the choice of appropriate tools. For the time being, we exploit the ENVIP portal, which provides the required means for reporting on the stakeholder workshops. We host a Wiki for the ENVIROFI Advisory Board activities to keep dialogues and interactions stored.

At the same time, we carried out investigations on connectors to test beds and Living Labs, including contact forms, user monitoring and feedback mechanisms on the use of specific enablers.

4.3 (Research and) Development

The project is in advanced state in terms of the specification and required development work within the scope of the thematic WPs, i.e. WP1, WP2 and WP3, as well as in WP5. In their combinations, ENVIROFI starts to provide (conceptual) prototypes, which illustrate how envisioned scenarios of the Environmental Usage Area could be realized within the FI. The resulting software components provide the basis for large scale implementation in phase 2 of the FI-PPP. Thus, they should become part of the eInnovation Infrastructure. Related discussions took place in the final consultation event of the project, see also task T6.2.

4.3.1 Connect

This includes collaborations with standardization organizations such as ISO, OGC and CEN, see deliverables D4.2 (van der Schaaf et al., 2011) and D6.2.2 (Schade et al., 2012). It also involves the stakeholders of the thematic work packages, see deliverables D1.3.2 (Schleidt et al., 2012), D2.3.2 (Kobernus and Pielorz, 2012), and D3.3.2 (Delaney et al, 2012). Further expansion of these stakeholder communities will now be established by promoting linkage to existing Living Labs and test beds within Europe.

Main stakeholders include:

- *Environmental agencies* on sub-national, national and European level;
- *Public authorities* of national and regional and other level;
- *Industries* from the primary, secondary and service sector;
- *Platform providers* offering frameworks on which applications may be run;
- *Standardization organizations* providing the umbrella for establishing standard procedures.
- *Living Labs* providing user-driven innovation tools and methodologies (see Annex B)

4.3.2 Set Boundaries and Engage

- In terms of spatial extend we intent to concentrate on Europe. Scaling to global coverage will be examined at a later stage.
- Thematically, we concentrate on the three spheres covered by WP1 (biodiversity), WP2 (air quality and health) and WP3 (marine assets).
- In terms of standardization we keep considering OGC, ISO and CEN.
- Clear technical components are defined in scope of WP5, deliverable D5.2.2 (Modafferi et al., 2012).

Note: INSPIRE and GEOSS compliance is continuously examined here.

- Engagement with user communities has been initiated as reported on in the x.3.1 deliverables of WP1, WP2 and WP3 respectively.
- Investigations on trials are ongoing within Europe, also with engagement of the CONCORD project partner ENoLL.
- Presentations and discussions have been initiated within ISO, CEN and OGC. OGC even opened an IoT SWE working group in which ENVIROFI is involved.
- Again, future engagement might be reached by launching open competitions e.g. together with OGC, GEOSS or with the upcoming ENVIROFI workshops.

4.3.3 Support and Govern

So far, the required measures are project internal:

- WP1, WP2 and WP3 for thematic components.
- WP5 for common environmental enablers.
- WP4 for any reference model work, incl. standardization.
- WP6 for outreach, incl. exploitation of Living Labs to use. This is partially supported by CONCORD.
- Crowd participation through open calls on the Web, such as the biodiversity pilot of 'citizens in Tuscany' at www.envirofi.eu/citizens.aspx

4.3.4 Manage and Track

Again, so far, most of the required measures are project internal:

- WP1, WP2 and WP3 for thematic components.
- WP5 for common environmental enablers.
- WP4 for any reference model work, incl. standardization.
- WP6 for outreach, incl. exploitation of Living Labs to use. This is partially supported by CONCORD (using their Wiki).

4.4 Deployment

In terms of the elnnovation Infrastructure, deployment and instantiation is at the moment out of the scope of the first phase of the FI-PPP, which also holds for the ENVIROFI project. First tests might however be carried out in the second year of the project.

4.4.1 Connect

In terms of the elnnovation Infrastructure, deployment and instantiation is at the moment out of the scope of the first phase of the FI-PPP, which also holds for the ENVIROFI project. Main stakeholders include:

- *Citizens* of a particular social, political, or national community;
- *Environmental agencies* on sub-national, national and European level;
- *Public authorities* of national and regional and other level;
- *Industries* from the primary, secondary and service sector;
- *Platform providers* offering frameworks on which applications may be run;
- *Infrastructure providers* offering physical components and essential services;
- *Sensor network owners* holding the sensor and basic communication hardware.
- *Standardization organizations* providing the umbrella for establishing standard procedures.
- *Living Labs* for scaling up pilot applications.

