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Short Description: The aim of this document is to provide an analysis of the Community Networks and Digital Ecosystems possible relationships in order to empower the socio-economic study within the OPAALS network of excellence. Both phenomena are understood through socio-technical infrastructures theory by reflecting on the relations between communities, infrastructures, services and governance at the broadband-enhanced local innovation level. The document underlines the possible relation between CNs and DEs by explaining the role of some core dimensions and suggests some open issues that should be considered in the phase 2 of the OPAALS project.

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Domains	Social and economic science domains are involved in this deliverable.
Targets	The research community is the main target of this deliverable.

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EXECUTIVE SUMMARY

This deliverable examines the possible relationships between Community Networks (CNs) and Digital Ecosystems (DEs). Since CNs are a well known subject and DEs are a very new research issue, this study is based on a theoretically-informed and literature-based definition of the two. The Socio-Technical Infrastructures (STIs) theory has been used to generate a conceptual tool that enables the understanding of CNs and DEs at the broadband-based local development level. This conceptual tool has been called “CISG framework” and suggests to relationally define the four core dimensions of a local innovation phenomenon: communities, infrastructures, services, governance. The framework facilitated the creation of typologies of the many Community Network definitions and cases, and reflection on Digital Ecosystems by using the same dimensions.

Community Networks come from the bottom-up FreeNets and CivicNets traditions. The term generally refers to on-line services created and used with high involvement by a community belonging to a geographical area. Nevertheless, new understandings about CNs emerged and nowadays we are faced with many CN definitions (historical, activist, engineering-business, computer-mediated communication) that refer to four typologies:

- *Traditional CN*, - from FreeNets experience – focused on grassroots participation and the creation of “democratic” on-line services;
- *New grassroots CN*, based on the creation and self-management of networked infrastructures at grassroots level;
- *New government CN*, focused on the creation of networked infrastructures at local government level;
- *New government 2 CN*, based on advanced and virtualised services provided via public infrastructures.

More synthetically, the label “community network” nowadays refers to two tendencies: the *grassroots tradition* and the *government initiative*. The grassroot tradition is based on bottom-up and participatory processes for democratic technologies – both services and infrastructures – and direct participation in community decisions. The government initiatives are based more on top-down processes for local innovation based on public broadband infrastructures, business operators participation and high level services.

Digital Ecosystems are an emerging infrastructural architecture coupled with socio-economic processes that has been analysed with the CISG framework by considering the Aragon (Spain) and Midlands (UK) experiences. Government agencies usually promote the initiative typically in a top-down manner. Then, the roles of other influences such as regional catalysts, adopters, and researchers are recognised in a process that is business-based and could involve bottom-up instances.

The hardware infrastructure is usually not problematised in DEs research. The focus has been on the *service oriented infrastructure* as the sw infrastructure and the core service for the community. In this, many other services could be generated on a common shared language. Therefore, the objective of the DE is to allow at local level the creation of new on-

line services based on the *service oriented infrastructure* and Open Source standards. Apart from the scientific community standards for DEs (Open Source approach and service architecture), the governance of DEs is one of the most complex aspects and needs further analysis, along with the coupling to the socio-economic processes.

Once the pilot phase is finished, one can assume that DEs can include bottom-up oriented approaches (communities); greater focus on new access hardware as mobile phones (infrastructures); support for the creation of services automatically generated by a *service oriented infrastructure* (services), and facilitation of the self-management of the service infrastructures by the users themselves.

The relationship between CNs and DEs is therefore characterized by the asymmetry of the two subjects at the maturity level, but some conclusions could be drawn. The socio-technical perspective should be considered when analysing CNs and DEs in order to avoid the underestimation of relevant dimensions and relationships (like the hardware infrastructure for DEs). Three interplays could be underlined at this level of analysis:

- *Ubiquitous infrastructures.* Government CNs, by providing broadband and ubiquitous access to the network, might facilitate the performance and participation to DEs.
- *Advanced services*. DEs can offer added value services for CNs.
- *Community participation*. Grassroots CNs can provide useful models and participation practices for the future evolution of DEs.

It is therefore possible to consider future scenarios where CNs and DEs could work synergistically. The scenarios will be possible when a mature 'Government CN' and an efficient DE will emerge with a full technological development, and will be populated by a cloud of services and players. The possible synergies between CNs and DEs are:

- *CN and DE as a synergistic regional development strategy*: it will provide both digital divide reduction and new advanced services for the community.
- *DE and CN as sources of different but possible complementary services*: it will provide the possibility to make already existing B2B services interoperable. In this case the research community will play the role of the "knowledge provider", by making available advanced knowledge, supporting SMEs, and developing a territorial incentive towards innovation.
- *CN as a source of well-tested experience related to community participatory practices*: it will guide the DE research community in developing further a participatory process for defining models of governance applicable to the DE at the local and global levels.

The deliverable also suggests some core issues to consider in the phase 2 of OPAALS:

1. The *need to undergo a phase of detailed empirical research on DEs*.
2. The *need to analyse DEs by taking into consideration other aspects of the broadband-based local innovation* as CNs.
3. The need for a more in-depth study of policies for DEs at a regional level.

1. INTRODUCTION

The aim of this deliverable is to develop an understanding of the possible relationships between Digital Ecosystem and Community Networks. In order to reach this goal a theoretical framework to support the description of these phenomena is developed by relying upon a set of shared dimensions. This intends to make translatable two realities that have important points of contact and potential synergies, as well as non-secondary differences.

The first difference and difficulty in connecting the Digital Ecosystem with the concept of Community Network is related to the degree of abstraction and complexity of the two concepts. While the concept of Digital Ecosystem is at a high level of abstraction and generalisation, the concept of Community Network is grounded and calls for micro-realities.

This difference and difficulty arises from the different processes that bring to the constitution of the two concepts. The Digital Ecosystem was first defined in 2002 as a new research area characterised for being strongly interdisciplinary. The Digital Ecosystem definition - linked to an Open Source approach to research, technology and social action - emerged well before its first empirical declination[1]. The concept of Community Network, instead, is "an emerging" concept, (ex-post) that is used for defining a well established social practice, strongly characterised by its bottom-up approach (particularly in the 80s and 90s).

The different levels of abstraction and generalisation of the two concepts give rise to the need for the creation of a theoretical framework that facilitates the understanding of their potential synergies. Such a theoretical framework will be, in this deliverable, based on a socio-technical definition of technology infrastructure, seen as complex networks that comprise hardware, software and social practices. This framework brings the level of analysis of DE to a *broadband-based local innovation*, in which the DEs and CNs interact on multiple dimensions.

There are many reasons for choosing such an approach. On the one hand Community Networks deserve a socio-technical approach because of their phenomenological characteristics. Initially linked with the action of many small groups of citizens they still have now – when the role of Public Administration becomes more relevant – the characteristics of a social phenomenon strongly influenced by the discursive dynamics of its protagonists. In other terms, a Community Network is a social phenomenon that, based on technology, cannot be reduced only to its technological dimension. The latter argument is also true for Digital Ecosystems.

On the other hand, the concept of Digital Ecosystem, due its interdisciplinary nature, needs a socio-technical approach for bringing together the different disciplinary languages that characterise it. A fundamental element of the concept of digital ecosystem is that of "associative and autopoietic systems" that remains excluded from this theoretical framework.

The link between a constructivist based socio-technical approach and associative-autopoiesis (or even Second Order Cybernetics) is an interesting subject for further study but it is substantially beyond the objectives of this deliverable. Rather, this link will be considered in

1 'Empirical declination' refers not only to the technological infrastructure developed during the DBE Project, but also to its actual use at the territorial level by the Regional Catalysts and SMEs.

the 2nd phase of the project, WP12 In this context we can only say that the two approaches built form a common root conceptualise the subject as the core of any cognitive process. It is the social actor that interprets the reality that, in this way, looses its ontological nature. Second Order Cybernetics provide an important point of contact:

- Knowledge is not passively received either through the senses or by way of communication, but is actively built up by the cognition subject.
- The function of cognition is adaptive (in the biological sense of the term), tending towards fit or viability and serves the subject's organisation of the experiential world, not the discovery of an objective ontological reality" (von Glaserfeld, 1988, 1996).

In this deliverable the socio-technical approach will be applied as follows:

- For developing a theoretical framework able to describe and compare innovative processes such as DE and CNs:
- For conceptualising a methodological framework to be used during the field research (it will be applied in the analysis of Trentino case – D7.2 – and OPAALS's second phase)
- For recognising the dimensions and the processes patterns able to support the DE analysis in a associative and/or autopoietic prospective (to be developed further in WP12, OPAALS second phase).

In this deliverable, the link and the exchange between CNs and DEs will be mainly at the theoretical level. Nevertheless, in the second phase of OPAALS, the difficulties highlighted above will partially lose their urgency because the link between the two concepts will reach the pragmatic of human relations in a specific territory (the autonomous Province of Trento). The formulation of a theoretical framework that is able to link the concepts of CNs and DEs is not an easy task (It is easier, as will be seen in chapter 6, to create scenarios for a concrete, inter-linked application at the local level). Nevertheless, the two concepts show important similarities with reference to local innovation that could become the logical support of each other (Chapter 6).

The software environment developed by the DBE project (service factory, evolutionary environment and execution environment) helped to highlight the differences and complementarities of the two approaches, specifically if looking at the creation and interoperability of Community Networks in the Province of Trento.

Therefore, the following research questions emerged:

- Is it possible to consider the community network primarily as a tool for the creation and the access to the network infrastructure?
- Can it be argued that the digital ecosystem assumes an efficient network infrastructure as a prerequisite for the construction of digital ecosystems?
- Is it possible to imagine a common approach to local innovation that makes synergistic a territorial intervention aimed at developing simultaneously a network infrastructure and local digital ecosystems?

The deliverable is therefore structured as follows. Chapters 2 and 3 constitute the theoretical framework. Chapter 2 will introduce the theory of Socio-Technical infrastructure, while

Chapter 3 will construct the specific theoretical framework, called CISG. Chapters 4 and 5 will analyse the Community Networks and Digital Ecosystems through the CISG framework. Chapter 6 will attempt a first connection between DEs and CNs and will outline their possible synergies. Finally, Chapter 7 will reflect the importance of the socio-technical approach within OPAALS, draw conclusions and discuss the deliverable's remaining open issues.

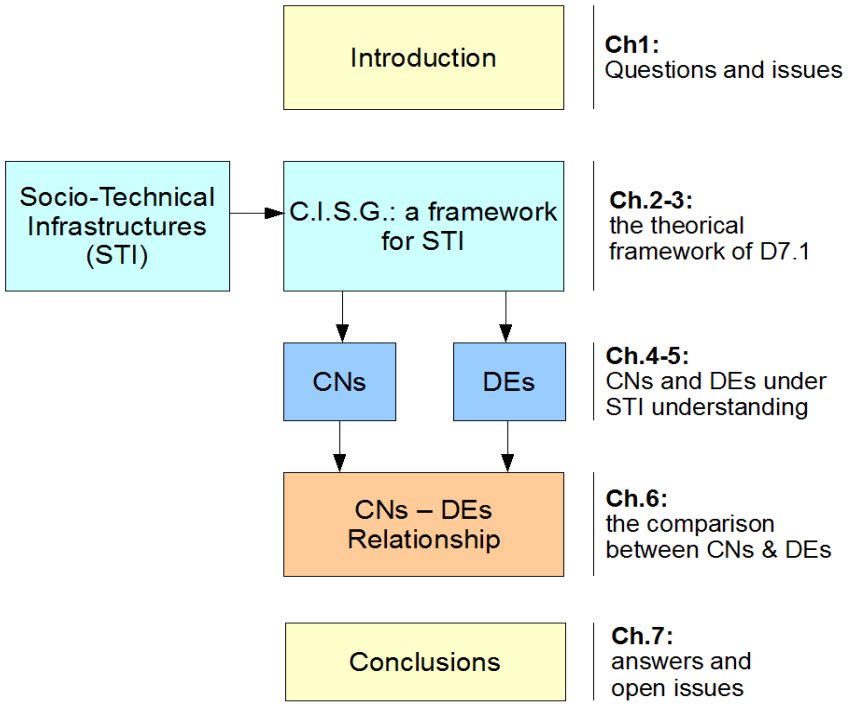

Figure 1: the structure of the deliverable.