4.4.2 Set Boundaries and Engage

In terms of the elnnovation Infrastructure, deployment and instantiation is at the moment out of the scope of the first phase of the FI-PPP, which also holds for the ENVIROFI project.

4.4.3 Support and Govern

In terms of the elnnovation Infrastructure, deployment and instantiation is at the moment out of the

scope of the first phase of the FI-PPP, which also holds for the ENVIROFI project.

4.4.4 Manage and Track

In terms of the elnnovation Infrastructure, deployment and instantiation is at the moment out of the scope of the first phase of the FI-PPP, which also holds for the ENVIROFI project.

5 Conclusions and Outlook

This third and last deliverable of task T6.3 consolidated the shift from the overall concept of the Digital Living Lab for Environmental and Geospatial Matters in the Future Internet to a community centric-view, collaboration enablers and an overarching eInnovation Infrastructure for stimulating the engagement of the stakeholder community. The connections to program level activities, mainly initiated by the CONCORD project have been established and carried out successfully. In respect to our goals indicated in Table 3, we have provided a first eInnovation Infrastructure specification and set the grounds for instantiating the eInnovation Infrastructure to connect the ENVIROFI applications and stakeholders. Actions and efforts to actively engage community building and merging with existing communities have been carried out.

Given the high number of participants and of available tools and mechanisms identified throughout this document, further decisions on advancing the eInnovation Infrastructure will require an honest reality check within ENVIROFI but also inside the FI-PPP programme. In the end, eInnovation infrastructure implementations will strongly depend on 'value for money' measures and how the overall FI-PPP Programme moves towards a real ecosystem of enablers, services, applications and stakeholders (e.g. SMEs) pursuing marketable products and services. Given the available resources, prioritizations still have to be made across FI-PPP projects and risks have to be defined and closely monitored. From our perspective, final decisions should be taken to the best possible benefit to FI and to the environmental informatics field. The intense debate on the intended use of eInnovation Infrastructure and Living Labs under the lens of phases 2 and 3 of the FI-PPP has been initiated, including considerations of usage area internal activities (e.g. roadmaps of INSPIRE, SEIS and GEOSS).

The next follow-up actions in case of a short project extension until June 2013 will likely be community consultation and dissemination activities such as a workshop collocated in the upcoming INSPIRE 2013 conference, to be held in Florence, Italy, to showcase the latest developments of the ENVIROFI pilot applications. As one of the ENVIROFI pilots is centered on biodiversity and a great deal of stakeholders in this domain comes from the Region of Tuscany, this workshop may represent a great opportunity for further stakeholder engagement and dissemination. Results of these follow-up activities will be reported on in the dissemination plan and report deliverable, as part of WP7.

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Table 4. References

Annex A: List of Stakeholders

Stakeholder	Type				Role				Geographical Extent	Theme
	Organization	Community	Enterprise	Other	User	Resource Provider	Technology Provider	Other		
AEMET	✓					✓			National	Weather
G-OWS		✓					✓		Global	Transversal
GBIF Austria	✓	✓			✓	✓			National	Ecosystems
IOC-UNESCO	✓				✓	✓			Global	Water
52N			✓				✓		Global	Transversal
LifeWatch		✓		✓	✓	✓	✓		Europe	Ecosystems
Birdlife international		✓			✓				Global	Ecosystems
CEN TC211 – WG5	✓						✓		Europe	Transversal
DG Environment				✓	✓				Europe	Multithematic
EEA	✓				✓		✓		Europe	Multithematic
ENoLL				✓	✓				Europe	Multithematic
GBIF		✓			✓				Global	Ecosystems
GI@School				✓				✓	Global	Multithematic
GMES				✓	✓				Europe	Disasters
IFSA		✓					✓		Europe	Transversal
INSPIRE		✓			✓	✓	✓		Europe	Multithematic
ISO/IEC JTC 1/WG 7	✓						✓		Global	Transversal
ISO TC211	✓						✓		Global	Transversal
OGC	✓						✓		Global	Transversal
AGILE PTB		✓				✓		✓	Europe	Transversal
PUCK		✓					✓		Global	Transversal
RSPB		✓			✓				National	Ecosystems
SEIS		✓			✓			✓	Europe	Multithematic
UNEP-WCMC	✓				✓				Global	Multithematic
WMO	✓				✓		✓		Global	Weather
LTER	✓	✓			✓	✓	✓		Europe	Ecosystems
NFC	✓						✓		Global	Transversal
EGU	✓				✓			✓	Europe	Multithematic
GEO/GEOSS AIP		✓					✓		Global	Transversal
European GEO SIF		✓					✓		Europe	Transversal