Before approaching the focus of the deliverable, i.e. the CNs-DEs possible relationship, we wish to introduce a first definition of the 'digital ecosystem' (DE). Such a definition will provide an operational definition of the concept, useful for the overall guidance of the deliverable, as it does not intend to develop all of the aspects related to a digital ecosystem, but to retrace the most useful dimensions that allow the translation of a DE and a community network.

DE: the social sciences definition

It is important to notice (see Dini, 2007), that even inside the emerging community of practices of DE practitioners (that brings together different professionals, academics, ICT solutions developers and SMEs working on different projects inside the DE cluster), the concept has different meanings according to the disciplinary domain of reference (Table 1).

It is evident that there are several correspondences in the different definitions of the DE coming from the three disciplinary areas inside the scientific community of reference, but

there are also differences. The differences are not only related to terminology (different researchers give different names to a determined 'object'), as they are defining a given term from different 'angles' of observation (different researchers analyse, study and see a different 'object' while observing the DE). These different prospects are not alternative to each other but, on the contrary, they are complementary in defining a real interdisciplinary approach. As underlined by Bateson, the interdisciplinary is not given by grouping different academic approaches, but by the creation of a new 'object' understandable only through the synergy of different knowledge and methods (Bateson, 1984; as per Barthes, 1977).

Social Science	Computer Science	Natural Science
A community of users	Several categories of users	A population of interacting agents/applications
A shared set of languages	A set of languages	
A set of regulatory norms and guidelines to foster trust	A security and identity interface	
A population of services	A service oriented-infrastructure	A distributed evolutionary environment
An open-source service-oriented infrastructure	A service development environment	A dynamic, adaptive, learning, and scale-free network infrastructure
	A distributed P2P run-time environment	
	A distributed persistent storage layer	

Table 1: Digital Ecosystem definition (Source: Dini, 2007).

In this view, computer sciences are the link between social science (that find its focus, for example, in the relations between the actor/community and the service-oriented infrastructure), and natural science (that, put simply, studies the possible connections between the biological processes and software synthesis or design).

As summarised by Dini (2007: 27), these definitions, articulated through the three perspectives, summarise the *use* of the DE and its *synthesis*[2].

Related to the use, from the social science perspective, it is necessary to add another definition element. Since its first formulation, the concept of the DE has been linked to that of socio-economic development of European SMEs (and, amongst them, of software houses). The attention given to the small and micro European enterprises has not been context-free (as supported by the constructivist approach of the scientific community), but it has been materialised by the involvement of some European territories. Therefore, the DE can be also considered as a process of territorial innovation concretised by its multi-stockholders oriented approach (see Rathbone and Di Corinto, 2005; and Passani, 2007).

From this perspective the DE concept also takes into account the fact that European SMEs are strongly connected and dependent on their local realities and therefore the global solutions (also in terms of ICT) must be adaptable to the territorial and sector requirements of

2 Leaving unexplored the aspects related to the software design where language has a central role. In this respect, it is necessary to analyse the epistemological base of the DE to see that the definition of the DE is connected theoretically to the concept of CN (see Dini, 2007; Zeller and Wallmannsberger, 2007).

these enterprises (Dini et.al., 2005). Accordingly, the research on the Digital Ecosystems has developed interesting analyses and an approach for the inclusion of SMEs that passes through the activation of a network of regional actors capable of 'translating' the requests and necessities of these enterprises, therefore activating a process of technological innovation of business and research.

Therefore, the DE is a "service oriented infrastructure" populated by various services, that becomes an instrument for local innovation that passes from the creation and activation of diverse communities[3] of users and develops one "shared set of languages" and a "set of regulatory norms and guidelines to foster trust" [4].

It is based on "… a dynamic structure which consists of interconnected population and organisations" (Chang and West, 2006) and as a natural ecosystem it is self-organising, emerging, and adapting. As a classical industrial district it evolves through competition and cooperation simultaneously. It is also horizontal, decentralised and open[5].

This is the definition that will be used in this deliverable and that will, in chapter 5, help us in understanding and interpreting the DE using the CISG framework described in next chapter.

The partners contributed in the deliverable as follows: Chapters 1 and 7 are by CREATE-NET and T6; Chapters 2, 3, 4 and Section 6.1 are by CREATE-NET; Chapter 5 and 6.2 are by T6.

3 It is important to underline that besides the real construction of a community of users, the possibility to allow the access of already existing communities to the DE must be guaranteed. For example, for the DBE, the enterprises that have supported the development and testing of the service oriented infrastructure shared (even before the beginning of the DBE plan) some important connections with the local actors. They also had an understanding of the local social capital that has been demonstrated to be a very important variable for the initial population of a digital business ecosystem. The latter aspect makes possible to connect the concepts of the DE and CN, where the CN could be understood as a potential habitat of the DE.

4 See chapter 5, where the CISG framework is applied to the DE, and references to communities, services and norms are made.

5 This last specification makes the Digital Ecosystem as conceptualized in the DE cluster and in the DBE project very different from the concept of Business ecosystem introduced by Moore (1997) and recently developed by Iansiti and Levien (2004a). Already in 1993, Moore defined the business ecosystem as "An economic community supported by a foundation of interacting organisations and individuals - the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisations also include suppliers, lead producers, competitors, and other stakeholders. Over time, they co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments and to find mutually supportive roles". Beside others, two main points diversified a DE from a Business Ecosystem:

- In the BE actors other than economic (producers and consumers) are not present, whereas in DE they (public administration, intermediate actors, research centres, etc..) are crucial.
- In the BE the relational network seems to find a natural centre in one or few companies (this is especially stressed by Iansiti and Levien (2004b) that introduce the concept of 'keystone organisation'), whereas the DE is oriented towards an Open Source approach in which an open, flexible and scalable infrastructure can be used by different companies but no one (as in Internet) can become the owner or assume power over it.

2. THEORY: SOCIO-TECHNICAL INFRASTRUCTURES

What can be studied is always a relationship
or an infinite regress of relationships. Never a "thing."
(Bateson, 1978, p. 249)

This section will introduce *socio-technical infrastructures* (STI) as a theoretical framework for deliverable 7.1. Beginning with the *socio-technical perspective*, the document will then analyse more in depth the Infrastructure theory by Star et al., in order to explain the reasons for such choice within the social-technical theoretical framework and how the relation theory of infrastructures is going to be used.

2.1 The socio-technical perspective

Until a few years ago, the study of technology went through social or technological theories that had no connection with each other. This situation reflected the different conditions of natural and social sciences: the former described the world of things from an objectivist point of view, and the latter could only reach as far as the functional analysis[6] presented by Merton (1949), thus leaving out the study of contents.

The de-sacralisation of scientific knowledge[7] by authors such as Bloor (1976) and Collins (1983) allowed knowledge sociology to analyse science as a profane production of knowledge, directly related to prominent social groups. The *sociology of scientific knowledge* generated a vigorous research programme[8]. Consequently, the comparison of scientific facts with technological artefacts from the point of view of their production gave way to the so-called *science and technology studies* (Pinch and Bijker, 1987).

These activities founded the socio-technical perspective on the scientific, technological and innovation production. It is a stream of constructivism, which is also known as *new sociology of technology*, dealing with the social production of artifacts (Knorr Cetina, 1981). It stems from the studies on scientific laboratories included in research masterpieces by Knorr Cetina (1981), Latour and Woolgar (1979), with a further expansion in different approaches during the '80s (Bijker, Hughes and Pinch, 1987; Law, 1986, 1991; Bijker and Law, 1992).

As suggested by the title "*Shaping Technology/Building Society"* (Bijker and Law, *1992), socio-technical constructivism* does not concentrate only on the impacts of technology on society. The analysis of the social construction of technology is not linear (Pinch and Bijker, 1987) and is "context-sensitive" ("situatedness" as in Suchman, 1987). At the same time,

6 With the *functional analysis* Merton proposed to delve into specific functions of social rules constituting a social structure, including science.

7 Bloor stated that science and scientific knowledge are generally treated in the same way as believers address holy matters.

8 EPOR is the "Empirical Program of Relativism", which studied scientific controversies as well as scientific laboratories (Pinch and Bijker 1987).

research tends to study how such complex processes recreate society.

2.2 Socio-technical infrastructures (STIs)

Under the umbrella of socio-technical studies, we will refer to the theory of infrastructures. Susan Leigh Star et al. believe in the need to consider infrastructures with an ethnographic sensitivity[9] through the relational lens. In fact, the mechanical vision that is usually taken for granted can interpret infrastructures as technological substrates of networked services. This way, the majority of complex socio-technical relations is lost. On the contrary, infrastructures can be considered as artefacts emerging from practice, directly connected to human activities and material structures (Star, Ruhleder, 1996).

"In my own research this became clear when I did fieldwork over three years with a community of biologists (...) few biologists ended up using the system. It seemed the difficulty was not in the interface or the representation of the work process embedded in the system, but rather in the infrastructure – incompatible platforms, recalcitrant local computing centers, and bottlenecked resources. We were forced to develop a more relational definition of infrastructure, and at the same time, challenge received views of good use of ethnography in systems development." (Star 1999:380)

Thus, when the mechanistic understanding of infrastructures is taken for granted, the study of systems and interfaces is very limited. This vision is continuously reinforced by researchers also in multidisciplinary settings. In fact, computer science researchers and technicians prefer to operate at a distance from the places where the system is actually used – *design from nowhere* (Suchman, 2002)[10] – and for social scientists it is typically hard to access "their" systems. On the other side, social researchers tend to consider as "boring" all technological platforms and they would rather not analyse them further (Star, 1999). These are the reasons why the Information Systems Research in the '90s was tainted by an inconsistent, simplistic and narrowing way of considering technology[11] (Orlikowski and Iacono, 2001).

Star and Griesemer (1994) suggest considering technologies as infrastructures, as transparent sets to be analysed also from an ethnographic perspective. Infrastructures are *transparent*[12] because they invisibly support some tasks and are far more complex than any other technological artefact. They are usually taken for granted since they play a background role, and different actors perceive them differently. For example, we all use sinks everyday but tend to ignore the draining infrastructure underneath, whereas a plumber would have a clear view of the infrastructure but not of the reasons why we use water.

In order to get over taken-for-granted technical details, Star suggests maintaining an ethnographic perspective when gathering and analysing data. Some tricks, proposed by Star

9 Ethnography is a very well known research method in social sciences. It consists in direct, first-hand observation of daily behavior or in-depth interviews. With "ethnographic sensibility" we intend the qualitative research attitude that involves critical direct observation and analysis of what happens in specific contexts.

10 Within participative design of informatics systems, Suchman (2002) suggests founding the entire process on local accountabilities, i.e. local knowledge that define in-use technology in terms of localisation.

11 Only 12% of ISR articles studied by Orlikowski and Iacono (2001) in the '90s is based on a vision of technology as a whole that has been problematised by using many different dimensions.

12 It is a user perspective on infrastructures and readers could prefer 'translucent' or 'invisible'. We will adopt the term 'transparent' because Star and colleagues use this term since the 1996.

herself, might do to better to analyse infrastructures in empirical analysis: 1) Identify different narratives used by actors[13] to make sense of the infrastructure; 2) Help resurface the invisible work by somehow going backstage, where things are hidden; 3) Emphasise paradoxes in the infrastructure (Star, 1999, 2002).

Information infrastructures are described from the same perspective as *digital facilities and services usually associated with the Internet*. In fact, the Global Information Infrastructure refers to an information and communication system that operates beyond national boundaries. With the infrastructure metaphor it is possible to analyse also "*large-scale information infrastructures*", namely complex networks composed by Hardware and Software connected by specific social and organisational practices, used to coordinate the whole of complex disciplines or organisations[14] (Bowker et al, 2007).

Through a socio-technical lens, then, the infrastructure is not "an implemented technological system [any more]. Under a relational lens it is more related to a *when* than to a *what.* Therefore infrastructures occur when local practices are made possible by larger-scale technologies and usually emerge with the following dimensions:

- "*Embeddedness*. Infrastructure is "sunk" into, inside of, other structures, social arrangements and technologies;
- *Transparency*. Infrastructure is transparent to use, in the sense that it does not have to be reinvented each time or assembled for each task, but invisibly supports those tasks;
- *Reach or scope*. This may be either spatial or temporal -- infrastructure has reach beyond a single event or one-site practice;
- *Learned as part of membership*. The taken-for-grantedness of artefacts and organizational arrangements is a *sine qua non* of membership in a community of practice (...). Strangers and outsiders encounter infrastructure as a target object to be learned about. New participants acquire a naturalized familiarity with its objects as they become members;
- *Links with conventions of practice*. Infrastructure both shapes and is shaped by the conventions of a community of practice, e.g. the ways that cycles of day-night work are affected by and affect electrical power rates and needs. Generations of typists have learned the QWERTY keyboard; its limitations are inherited by the computer keyboard and thence by the design of today's computer furniture (...);
- *Embodiment of standards*. Modified by scope and often by conflicting conventions, infrastructure takes on transparency by plugging into other infrastructures and tools in a standardized fashion;
- *Built on an installed base*. Infrastructure does not grow *de novo*; it wrestles with the "inertia of the installed base" and inherits strengths and limitations from that base. Optical fibers run along old railroad lines; new systems are designed for backward-compatibility; and failing to account for these constraints may be fatal or distorting to new development processes (...);
- *Becomes visible upon breakdown.* The normally invisible quality of working infrastructure becomes visible when it breaks: the server is down, the bridge washes out, there is a power blackout. Even when there are back-up mechanisms or procedures, their existence further highlights the now-visible infrastructure." (Star and Ruhleder,1996)
- "*Is fixed in modular increments*, not all at once or globally." (Star, 1999)

13 "Actors" are the subjects of action in social science.

14 *Cyberinfrastructures* are defined by the US National Science Foundation as "those layers that sit between base technology (a computer science concern) and discipline-specific science".

2.3 Why and how to use the STIs theory

In this section we will provide answers to three questions related to the Socio-Technical Infrastructures theory (STIs): (1) Why precisely the STIs approach and not other socio-technical theories? (2) How will we use this theory? (3) What is the added value brought by the use of this theory within the associative and systemic perspective of the OPAALS project? The first question demands a brief introduction to the fundamental threads of the social studies of technology, so as to contextualise Star et al.'s theory within specific choices and perspectives.

Two main approaches stemmed from the socio-technical studies on the technology of the '90s: the *social* relativism or constructionism – Social Construction of Technology or SCOT model – and the *radical* or Actor-Network Theory (ANT). The SCOT model is well exemplified by Bijker and Pinch (1987): it studies the construction of technology through the analysis of those innovation trajectories described by "relevant social groups". The artifact finds its "closure and stabilization" through a negotiation process where the specific interests of groups play on "interpretative flexibility". For example, a bicycle is now a partially stable artifact due to interpretation and negotiations among opposites, manufacturers, sportsmen women, etc.

If the SCOT model represents the sociological orthodoxy within the study of technology, ANT theory is so innovative in the field of sociology that it has been coined as a *method*[15]. In brief, ANT suggests analysing socio-technical fields as unstable assemblies made of heterogeneous elements that reciprocally are defined through a recurring process of translations (Callon and Latour, 1981; Callon, 1986, 1991; Latour 1992; Law, 1987; Law and Hassard 1999).

For ANT the action as "translation" is based on the assumption that "to translate is to betray". Basically every change – movement or interpretation – modifies the object, thus embodying the radical relativism of such theory. If an element of the network changes – i.e. interprets – its role considerably[16], the whole network experiences the same change. To give an idea of how unique this theory is, ANT allows researchers to consider also non-human actors, the involuntary action, the network as actor and all elements in the network as created from that particular relation with other elements, always in a context of constant unbalance and tension. Moreover, ANT is often proposed as a whole of flexible tools to be recreated in specific research contexts with the aim of ensuring a relentless growth of the perspective without necessarily using the "ANT" label. For all these reasons ANT can be considered a method to be used rather than a stable theory (Law and Hassard, 1999).

15 Barbara Czarniawska (2003) defined Bruno Latour's rationale as "style like method". Lee and Hassard (1999) defined ANT as an "empiric research strategy". Law (1999) defines ANT as a flow theory based on a non-Euclidean space. Latour (1988) suggested replacing the "non-contradiction principle" according to which every single contradiction would state the illegitimacy of explanation, where the "translation principle" is based on weak and intrinsically contradictory narrations. ANT is deeply rooted in the post-structural philosophy and especially to Foucault's micro-power and Derrida's deconstruction.

16 It is the researcher's responsibility to give an arbitrary definition to such significance. The reflective characteristic of the most radical ANT is considered as an inclusion of the observer in the object under observation, leading to the necessity to introduce weak explanations in any scientific field.

Going back to socio-technical infrastructures, Star et al.'s theory represents an evolution of SCOT and ANT approaches because:

- *It gets over taken-for-granted data*: striving to go beyond the mechanicistic interpretation of infrastructures;
- *Infrastructures become heterogeneous networks*: infrastructures are complex systems of hardware, software and social practices;
- *It has an intrinsic constructionist and relational character*: stating that the elements and the infrastructure define one another;
- *It connects social practice with technology*: it accepts the definition of infrastructures through contextualisation and in the presence of specific social practices.

In addition, the socio-technical vision of infrastructures recalls previous analyses close to the ANT by Star et al. (Star and Griesemer, 1989; Star, 1991). If we consider the profound similarities, the infrastructures theory can be considered as an evolution of ANT because it develops the logic without using its label.

What is the added value brought by the use of this theory within the systemic perspective of the OPAALS project? We must emphasize the positive influence of using the concept of infrastructure in a socio-technical way within contexts that typically adopt different perspectives. For example, the techno-centric computer science and, in this case, OPAALS project, part of which supports a systemic vision based on the concept of autopoiesis.

One of the answers to such questions can be found in *Information Systems Research* (ISR), the most dynamic and precise discipline that deals with IS by taking into consideration the multiple dimensions involved through the contributions of different disciplines. Orlikowski and Iacono (2001) stress the need to adopt less mechanistic perspectives in order to understand technology in relation with the other dimensions of reality. One can infer that the aim is not to prefer one perspective among others, but to take advantage of different means to better understand the phenomena analysed.

Boudreau and Robey (1999) further emphasize this approach. As ISR is a multidisciplinary science, it seems normal and perfectly acceptable to achieve results that are not aligned but contradictory. Nevertheless, the frustrating result in ISR of the '90s is that against the numerous and inspired invitations to adopt non-deterministic approaches (DeSanctis and Poole, 1994; Markus and Robey, 1988, Orlikowsky and Robey, 1993), the majority of studies remained firmly anchored in deterministic logic. Among various suggestions to sort out of the *empasse*, Boudreau and Robey say that researchers should use multiple explanations, without supporting a single one based on the preconceptions of a specific theory.

The opinion of the writer is that the study of digital ecosystems as proposed by the OPAALS project can take advantage of the indications resulting from the research strand that is currently studying IS from a multidisciplinary perspective. More specifically, the use of a socio-technical theory on infrastructures within OPAALS research is useful to understand CNs and DEs under a single view that is not influenced by binding approaches often used in the field. In fact, the reduction of such phenomena within their own group results in the loss of important dimensions. For example, the way DEs are understood within OPAALS does not

consider until now hardware infrastructures, and it would be a limitation to consider CNs as network infrastructures to be connected to the current DE.

Within OPAALS, the social sciences “associative” and the biology “systemic” (autopoietic) approaches are epistemologically different. With this deliverable we would work within the first domain. Such diversity can be interpreted either as a heresy or as an improvement because an evolving science should be able to seize such opportunities. Using STI theory helps us look through a different lens, thus catching different aspects of those infrastructures that we tend to place on a secondary level when approaching all Digital Ecosystem discussions.

Then how should we use such theory in the research between Community Networks and Digital Ecosystems? Our strategy is to perceive CNs and DEs as infrastructures, that are networks composed by heterogeneous elements, which different observers tend to consider in a different way, thus placing less relevant objects on a secondary level.

On the one hand a more precise use, basically an ethnographic and longitudinal analysis of infrastructures-under-construction using the dimensions suggested by Star, will be possible under empirical research conditions. On the other hand, we need a theoretical framework to understand separately CNs and DEs and consequently compare them as phenomena. To do this, we need to use the infrastructure theory in a method-like way, referring to its principles without using its dimensions for the time being. For this reason, the next chapter will define from a relational and ecological way the main dimensions of socio-technical infrastructures, which as CNs and DEs are specifically connected to the local framework.

3. C.I.S.G.: A FRAMEWORK FOR SOCIO-TECHNICAL INFRASTRUCTURES

This section introduces C.I.S.G. (Communities, Infrastructures, Services, Governances) as a specific analytical framework based on the socio-technical theory of infrastructures. The objective is to create a common relational platform that may prove useful to understand any kind of socio-technical infrastructure (STI) connected to local development and innovation. For this deliverable such a platform will be used to understand CNs and DEs phenomena at first on their own, then through comparison.