Table 5. Profiles of stakeholders by July 2011, Month 4 (D6.1.2)

Stakeholder	Type				Role				Geographical Extent	Theme
	Organization	Community	Enterprise	Other	User	Resource Provider	Technology Provider	Other		
Municipality of Florence http://en.comune.fi.it/	✓				✓				Local	Transversal
LEA La Finoria http://www.leafinoria.org/			✓		✓				Local	Transversal
Australian Government, Bureau of Meteorology http://www.bom.gov.au/	✓				✓	✓			National	Weather
Terradata Environmetrics http://www.terradata.it/			✓		✓				Local	Ecosystems
Museo di Storia Naturale della Maremma http://www.diba.unifi.it/	✓				✓				Local	Ecosystems
Department of Agricultural biotechnology, University of Firenze http://www.diba.unifi.it/	✓				✓				Europe	Ecosystems
Norge Asthma & Allergy Forbund http://www.naaf.no	✓					✓			National	Weather
HMRC UCC – Hydraulics and Maritime Research Centre at University College Cork http://hmrc.ucc.ie/		✓		✓					Europe	Energy
MRIA – Marine Renewables Industry Association http://www.mria.ie/	✓			✓					Europe	Energy
SEAI – Sustainable Energy Authority of Ireland http://www.seai.ie/	✓			✓					National	Energy
MARINET - Marine Renewables Infrastructure Network http://www.fp7-marinet.eu/		✓		✓					Europe	Water

EU-OEA - European Ocean Energy Association http://www.eu-oea.com/	✓	✓		Europe	Water
Atlantic Ocean Energy Alliance http://www.aoea.ie/	✓	✓		National	Energy
Aquamarine Power Ltd. http://www.wavebob.com/		✓	✓	Global	Energy
Wavebob Ltd. http://www.wavebob.com/		✓	✓	Global	Energy
Ocean Energy Ltd. http://www.oceanenergy.ie/		✓	✓	Europe	Energy
Eirgrid http://www.eirgrid.com/	✓	✓		National	Energy
ESB / ESBI http://www.esbi.ie/	✓	✓	✓	Global	Energy

Table 6. Profiles of additional stakeholders by May 2012, Month 14 (D6.3.2)

Stakeholder	Type				Role				Geographical Extent	Theme
	Organization	Community	Enterprise	Other	User	Resource Provider	Technology Provider	Other		
Parco Nord Milano http://www.parconord.milano.it	✓				✓				Local	Ecosystems
Regione Toscana http://www.regione.toscana.it	✓				✓				Local	Transversal
Comune di Monticiano http://www.comune.monticiano.si.it	✓				✓				Local	Transversal
Unicoop Tirreno – sezione Maremma Est http://www.unicoptirreno.e-coop.it	✓				✓				Local	Transversal
Comune di Roccastrada http://www.comune.roccastrada.gr.it	✓				✓				Local	Transversal
Per Prata tra passato e Futuro http://www.pratadimaremma.it/	✓				✓	✓			Local	Ecosystems

Table 7. Profiles of additional stakeholders by January 2013, Month 22 (D6.3.3)

Annex B: Report on Interactions with Living Labs

Based on the discussions with CONCORD (already reported on in Annex A of D 6.3.2) and using the [ENoLL portal](#), we identified a set of potentially interesting living labs. We directly contacted the following living labs which share topics (environment, sensors, mobile devices, etc.) with the ENVIROFI project:

- IBBT ilab.o, Belgium (<http://www.openlivinglabs.eu/livinglab/iminds-ilabo>)
- Ghent Living Lab, Belgium (<http://www.openlivinglabs.eu/livinglab/iminds-ilabo>)
- City Lab Coventry, UK (<http://www.openlivinglabs.eu/livinglab/city-lab-coventry>)
- Botnia Living Lab, Sweden (<http://www.openlivinglabs.eu/node/125>)
- Testbed Helsinki, Finland (<http://testbed.fmi.fi/>)
- Bird Living Lab (Basque Country), Spain (<http://www.openlivinglabs.eu/livinglab/bird-living-lab>)
- Helsinki Living Labs, Forum Virium Helsinki, Finland (<http://www.openlivinglabs.eu/livinglab/helsinki-living-lab-forum-virium-helsinki>)
- Mobile Vikings, Belgium (mobilevikings.com/)

In addition, and based on the comments from the 1st ENVIROFI project review (in month 6), we started to elaborate on possible collaborations with the ELLIOT project (Experiential Living Lab for the Internet of Things, www.elliott-project.eu/) and Mobile Vikings, an online mobile operator in Belgium. They are not a living lab in itself, but closely linked (via INRIA as a project partner) to a French Living Laboratory and the iBBT iLab.o respectively.

Below, we present the track record of the LLs and ENVIROFI discussions, as maintained in the ENVIROFI Stakeholder and Components Wiki (wiki.envirofi.eu), not publically available at the time of writing this document. Not all contacted LLs are reported below. It is worthwhile to note also that iBBT iLabs.o and City Lab Coventry were partners in the follow-up ENVIROFI-2 project proposal submitted for Phase 2 of the FI-PPP programme.

B.1 iBBT iLab.o

iBBT has been recently renamed as iMinds (www.iminds.be/en), and the iLabs.o is now reachable via <http://www.iminds.be/en/develop-test/ilab-o>, <http://www.openlivinglabs.eu/livinglab/iminds-ilabo>

People contacted:

- Pieter Ballon

General information:

- 1st wave LL, Belgium.
- Dedicated LL work since 2006.
- The living lab of IBBT, a big research institute and centre of excellence in Flanders (ca 1000 researchers).
- As the institute is technical, also ilab.o is very technology oriented.
- 10-15 permanent personal for maintaining the LL itself, planning trials, etc.
- Additional 10-15 researchers working on user and business research (methods).
- Additional team of software developers.

- Set of over 4000 fully profiled volunteers.
- Partner in CONCORD and leading partner in several FI projects, including FIRE.

Main Activities:

- Requirement of test users (profiling and follow-up).
- Data capturing and analysis (qualitative and quantitative descriptions of peoples' behavior).
- Test application development (giving the users apps to test).
- Community interaction (adding social/community dynamics to classical user requirements).
- Capturing iterative aspects (follow-up users, managing growth and maintaining enthusiasm).
- Selected Current European Projects:
 - EPIC: Trials with cloud-based smart energy and community applications. Business Partners: IBM, Deloitte, Navidis, Immoweb. Our role: Overall project leader, and executing the Living Lab test on an augmented reality prototype.
 - SMART I+P: Monitoring of very large crowds of people through sensors. Business Partners: Alcatel Lucent, ... Our role: We lead the Living Lab large-scale trial.
 - CONSERN: Energy-aware self-managing wireless networks. Lead Partner(s): Intel, Huawei, Toshiba, NKUA, IMEC, Fraunhofer, OTE Our role: We lead the work package on business modeling and environmental-economic impact assessment of CONSERN.
 - APOLLON: Trial of tracking and tracing of volunteers for emergency situations. Business partners: SAP, Logica,... Our role: Overall project lead, Living Lab trial.
- Selected Current National Projects:
 - INCITIES: Smart city and smart energy platform. Business partners: Fifth Play, Telenet. Our role: Living Lab trial related to smart city platform, and smart energy meters.
 - GREENWECAN: Community-based wireless sensor network in smart city. Business partners: Androme, Bausch, Be-Mobile, Mondial Telecom, OneAccess, Stad Gent, Tele Atlas. Our role: Responsible for identifying and developing relevant community based business models for GreenWeCan.
 - SMARTE: Smart energy applications at home. Business partners: SPE Luminus, Xemex, Niko, Ferranti, Telenet. Our role: Responsible for user testing and business modeling.
 - ADMID: Sensor-based applications and middleware for transport and logistics. Business partners: H.Essers, IBM, idXs. Our role: Responsible for Business cases.
 - ESSENCES: Low-power distributed spectrum sensing. Our role: use case analysis, regulatory analysis, construction and evaluation of business scenarios, specific evaluation of platform models for spectrum sensing infrastructures.
 - NGWINETS: Heterogeneous wireless networks, cognitive radio. Our role: Techno-economic research on cognitive radio in general and spectrum sensing specifically.