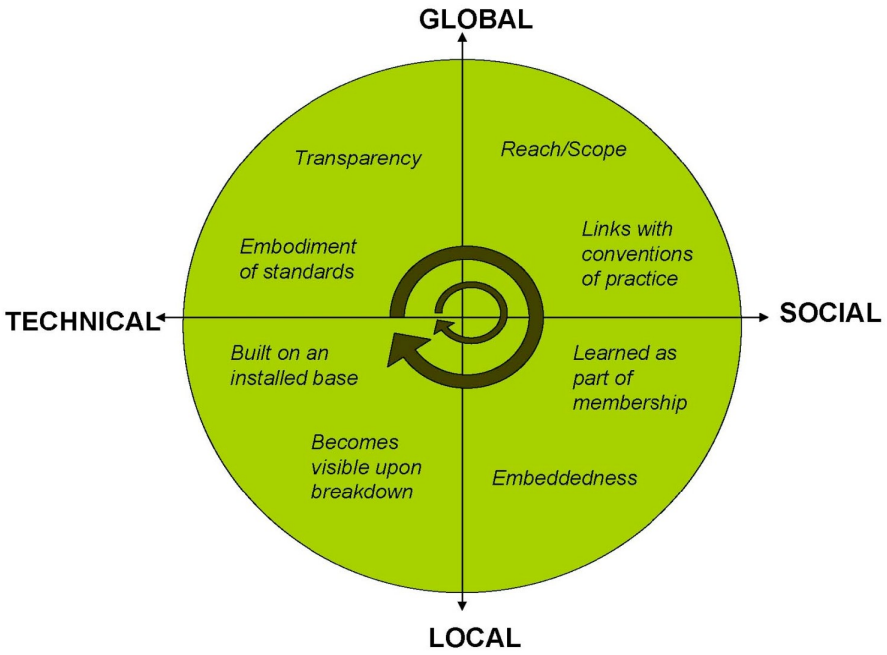

Figure 2: Information infrastructure as distributions along technical/social and global/local axes. (Source: Bowker, Baker et al, 2007:6; http://interoperability.ucsd.edu/docs/07BowkerBaker_InfraStudies.pdf)

The "local" factor is particularly relevant for this study and is not to be considered in contrast with "global". The former indicates the context of creation or impact of a specific innovation in a defined geographical area. As emphasized by Bowker et al. (2007) and represented in Figure 2, the socio-technical continuum of infrastructures can be analysed on a local-global continuum. Thus, in our case, it means to define a framework able to state the creation and impacts inside and outside the local context, once it has been used to describe specific situations. The constitutive elements of the framework will then develop on a local-global continuum to be described in defined cases.

Any ICT-based innovation related to local development is characterised by a series of typical dimensions. Those who support a mechanistic view of processes will state that good technologies are indeed crucial factors. Once such technologies have been adopted and

defined, the economic and social framework will gain an innovative benefit. On the contrary, those who focus more on social sciences tend to underestimate the importance and complexity of factors closely related to technology, stating that innovation is primarily composed by good relations and social negotiations.

Nevertheless, the phenomena linked to local socio-technical innovation can be understood through a more complex point of view, namely (a) by clearly defining the main elements that constitute innovation, thus (b) re-defining them through a relational dimension within specific contexts. In the first section of this chapter we will deal with the static definition of elements, whereas in the second we will introduce the relational one.

3.1 The C.I.S.G. framework

The elements that play a pivotal role within innovative socio-technical processes related to ICTs are potentially infinite. A technologist might want to include the adoption of specific infrastructural standards as main variables, though a social scientist would put the emphasis on specific behavioural models. As we tried to group together different elements under categories that may provide a fairly simple analytical tool, but complex enough to reveal the main characteristics of innovation as socio-technical infrastructures, we have defined four dimensions (Figure 3):

- Communities;
- Infrastructures;
- Services;
- Governances.

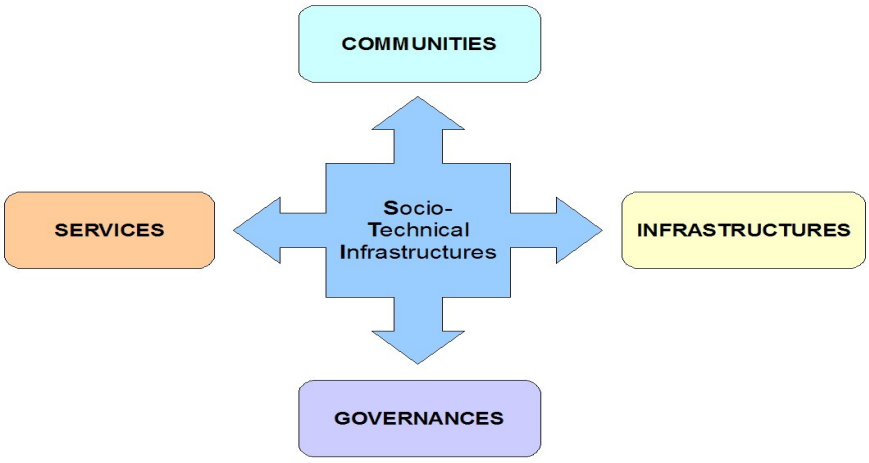

Figure 3: The C.I.S.G. framework for Socio-Technical Infrastructures.

The dimensions are plural because we wish to emphasize their multiple and heterogeneous character. It seems more appropriate to approach the study of any object as a plurality of

different elements, where analysis is responsible for unveiling such complexity. Following the suggestion of Clegg and Hardy (1996)[17], for infrastructures we will consider (a) the more general aspects of '"infrastructure", (b) the variety of "infrastructures", and (c) "infrastructuring" as a process of relational and reciprocal construction that will be analysed in the second section of this chapter.

In the following sections we describe the four dimensions by using further sub-dimensions. Those sub-dimensions have only indicative character. The researcher is asked to use the sub-dimensions that emerge as relevant in his/her specific research.

3.1.1 Communities

The stakeholders that participate in an innovative socio-technical infrastructure may vary in nature and role. Since Pinch and Bijker identified the manufacturers, sportsmen, women etc. who co-constructed the artefact 'bicycle', we can draw up a long list of stakeholders involved and influenced by larger infrastructures. At first, we can divide local communities into three subgroups to be improved and modified according to further elements identified in the analysis phase: citizens, business, government (Figure 4).

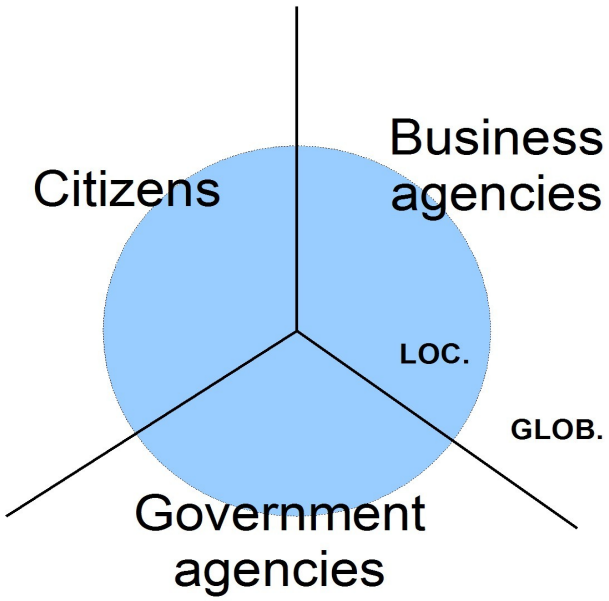

Figure 4: Sub-dimensions of "communities" in the C.I.S.G. framework.

17 Clegg and Hardy (1996) suggested to consider as different entitites "organization", "organizations" and "organizing" in organization studies.

Citizens can be individuals, families, associations, groups of activists, or any group of people. In any case, each group is characterised by some sort of interest in STI, either implicit or explicit for their action. For example: a group of citizens can be interested in the private use of a technology meant for the local public administration, or a grassroots committee can strive to create a mesh network.

Business agencies can be either the companies interested in STI as object of their business, or companies looking for new services. Among the former we can include local Internet Providers interested in selling services, among the latter we can include those interested in actually using such services.

Government agencies are those linked to the Public Administration, which somehow take part in the STI. They can be regulatory and/or funding agencies such as local governments, or agencies supporting innovation like regional informatics departments and public business innovation centres.

The communities involved in an STI may belong to the local or global context as indicated in Figure 4. “Global citizens” might be groups of activists or external (i.e. non-local) associations that support grassroots movements in a specific context. “Global business agencies” can be external companies interested in providing services on the specific territory. “Global government agencies” could be national or international agencies that regulate or provide funds for an STI.

3.1.2 Infrastructures

The term *infrastructure,* as a dimension of the C.I.S.G. framework, should not be confused with the socio-technical vision of infrastructures (STI). The former represents the most technological element of the latter. It must be noted that infrastructures are mostly transparent to their users and recognised through their role[18], emerging during breakdowns, to be analysed according to the characteristics suggested by Star and Ruhleder (1996 – see Ch.2). Always under Star et al.'s socio-technical view, we will consider the hardware and software infrastructure parts together.

By *Hw infrastructure* or *networked infrastructures* we think of all the material technologies involved that are relevant within an STI. Consequently, according to how deep is the analysis foreseen by the researcher in specific situations, we take into consideration elements such as personal computers, peripherals, telematic networks and/or components of these technologies with their respective standards.

Sw infrastructure includes all those programmes that allow a hardware infrastructure to operate and produce services. This way, according to the detail of the analysis, we can consider single applications, middleware and other software macro-elements, and/or their components as single code lines and their standards. In fact, it is up to the researcher to emphasize how within an analysis a single code line emerges as an important element able to define the direction of the whole infrastructure.

18 For example, a technologist would 'see' more infrastructures than the common user.

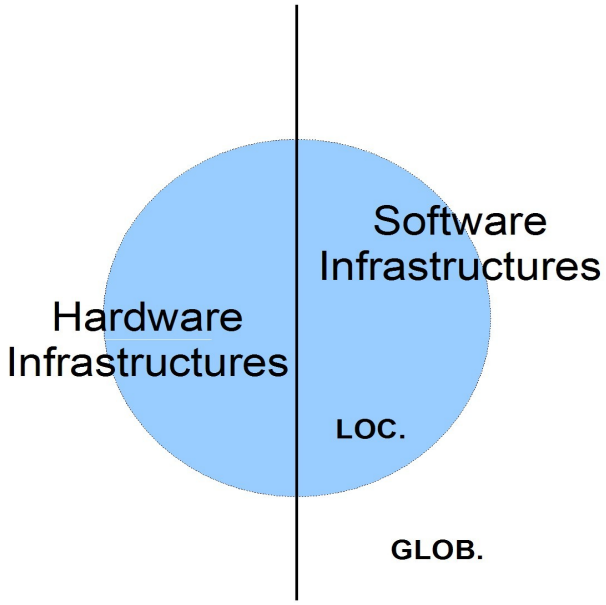

Figure 5: Sub-dimensions of "infrastructures" in the C.I.S.G. framework.

The infrastructures implied in an STI constitutes a network of elements within a local-global continuum (Figure 5). The telematic black-out on 9/11 in New York 2001 tells us that, as a general rule, it is not possible to exclude the whole Hw Internet infrastructure from the majority of local networked infrastructures like the LAN of a company. Optical fiber networks, servers, remote calculation centers and many other elements and sub-elements can be considered in this dimension. Similarly, one can consider all 'global' software that does not belong to the specific geographical area analysed, but nevertheless supports the functioning of such infrastructure.

3.1.3 Services

The production of services for communities constitutes the main aim of any infrastructure. Considering the case of ICT-based STIs, we refer to on-line services such as connectivity or more advanced services such as traffic monitoring, as well as specific services for e-Government and e-Business. At this level, we can differentiate between services as on-line and off-line. *On-line services* are those directly operating thanks to infrastructures, such as Internet connectivity for the community. *Off-line services* for STIs can be described as an externality of on-line services: they are generated from on-line services with the help of local operators, and represent second-level innovative services that impact the territory. For example, they might be provided to citizens by a group of collaborating companies, thanks to the brand-new infrastructure.

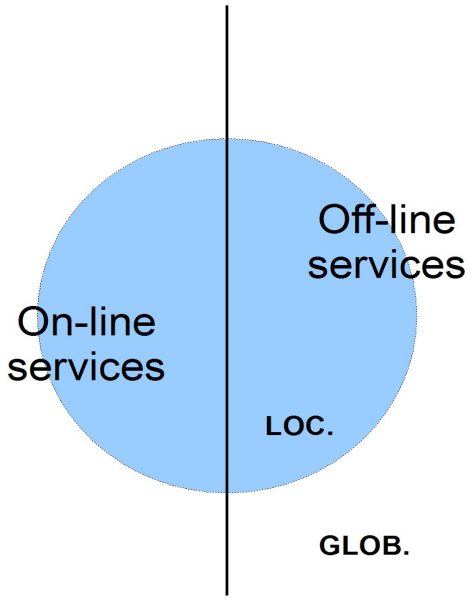

Figure 6: Sub-dimensions of "services" in the C.I.S.G. framework.

Again, as a general rule for services, it is not possible to define the local or global context without the help of a specific case, although it is not even possible to exclude the global context (Figure 6). In fact, we can think of new services to support the collaboration of local companies in their area, but also of services that generate a better or anyway different relation among such networks of local enterprises and other similar networks in different geographical areas.

3.1.4 Governances

The term *Governance* has different meanings in the field of social sciences (Rhodes,1996); in this section we will refer more generally to the use of authorities, structures and institutions by means of an actor that controls and/or coordinates a specific activity. Within the C.I.S.G. framework, communities use governance to manage or control the socio-technical infrastructure, and at this level we can consider grassroots governance, corporate governance, and “government governance”.

Grassroots governance refers to the self-government of citizens on STI, on which they directly exercise their power. An example is the self-management of network infrastructures by citizens who decide to solve a digital-divide gap.

Corporate governance is how business agencies, in this context, govern the STIs under their control. An example is the activity of Internet Providers that regulate and manage company infrastructures used by other actors.

Government governance is how a government agency manages innovation on its territory. For example, the definition of regulations for a local government that uses a public information infrastructure.

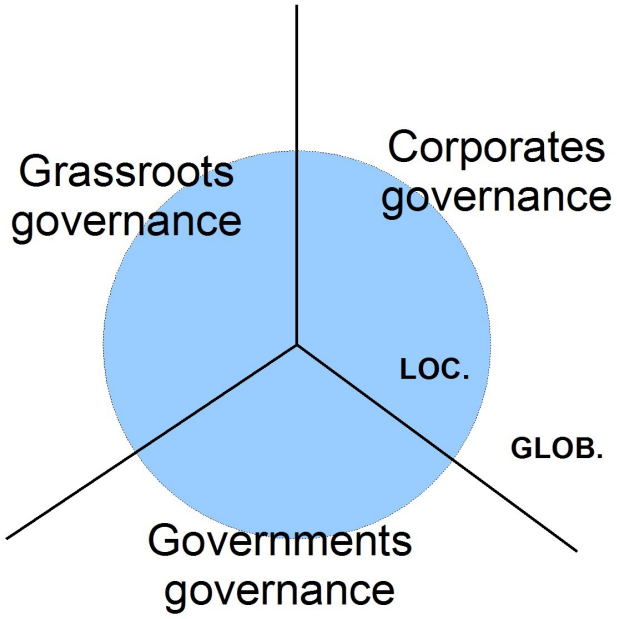

Figure 7: Sub-dimensions of "governances" in the C.I.S.G. framework.

For governances we can again consider the local-global continuum represented in Figure 7. More practically, a skilled international grassroots association can suggest some governance practices to a new local group; or the governance practices of a local company can refer to those used by the corporation controlling it; the national/international governance can influence or overcome the authority of the local government.

3.2 The relational character of the framework

The C.I.S.G. framework has been designed to study STIs under a relational perspective, thus reminding the researcher that the definition of each element must be settled with reference to its relation with all other elements. The analysis of such relations may provide an added value to the study only if contextualised, by explaining actual complex relations and continuity among elements of specific cases.

For the C.I.S.G. framework we can lay down three levels of abstraction:

- Relational description at abstract framework level: useful as theoretical-methodological

explanation on the nature of the framework. Basically, it is the aim of this section;

- Relational description at the level of specific types of STIs: useful for descriptive and comparative purposes between different phenomena such as CNs and DEs. This is the aim of the current deliverable;
- Analysis of specific case studies for STIs: it allows the researcher to analyse more in depth some contexts, such as CN for PAT (Italy) or DE at Zaragoza (Spain). It is the aim of D7.2 for OPAALS.

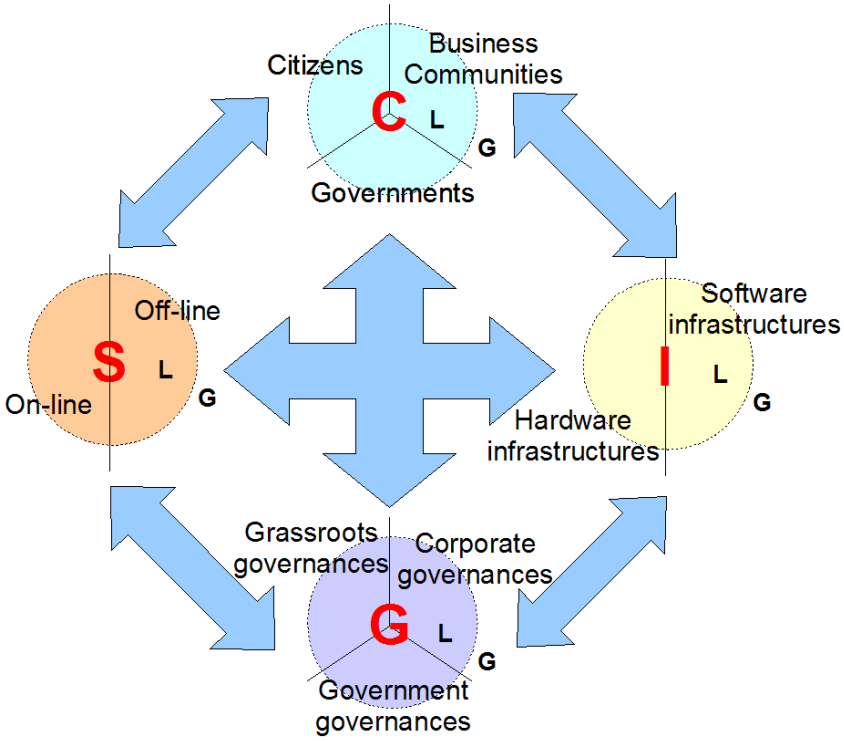

Figure 8: a relational view of C.I.S.G. framework.

From a theoretical-methodological point of view, we can generally describe the relational characteristics of the C.I.S.G. (Figure 8) framework as follows:

- *Communities*. Created independently or co-created in cooperation with other agencies, infrastructures (I) and services (S) for personal objectives. They can build up their own types of governances (G) and, if needed, ask the public administration to put into practice and control specific governance models or frameworks;
- *Infrastructures*. Created by some communities (C) to be used for cooperative working. They implement some services (S) and are managed through governance (G).

- *Services*. Created by/for communities (C) and activated by specific infrastructures (I) and governances (G);
- *Governances*. Created by/for communities (C). Services (S) and infrastructures (I) are implemented and regulated by governances.

When specific typologies of STI exist, especially when analysing specific cases, the C.I.S.G. framework will prove to be a fundamental tool for the researcher. For a specific case it will be possible to describe “what” relation connects elements and “how” it happens.

4. COMMUNITY NETWORKS

"I sent my first e-mail 3 years ago.
At midnight I wrote a message:
'Ciao, my name's Beppe Grillo, do you want to communicate?' (...)
At 6 A.M. I got up and a miracle happened. I got a reply!
It was my neighbour. If we opened the window we could say "g'morning!" to each other..."
(Beppe Grillo, – www.beppegrillo.it -, Trento, October 11th 2007)

In this chapter we will describe and analyse the Community Networks phenomenon. At first, we will introduce CNs with a non-relational approach, explaining what CNs are through some definitions taken from the literature available. Then we will use the C.I.S.G. framework to suggest a relational description of CNs considered as specific STIs typologies (see section 3.2). Thus we will present and compare: (a) the different definitions of CN taken from the literature, and (b) the different CN phenomenon typologies.

4.1 What is a CN? Different views and interests

The dedicated literature provides different definitions, implicit or explicit, for Community Network. Each interpretation for this phenomenon belongs to a specific research and/or area of interest. The 'historical' perspective by Shapiro (1999) serves as a useful introduction to the topic:

"Community networking has its origins in services such as the Free-Net, which emerged in the '80s and early '90s to offer online access, sometimes along with local news and information" (Shapiro, 1999)

CNs are the offspring of on-line services such as Free-Net, which in the '80 and '90 provided the access to information for local communities. Coherently with this community vision, we can consider activists' actions such as those of Douglas Schuler's (1996):

"Before computers took central stage, the term community network was a sociological concept that described the pattern of communications and relationship of a community. This was the web of community that described how news traveled and how social problems were addressed in the community." (Schuler, 1996:25)

"Community networking", a concept used to describe the relation network of a community, has been influenced by ICTs. In the middle of the '90s Schuler, as member of the Computer Professionals for Social Responsibility (www.cpsr.org) group, and activists for the Seattle Community Network Association (www.scna.org) defined the theory for "new community networks":

"New computer-based community networks are a recent innovation that are intended to help revitalize, strengthen, and help expand existing people-based community networks much in the same way that previous civic innovation have helped communities historically." (Schuler, 1996:25)

If new computer-based CNs are used to strengthen the existing people-based CNs, Schuler

(2001) considers CNs as “cultures of democracy”. Due to the ritualized political process in what he ironically refers to as developed countries, Schuler considers the activism of CNs as the new face of democratic power. According to Schuler, the elements of CNs are the following:

- *Civic culture*: formal and ritualised processes (i.e.: voting) are not enough for democracy. The direct participation in collective decision might be facilitated by new media, which could be created specifically to achieve this aim;
- *Computer professionals in the community*: if each citizen is responsible for democracy, computer professionals are responsible for democratic media. Their specific knowledge is imbued with an ethical dimension. Computer professionals should work in “collaborative community teams on policy, social work and technology development”;
- *Democratic technology*: a technology characterised by a democratic aspect might be created by means of an interdisciplinary and collaborative work from researchers, practitioners and social activists.