Highlights for ENVIROFI:

- Study on community dynamics in the area of health, well-being and sensing.
- Citizen-based air quality monitoring for the city of Brussels.

Possible Involvements:

- Potential roles in phase 2 will depend on the exact (trial) case. ilab.o is part of (the legal entity) IBBT. On the one hand, they could get involved as an organizing partner, with no additional trial

organization. On the other hand, if we require for example data from the city of Brussels, the responsible organization has to get involved, too. In addition, local LLs, such as the one on Ghent (see also our list of favorites) might get involved with partial regional funding.

Interests/Expectations in ENVIROFI:

- Phase 2 should be about scaling as a main activity.
- Community/Social dynamics are a must!
- Continuing their research in the areas of health and well-being
- Building on the Air Quality monitoring in Brussels.
- Building a communities of interest and of practice for the biodiversity domain.
- Open to other applications.

B.2 City Lab Coventry

Coventry University's 2015 strategy is to tackle global issues via 6 Grand Challenge Initiatives (GCI's). These GCI's are now driving the research agenda at Coventry University and include, Digital Media, Low Impact Buildings, Low Carbon Vehicles, Integrated Transport and Logistics, Ageing community and sustainable agriculture and food.

City Lab Coventry (<http://www.openlivinglabs.eu/livinglab/city-lab-coventry>) is a joint venture between the University and the City Council that has been set up to address the global GCI's within the Smart city context by providing the City Centre as a test environment for low carbon ICT innovations. The University and the City Council own 90% of the land within Coventry City Centre, which is undergoing an £8 billion + regeneration programme over the next 15 years. City Lab Coventry is a real-life test and experimentation environment where users and producers co-create innovations. The City Lab Vision is to improve the quality of life for urban citizens and create an exemplar low carbon community in Coventry through: Establishing Coventry City as a test-bed, incubation hub and international showcase for low carbon innovations, Collaboration between key, world-renowned, research and industrial bodies, Use of the consortium's critical mass of expertise, facilities and resources to accelerate route to market. Within ENVIROFI City Lab Coventry could provide access to citizens as expert users, transport modes, buildings, ICT city infrastructure and existing demonstrator and business support programmes.

People contacted:

- Sinead Ouillon
- Kuo-Ming Chao (Leader of Distributed Systems and Modelling Research Group, Coventry University)
- Tim Luft (director of serious games institute)
- Pete Stojic (National Physical Laboratory (NPL) strategic partnership manager)

General information:

- 5th wave LL, UK.
- Main players are the University and the City Council, which together own 90% of the land in the city center.
- Opening the city doors to individuals and companies for demonstrating and testing their products/services.
- In contact with 7000 SMEs (mainly in Europe) for providing them a platform.

- They host a science park and an AppLab (together with the 1st serious games institute of the UM, now there are also others).
- They coordinate EU-level projects for fostering innovation (mainly on networking).

Main Activities

- Applied research and first-day user involvement in:
 - Sustainable Mobility
 - Energy Efficiency. Sustainable Energy. Climate change
 - Industrial and logistics development
 - Smart Cities. Future Internet. Internet of things.
 - e-Government. e-Participation
- Ongoing (large) projects on:
 - energy and cars
 - ambient living and eHealth
- Experiences in Cloud Computing and SOA.

Highlights for ENVIROFI:

- Serious games institute (<http://www.seriousgamesinstitute.co.uk/>) and AppLab, with 30 developers and strong SME contacts (see below).
- National Physical Laboratory (<http://www.npl.co.uk/environmental-measurement/>) developing own sensors.
- Big health institute, which just acquired a multi-million pound program in the area of tele health.
- Currently establishing an board of expert citizens for higher level feedback.