A more technological interpretation that we will identify as "engineering-business" has recently been added to the social interpretations of CNs. Though considering the social and business dimensions, the “engineering community” tends to consider CNs as a synonym for “networked infrastructure”. Such infrastructure provides connectivity and advanced services to the local community. In *Broadband Services: Business models and Technology for Community Networks*, Chlamtac et al. (2005) wrote:

“Public participation in building broadband infrastructure and fostering the development of broadband services is often advisable for several reasons. (...) For local governments it is often a straightforward step to become – directly or indirectly – a telecom infrastructure operator, since their high-speed networks interconnecting public institutions are already in place and are being updated.” (see Chlamtac, Gumaste and Szabo, 2005a:3)

The local government becomes a relevant actor for understanding CNs, both for the creation of a local broadband infrastructure and for facilitating the development of services for the community. The new infrastructures can reduce the digital divide in districts under their control and foster local development for citizens and business sectors alike. Moreover, this provides the public-sector actor with the new role of “telecom operator” and regulator of services in its own network.

Finally, we can present the definition of CNs available in the Computer-Mediated Communication (CMC) research community. The paper “Community Networks: where offline communities meet online” by Kavanaugh et al. (2005) can be considered its manifesto. It emphasized the importance of local communities for CNs, but also the on-line/off-line lens used by the CMC community to describe the phenomenon:

“Community computing is computer networking among and between residents, organizations, government and businesses in a geographically bounded setting for local purposes and activities.” (Kavanaugh et al., 2005:2)

Each definition is interesting and adds important elements to our understanding. In fact, we can indicate the following elements as a CN's main characteristics:

a) *Geographically bounded setting*: physical reciprocity and physical and/or administrative boundaries denote a local community;

b) *Different agencies involved*: residents, organizations, government and business;

c) *Interests:* specific interests converge in community interests, or missions;

d) *Activities*: the different agencies' interests, because of a more or less explicitly negotiated community interest, converge in community activities;

e) *Computing*: computing activities and networked infrastructures enhance on-line spaces and activities for off-line communities

For example, a valley or a city define physical settings for local communities (a) where individuals, public agencies, enterprises and non-profit agencies compose the local community interests and purposes. (b) Different agencies' interests somehow converge in the community interest: residents converge with enterprises for cheap Internet connectivity, while the local government likes to sustain the broadband infrastructure constitution and other agencies are interested in developing services on it. (c) The local community starts discussing and planning for better Internet-based services. (d) The local community starts planning the deployment of a networked infrastructure that enhances local on-line services. (e) Then the local community possibly becomes a CN and starts its life cycle. In describing the different case studies we have to be clear if they are newcomers, an institutionalized reality or a suffering one.

4.2 When do we have a CN? CNs under the C.I.S.G. framework

If we try to understand CNs through the definitions discussed so far (historical, activist, engineering-business, CMC), we come across some difficulties. It is evident that (i) the intercommunicability of definitions is complex, and (ii) there is a lack of reasoning on the minimum number of elements such as those of the C.I.S.G. framework, which define CNs as socio-technical infrastructures deeply rooted in practice. As a fact, some definitions for CN make reference to substantially different objects (activist vs. engineering-business), while others tend to describe the same objects with different interests (activist vs. CMC).

	Historical *(Shapiro, 1999)*	***Activist*** *(Schuler, 1996)*	***Engineering-business*** *(Chlamtac et al., 2005)*	***CMC*** *(Kavanaugh et al., 2005)*
C	*Grassroots communities*	*Grassroots communities*	*Local government & business actors*	*Citizens, business org, government*
I	-	*Democratic technology*	*Public local broadband infrastructure*	-
S	*Online access news & information*	*Democratic technology*	*Online access and advanced services*	*On-line services*
G	-	*Bottom-up policies*	*Government regulation*	-

Table 2: Four definitions of CNs analysed through the C.I.S.G. framework.

For such purpose, it might be useful to compare the four definitions using the four elements that constitute the C.I.S.G. framework: communities, infrastructures, services, governances (Table 2).

Following the definition in section 3.2, we can use the C.I.S.G. framework to describe in general 'when' a CN is generated. This happens when the elements below find a balance such as to allow a socio-technical practice:

- *Communities* belonging to a geographical area that meets on-line (community networking) through ... ;
- technological *Infrastructures* composed by telecommunication infrastructures and the hardware/software networks that enable ... ;
- a series of *Services* offered on-line to promote and facilitate off-line and on-line actions;
- *Governances* of the different actors that take part in the CN (especially the public governance, which usually plays a central role for the creation and regulation of some CNs).

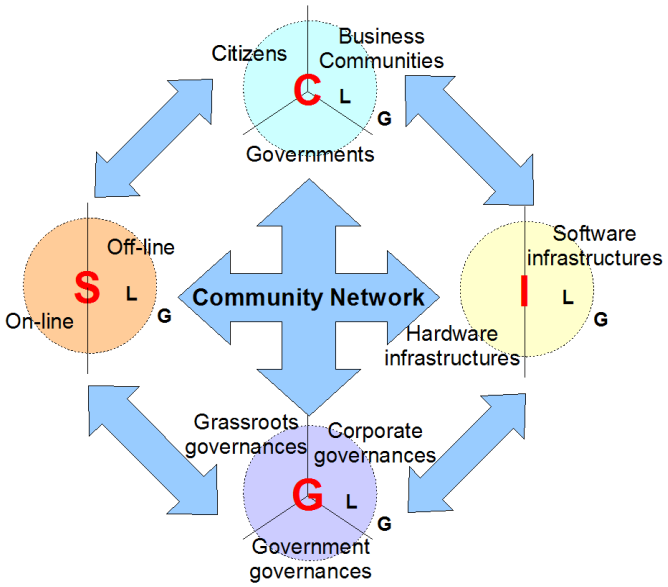

Figure 9: C.I.S.G. relationships in a Community Network.

This definition is mainly heuristic, thus it cannot satisfy the needs of the relational analysis presented in Figure 9. The in-depth socio-technical analysis of CNs, which resorts to a more capillary use of the C.I.S.G. framework and of the dimensions suggested by Star and Ruhleder (1996: see section 2.2), is only possible through an ethnography-based methodology for specific cases. Nevertheless, such a pre-ethnographic phase helps to analyse and compare different typologies of CNs.

4.3 Different typologies of CNs

From the literature and through web research, we can identify at least four typologies of CN already mentioned:

- Traditional CN;
- New grassroots CN;
- New government CN;
- New government 2 CN.

	Traditional	*New grassroot*	*New gov*	*New gov 2*
C	**grassroots**	**grassroots**	**government**	**government**
I	-	**Bottom-up infrastructures**	**Top-down infrastructures**	**Top-down infrastructures**
S	**Bottom-up services**	-	-	**Top-down high level services**
G	**Influence policies**	-	-	-

Table 3: The key dimensions in the four types of CN.

In Table 3 one can compare the four types of CN using the C.I.S.G. framework. As a first step, we can see that different communities characterise the type of CN with different key elements. The next section will present a closer analysis of such typologies.

4.3.1 Traditional CN

Example: Seattle Community Network (See Appendix 1)

Brief history and main characteristics

Traditional CNs are described by Schuler (1996) and Shapiro (1999), basically the new community networks resulting from FreeNets in the '80s. The aim is to provide communication and information services to citizens, but also to facilitate the direct participation of citizens in decisions concerning community. The Seattle Community Network is the most traditional and widely known CN, and its slogan is “Democratic Technology for All”.

Analysis of C.I.S.G.

- *Communities*: the grassroots community, composed by citizens and non-profit associations, is the leader of the action. It is possible to create partnerships with different agencies from the local government.
- *Infrastructures*: the hardware level is not considered
- *Services*: dealing traditionally with information and communication services among citizens and associations, sometimes also with public administrations. The level is generally low as (a) services must respond to the basic needs of the community, (b) they are generated through the participation of citizens, and (c) they must be easy to manage.
- Governances: the grassroots community tries to keep the CN under control through specific associations and by managing the network as an open tool for the community.

4.3.2 New grassroots CN

Example: Seattle Wireless (See Appendix 2)

Brief history and main characteristics

The new grassroots CNs represent the evolution from the hardware point of view of traditional CNs, sharing the ideology related to the deep democratic potential of new technologies. This typology of CN is generally initiated at grassroots level and its main aim is to facilitate the creation and management of network infrastructures by citizens. In rural communities the aim is to reduce the digital divide, thus to bring broadband infrastructures - optical fiber, XDSL, wireless mesh networks, etc. - to areas outside the control of operators. In cities the aim is generally that of setting up more antennas, namely public hot-spots for wireless services.

C.I.S.G. analysis

- *Communities*: the grassroots community, composed by citizens and non-profit associations, is the leader of the action. It is possible to create partnerships with different agencies from the local government.
- *Infrastructures*: creation and autonomous maintenance of networked infrastructures.
- *Services*: access to the network and informations for the self-maintenance of networked infrastructures.
- Governances: autonomous management by grassroots community, facilitating not-for-profit initiatives.

4.3.3 New government CN

Example: One Manchester (See Appendix 3)

Brief history and main characteristics

New government CNs refer to the definition “Engineering-business” (Chlamtac et al., 2005) in section 4.1. These are quite recent cases where local authorities, often supported by institutions and funds from Ministries and International associations, participate in the creation and management of regional or local (city) broadband networked infrastructures.

Relation among C.I.S.G. elements

- *Communities*: the government community is leader of the action, often in partnership with important business agencies such as telecom providers. The grassroots community might participate on different levels.
- *Infrastructures*: creation of new broadband networked infrastructures – wired and/or wireless.
- *Services*: according to the cases, support is aimed at the development of services for citizens – above all connectivity - business sector, and public sector.
- *Governances*: public agencies could make different choices on community participation to services. From a strictly business point of view, what counts is the management of infrastructures and services. Since it is hard to maintain the direct control of both, different separation strategies could be chosen. Two strategies are currently being discussed[19]:
  - “Openreach Model”: functional separation. It generally needs a strong warranting agency.
  - “One Network Model”: structural separation. Many operators participate in the network management under the warrant agency control.

4.3.4 New government 2 CN

Example: Virtual Helsinki (See Appendix 4)

Brief history and main characteristics

New government 2 CNs are the new government CN adopting services of virtual presence such as Virtual Helsinki and Digital City Kyoto described by Ishida (2000). At the end of the

19 http://www.telecomsregs.com/workshop.htm

'90s the activist and business-engineering visions of CNs converged on the term “Digital Cities”. Some FreeNets and CivicNets became fruitful spaces of information and dialogue among citizens. On-line communication spaces for citizens began to adopt the metaphor of the city just as public broadband infrastructures were being installed.

Currently, under the term “Digital Cities”, one can find studies on architectures, infrastructures, services, policies and communities. Nevertheless, the bottom-up approach of CNs in the '90s has been absorbed by institutional, research and business initiatives (Ishida and Isbister, 2000; Tanabe, Van den Besselaar and Ishida, 2002; Van den Besselaar and Koizumi, 2005).

Relation among C.I.S.G. elements

- *Communities*: the government community is generally the leader of the action along with important business agencies such as telecom providers, as well as research centres on virtual architectures. The grassroots community might participate on different levels.
- *Infrastructures*: creation of new broadband networked infrastructures – wired and/or wireless.
- *Services*: according to the cases, support is aimed at the development of services for citizens – above all connectivity –, business sector and public sector. A virtual visualization system as support to services is created.
- Governances: as in the case of new government CNs, the local government assigns the creation and management of the CN to an ad-hoc agency. Different models of participation for citizens and business actors are available.

4.4 Conclusion: through CNs as ubiquitous infrastructures and services

So far we have considered the different definitions and characteristics of CNs. The typologies introduced do not cover the whole of their phenomenological complexity, but can undoubtedly help to identify and define the main characteristics of the heterogeneous world of CNs. To sum up, there is a common tendency in all the typologies presented here. CNs tend towards a growing involvement of networked infrastructures to achieve ubiquitous and full territorial Internet accessibility, and towards the support of advanced services.

In the last few years, local governments started numerous projects for the implementation of broadband infrastructures in the territory under their jurisdiction (new government CNs). Partnerships with business and research sectors deal with the creation of infrastructures as well as the creation and management of services for local development. With the introduction of wireless technologies, even grassroots communities began to create their own networked infrastructures (new grassroots CNs). The installation of antennas still appears to be the most economic solution, thus leading in recent years towards a proliferation of hot-spots and private mesh networks.

Therefore, as an effect of both public policies and private initiatives, the future scenario shows an almost complete coverage of the built-up area with networked infrastructures. This is the case of “developed countries”, including those countries that are deemed to develop further in the near future such as Brazil, Russia, India and China. Broadband services might be developed and managed on these infrastructures for different layers of local communities.

As we emphasize the dimension of networked infrastructures of CNs, we cannot forget that this phenomenon is intrinsically related to grassroots participation. Under a socio-technical vision, CNs are not to be reduced to networked infrastructures similar to many Digital Cities. As indicated by De Cindio et al (2007), a recent tendency of CNs is to join top-down and bottom-up forces through Deliberative Community Networks. Thanks to this cooperation, the citizens connected to the network will be able to directly participate in the choices of the local government.

5. DIGITAL ECOSYSTEMS

The aim of this chapter is to describe the concept of Digital Ecosystems (DE) through the CISG framework described in Chapter 3. Starting from the definition of DE given in Chapter 1 and positioning ourselves within a sociological prospective we will try to define which communities, which models of governance, which infrastructures and services can characterise digital ecosystems.

As background in this deliverable, one of the greatest difficulties we meet in comparing DEs with CNs regards the different levels of maturity of the two concepts and the phonomenological gap that separates them. While the concept of CN emerged from socio-techical experiences developed in several territories, the concept of DE pre-exists practical, full implementations. This is primarily due to the fact that digital ecosystems are, today, first of all a wide research field, still under development. They are, simultaneously, a highly interdisciplinary theoretical framework, a service-oriented infrastructure widespread, decentralized and open, as well as a methodology for the involvement of territories and communities of users.

As we have seen in chapter 4, there are many examples of existing CNs and their history is rich enough to be able to build a stable typology; digital ecosystems - on the contrary - are not yet a concrete and stabilised reality; for this reason we choose here to compare CNs with the experience made on the one hand in two territories in the framework of the DBE project and, on the other hand, with a future scenario for DE implementation. The example taken from the DBE project describes, in a selective synthetic way, the state of the art, and the future-oriented scenario represents a projection of the current DE development.

The DE scenario is based on the hypothesis of a full implementation of the service-oriented infrastructure with its adaptive characteristics and evolutionary instruments and a full, independent use by end-users. The scenario is positioned, therefore, in a temporal range of three to five years. This time frame is based on responses collected during a delphi analysis conducted at the end of the DBE project where most of the 120 interviewed players were optimistic for a full realisation of digital ecosystems in a period of three to five years specifically (see Passani, 2006).

5.1 Communities

With reference to the CISG dimension: the community, in the DBE implementation in the Aragon region (in Spain) and in the Midlands (in England) was composed of the following actors:

- Influencers
- Regional Catalyst

- Adopters.

These actors can be related to two of the three components of communities defined in the CISG model: Business Agencies (Adopters) and government agencies (Influencers and Regional Catalysts). The citizens' component, which characterises grass-roots CNs, is currently absent.

It is possible to say that the communities involved in Digital Ecosystems during the project DBE did not aggregate themselves spontaneously, but have followed a top-down model in which the Regional Catalyst (in these cases a local development agency and a university) has played a central role. Nonetheless the model of the ecosystem population realized by Regional Catalysts was based upon pre-existing social networks so that, although the community was largely "created", it cannot be defined as artificial as it is based on the regional capital already available in the territory (see Passani, 2007) .

Proceeding with the comparison, it is possible to define the actors that make up the DE during the DBE project as follows[20]:

The **influencers** are those players who are able (and accepted) to influence the behaviour or the necessary conditions for allowing SMEs to enter the Digital Ecosystem. Usually these are those institutions that can support the policies of local SMEs (policy makers, local development agencies, business associations and other intermediate players).

The **regional catalyst** is an organization that is able to coordinate the training of regional SMEs and the local constituency building. The catalyst must therefore have the capacity to involve local SMEs (which must then consider it as a credible point of reference) and has to be able to select and work with influencers and have a in-depth understanding of the realities of advanced software development in the region. In other words, the regional catalyst must have a direct knowledge of the local productive fabric and must be recognised as a credible partner (possible Regional Catalysts are technological parks, local development agencies, technology transfer agencies, etc...).

The **adopters** are SMEs, the heart of DEs. SMEs are the main users of DEs and, at the same time, are those who populate the ecosystem with their own services.

The SMEs involved are aggregated in different typologies and are divided between software developers and users.

If this is the community of actors from the local point of view there is a parallel community placed on the global side (see Section 3.1.1). The latter is composed of researchers who technologically and theoretically developed the DE. This second community, which is a key resource in terms of creation and implementation of common knowledge, is largely represented by the partners of the network of excellence OPAALS and other DE Cluster projects and, during the DBE project, was visible to local users primarily through online interaction.

With reference to the scenario of digital ecosystems after the end of the research phase, it

20 For a detailed description of DBE local actors, please see deliverable 27.1, 27.3, 31.1 and 31.3. available on the project website www.digital-ecosystems.org

will continue to be constituted, at the local level, by business units and government agencies, but the leadership between the two components is currently not predictable. If it is easy to imagine a top-down approach in which the government agencies will do the promotion and the implementation of the DE at the local level as is currently happening. A more bottom-up approach cannot be excluded where the initiative starts from an existing aggregation of business units looking only at a later stage for government agencies' support regarding economic or political recognition. Regarding the global community, however, besides the scientific community we will probably assist in the growing relevance of the Open Source community (as indicated by the output of Delphi research conducted in 2006). The Open Source Community will probably become an important source for DE-adapted software and solutions. In order to maximise the positive inputs of those different communities (the territorial, the scientific and the open source ones) there is a need to define a specific governance models. At the time of writing, it is not predicable and represents an important field for further research (see Darking, 2005).

5.2 Infrastructures

The DE can be seen as a distributed and decentralized software oriented architecture, which is composed of three macro-layers:

- Service Factory (SF);
- Service Execution Environment (ExE);
- Evolutionary Environment (EvE).

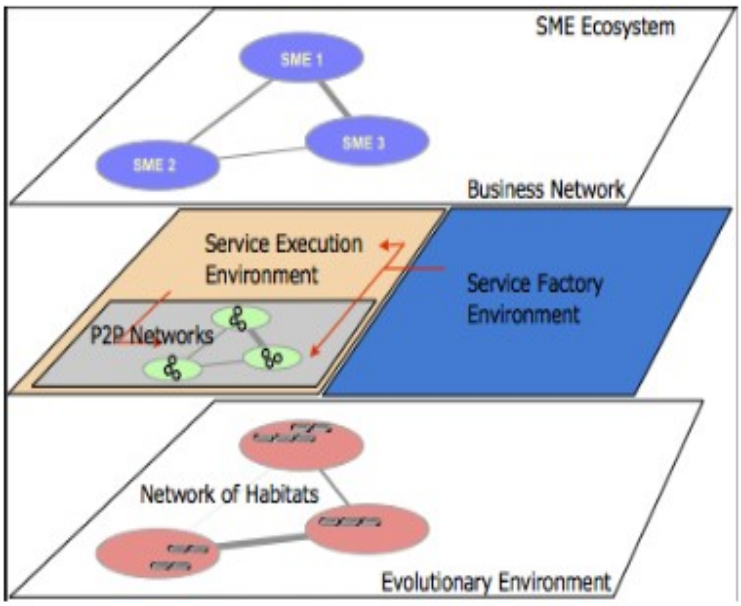

Figure 10: DBE architecture (source: DBE).

Figure 10 shows at the highest level the real network of SMEs, the intermediate level shows the two environments visible to the SMEs: the Factory Service and the Execution Environment. The third level is the most advanced and allows the automatic evolutionary process, namely the automatic recognition and combination of services. This part of the DBE has not been completed yet and is being worked on in OPAALS.

It is already clear from this initial breakdown of the DE technological structure that it belongs, according to the CIRS definition, to the area of software infrastructure. The DE must, in other words, be able to rely on pre-existing hardware infrastructure or on an ad hoc developed one. The service-oriented infrastructure of DE is neutral with respect to to the hardware. It can operate on very different hardware and connectivity systems. The scientific community of Digital Ecosystems has recently developed hardware, called DE-BOX, facilitating SMEs' access to services, but this does not replace the hardware infrastructure that every company must have in order to enter the DE. Due to the characteristics of the DE, the users do not need very complex or advanced solutions in terms of hardware and connectivity infrastructure but, at least currently, a good network connection and a computer connected to it are required.

Regarding the scenario of development, in the future, it might be possible to access the DE also through other types of hardware such as a mobile phone, but certainly the core point of DE will still be the services and not the hardware of connectivity infrastructure. With reference to another dimension of the CISG definition, the global/local orientation of the infrastructure, it is possible to say that the DE architecture, due to its open, decentralized and flexible nature, is global in nature even if, at present, the services are mainly conceptualised for local usage.

5.3 Services

On the services side, the DE distances itself from the majority of historic CNs because it addresses mainly business units (not citizens), and it is characterised by its bottom-up approach. The DE does not create services itself. Its main service is the infrastructure that gives the SMEs the opportunity to share a language, work collaboratively and share information, services and software components. Thus, the bottom-up dimension of the DE is constituted by the fact that it will be populated by services that SMEs (users and providers) will make available.

For example, in the case of Aragon, the DE has made possible the communication and the cooperation between companies in the tourism sector by providing a middleware capable of making SMEs talk with each other regardless of the different languages they use to describe and manage their services. Thanks to the DE, SMEs are now able to share information in an automatic way and to improve the quality of their services.

Based on the CISG definition, it is possible to say that the DE services are classified as off-line services. These services are made available by both the scientific community of

reference and individual companies that populate the local ecosystems.

The DE scenario shows that the bottom-up approach will be the future of the ecosystems. At the current research stage, because the ecosystems have not yet reached a critical mass of users that make them economically attractive for individual companies, the establishment of ad hoc services and the migration of existing services has been supported by the EU or by local funds that help SMEs to cover the costs of integration.

Once a critical mass of users is reached, the access to the DE will represent an investment for the SMEs and the bottom-up approach will become more evident. However, even in this case there is still a place for government agencies that could become providers of eGovernment, eProcurement, eHealth and eInclusion services. If this possibility is supported by local public players this could also have an impact on the "community" dimension because it could attract to the DE those citizens that are currently using these services through the web. In parallel, SMEs that are using the DE for business transactions could also use it to innovate their relationship with the Public administration.