Interests/Expectations in ENVIROFI:

- Very interested in the environmental domain, also because the environmental usage area is the most generic of all.
- Several ideas on combining environment (e.g. air quality) with energy, transport and health.
- Could provide a testbed on the one hand, but also engage the AppLad for exploiting novel products.
- Fresh study case to proof ENVIROFI results.
- Considering scaling, they are well networked in the context of the UK smart city agenda and could leverage on a digital living lab with Manchester, Bristol and Birmingham.
- City Lab Coventry can provide access to citizens, vehicles, buildings, roads etc.
- App lab and e learning environment to support an ecosystem of developers to use ENVIRO-FI Toolkit
- Experiments to scale up geographically (further details on ENVIROFI Wiki)
- Experiments to Scale up to other sectors (further details on ENVIROFI Wiki)
- Provide SME's for experiments – we could provide a brokerage service, Coventry already has funding for this (further details on ENVIROFI Wiki)

Serious Games Institute (and App Lab) is one of the City Lab Coventry resources of relevance to ENVIROFI. For use in training (in virtual and real environments) an ecosystem of developers to use the ENVIROFI Toolkit: The Serious Games Institute (SGI) is a wholly owned subsidiary of Coventry University, it supports City Lab Coventry by providing funding for local SME's to develop mobile business applications. The SGI supports the development of digital media, in particular; - Serious Games, 3D animation/ virtual worlds/ games based training/ mobile applications and associated technology. The mobile 'apps' lab rolls out specialist industry training with regard to mobile technology, develops mobile proof of concepts and commercial prototype design and development, places PHD and MSC students into industry to work on mobile projects, champions public/private project development, and supports organisations in the development of their mobile strategy. The Studio is manned by 30 developers (4 in Satellite office in Singapore, 2 in South Africa NW University) and includes HTML5 / Web App development, Cross platform development team, Prototype development through to full commercial product, Mobile Strategy development, R & D, GPS, Image Recognition, Augmented Reality development and Mobile Training Courses.

B.3 Botnia Living Lab

<http://www.openlivinglabs.eu/node/125>

People contacted:

- Annika Sällström

General information:

- Sweden's first and largest open Living Lab for human-centric ICT development.

Main Activities:

- We are active in different domains with our Living Lab activities such as Smart Cities, GreenIT, Intelligent roads etc.
- Some ongoing projects where we are involved at the moment all involving end-users/citizens in different phases of the innovation lifecycle are:
 - TEFIS: platform for Future Internet Experimentation where we have three on-going pilots where we are involved: in the domains of mobile media, tourism services and e-learning;
 - Apollon: our involvement is mainly in cross-border pilots in the energy efficiency domain;
 - SITE: Energy awareness in schools;
 - SATIN; Platform for mobile apps by the users;
 - Sense Smart City: Sensor technologies in a city setting developing a platform for Smart City service creation, Pilots are in e-health, traffic management and city management;
 - SmartIES: Smart Energy savers - citizens engaged in the development of their energy saving services;
 - SocialLL: social media for user-driven innovation; and
 - Cassandra: a platform for decision-support in energy savings and Smart Grid services

Highlights for ENVIROFI:

- Our experience in applications related to environmental measurements or earth observations

the cases in the project list above probably relates best to environmental measurements rather than earth observations but from our Living Lab work we are "domain-independent" as long as it involves humans and IT - either in people's daily life or as professionals,

Interests/Expectations in ENVIROFI:

- One of our expertise is in research in user-driven innovation (methods, tools etc.)

B.4 Helsinki Testbed

Helsinki Testbed (<http://testbed.fmi.fi/>), part of the Finnish Meteorological institute.

People contacted:

- Juha Hyyppä
- Jarkko Koskinen

General information:

- It is not a LL a such
- they host a testbed and are connected to an active user community.

Main Activities

- The Finnish Meteorological institute maintains Testbed Helsinki, which is quite an impressive test environment for mesoscale weather research, forecast and dispersion models development and verification, demonstration of integration of modern technologies with complete weather observation systems, end-user product development and demonstration and data distribution for public and research community.

Highlights for ENVIROFI:

- They would be interested in collaborating with ENVIROFI, and possibly applying for Phase two with the consortium. The unit is working on Research and Development for Spatial Data Infrastructures. They especially would like to bring to the project location based services and 3Dvirtualisation of data. They have done some impressive work on that in Finland.

Interests/Expectations in ENVIROFI:

- This is definitely relevant and sounds interesting in general for ENVIROFI. However, we have quite some own development capacity on weather related systems in our consortium. It would be important to understand how the 'end-user product development and demonstration and data distribution for public and research community' part of this story works. Speaking for our weather/air quality related partners here, it would be essential to identify the communalities and complementing capacities.