In the DE scenario, the creation of automatically generated services will be constituted by a combination of the services made available to users. This aspect is related to the Evolutionary Environment and is one of the added values of DEs. This is a very complex mechanism that allows individual SMEs to map all the relevant services available in the system. Starting from the mapping, the EvE will create chains of optimal services for SMEs using an evolutionary approach. A deeper description of the DE service dimension would be outside the scope of the present deliverable[21]. Nevertheless it is important to underline that the DE shows important innovative elements that seem to be more complex and with more variety if compared to those currently available in most CNs, and this could constitute an interesting field of research for the second phase of OPAALS. Even analysing just one territory could help us to see which kinds of services are needed for potential users. For now, the DE, thanks to its technological characteristics, can offer interesting added value to various CNs.

5.4 Governance

The aspects of governance of Digital Ecosystems are among the most complex dimensions hitherto considered. Since governance represents one of the lines of research still structuring digital ecosystems, it is difficult to describe it as well as to develop a vision of the middle-long term. The multiplicity of actors involved in the current phase of research (scientific community, small businesses, government agencies, etc.) and aspects of DE definition (service-oriented infrastructure, community of users, process of local development, etc.) make it particularly difficult to achieve a single definition.

Proceeding step by step, or by layers, it is possible to say that, with regard to service-oriented infrastructure, it was developed through an Open Source framework and therefore to make reference to the governance frameworks available in the Open Source community. In point of

21 http://www.digital-ecosystem.org/Members/aenglishx/learn/Members/aenglishx/linkstofiles/deliverables/eve

fact, inside the so-called OS community there are many different approaches to decision making processes, participative models, leadership management, and so on. From the point of view of the actors involved, this layer now sees as protagonists the scientific community that has generated the DE and, as emerged in the Delphi survey conducted in 2006, this approach is welcomed also by many SMEs and local government agencies.

Upon this layer, however, there are other important ones that do not address the development of the service infrastructure but only its usage. In this field the challenge is to find a balance between the users needs, the interests of the scientific community that has developed the DE and the rules that every local government could/must develop when applying the Digital Ecosystems within a wider local development plan (see Darking, 2005).

Whatever governance model will be developed, it will need to - making reference to the CISG definition – integrate and find a balance between the user communities' governance and the Government Governance of public agencies that will implement the DE in their territories.

	Existing DE	***DE scenario***
C	composed of business agencies and government agencies+researcher. Top-down oriented	composed of Business agencies and government agencies+researcher+Open Source community Top-down oriented but possibly also grass-roots
I	**service oriented infrastructure?**	**service-oriented infrastructure?**
S	top-down evolved services	**bottom-up services + top-down services + evolved automatised development of services**
G	community governance	balance between community governance and government governance

Table 4: the present and future DE scenario.

In the chapter that follows we will analyze the elements listed above to find a possible partial translation and synergy between Digital Ecosystems and Community Networks. We will start by taking note of the differences that separate them from the epistemological and phenomenological aspects already highlighted.

6. COMMUNITY NETWORKS AND DIGITAL ECOSYSTEMS

6.1 Constructive coupling between CNs and DEs

In this section we will compare CNs and DEs on the basis of the results of the C.I.S.G. analysis[22]. Firstly, we will consider together the different cases and begin our analysis from the current tendencies of CNs. Secondly, we will go further by analysing two of the most common cases in CNs, grassroots and government. Finally, we will refer to the complete picture again to emphasize the main elements that characterise the relationship between CNs and DEs in the context of broadband-based local innovation.

According to the latest tendencies (see Section 4.4), CNs can now be considered as infrastructures for ubiquitous and full territorial accessibility to the Net. In fact, we showed how the actions of citizens, and above all of local governments, are focusing on the hardware/ broadband side of CNs, especially regarding future provision of on-line services covering almost the whole built-up area. From this point of view, the relation between CNs and DEs seems to become an interplay of infrastructures and services at local level (Figure 11).

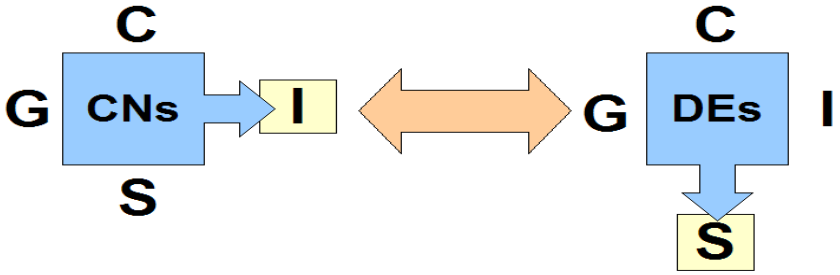

Figure 11: Generic interplay between CNs and DEs

Thus, we are able to go deeper in the analysis by considering two of the most common cases for CNs: the government and grassroots matrices.

Government CNs (“new government CNs” and “new government CNs 2” in section 4.3) are characterised by public network infrastructures on which the government can enable a wide choice of services, either directly of through specific operators. The local government, in this case, defines particular policies for using infrastructures and services. Due to the importance of the institutional level, such a typology of CN is the one that generally better suits DEs

22 The C.I.S.G. framework used to understand Socio-Technical Infrastructures is based on the relationship among four dimensions: communities, infrastructures, services, governances (see Chapter 3).

(Figure 12). In addition, we can say that the extension of network infrastructures, the local politics focussed on the reduction of the digital divide and the attention to services with an added value for local development, are all pivotal characteristics for Government CNs. A DE that is born on the same territory of such a CN can then generate a virtuous circle, through which local innovation benefits from the infrastructures of the CN and the services of the DE.

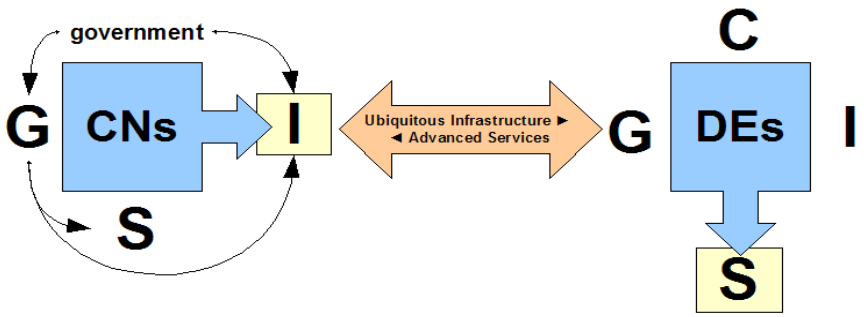

Figure 12: Interplay between Government CNs and DEs.

Grassroots CNs are characterised by a strong social component and a bottom-up action towards services and politics close to citizens, if not directly under their control (“Traditional CN”, see section 4.3.1). A recent tendency is the creation and direct management of network infrastructures by grassroots communities (“New grassroots CN”, see section 4.3.2). The CN as a phenomenon encouraging grassroots participation represents the core of the idea (Schuler, 1996). Therefore, the infrastructural interpretation of CNs connected to the action of local governments cannot complete the comparison with DEs. The remarkable tradition of grassroots CNs helps us understand that the models and direct participation practices of citizens are an important element for local development. As DEs are able to get hold of a model for participation, it is nevertheless necessary to verify if and how DEs can offer services for the local community (Figure 13).

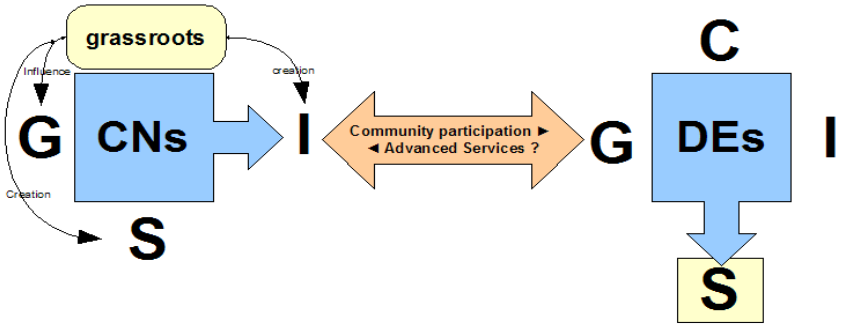

Figure 13: Interplay between Grassroots CNs and DEs.

For the relation between CN and DE we can suggest three interplay vectors or kinds of coupling that might generate a virtuous circle at broadband-based local development level (Figure 14):

1. *Ubiquitous infrastructures.* CNs, considered as networked infrastructures generated and regulated by the local government can provide a broadband and ubiquitous access to the net in a specific territory. This way, new stakeholders (e.g.: SMEs located in areas that had no previous access) can participate in the DE.
2. *Advanced services*. DEs can offer added-value services to broadband-based local innovation processes.
3. *Community participation*. CNs, considered as elements that boost grassroots participation, either to influence local policies and keep up independent added value services for a grassroots community, can provide an added value element to DEs. Such elements are constituted by models and practices for participation, both in the planning/maintenance of technologies[23] and in the direct influence on policies[24].

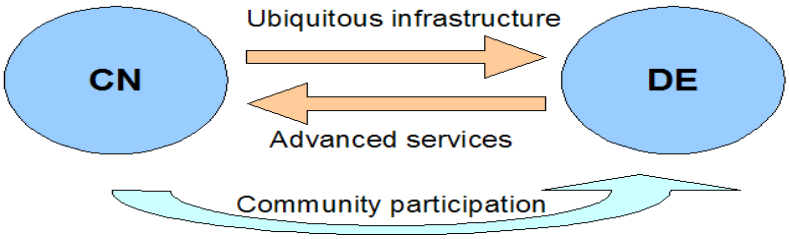

Figure 14: the possible positive interplay between CNs and DEs.

6.2 Lessons learned: on how CNs and DEs can help each other

As has been described, there are at least three levels of reciprocal play between CNs and DEs, which can also be regarded as possible scenarios of operational development. In the first level, CNs as ubiquitous infrastructures, a local government could undertake the development of a network infrastructure based on the model of CNs and, in parallel, the development of one or more ecological habitats. As the term 'habitat' connotes, it is possible to estimate the individuals in a digital ecosystem on the basis of their homogeneity with the commercial sector (tourist sector, manufacturing sector), or on the basis of the required services (habitat of legal services for SMEs, habitat of services for the management of complex projects). Accordingly, the local government characterises two needs at the same

23 Reference: Participatory Design as a methodology traditionally connected to community networking (Schuler and Namioka, 1993).

24 Reference: community networking as tool for indirect influence (Schuler, 1996) or direct influence (De Cindio et al. 2007) on public policies.

time: on one side, one or more sectors could benefit from better access to information services; on the other, one territorial area or a category of users could benefit from access to the network. In the case of Aragon (between 2003 and 2006), the creation of a digital business ecosystem for the tourist sector also activated an immense operation tending to reduce the digital divide that characterised the periphery of the region. This second operation can be defined as a 'Government CN'.

The digital business ecosystem has described final users of services (user SMEs, in paragraph 5.1) and small lodges, disseminated in the rural areas (known as 'casas rurales' in the Pyrenees). The area is also involved in the Wi-max plan of the government of Aragon in collaboration with the interested provinces. The coherence of the two initiatives was not originated only from the direct involvement of the regional government of Aragon in the two initiatives (the government finances both of them), but also from the links between the ITA (Technological Institue of Aragon) and Embou. ITA was the Regional Catalyst of the DBE project, and works closely to Embou, an SME that was involved as a service provider in the DBE project. Embou, born through an enterprise incubator of the government of Aragon and through that connected to ITA, is the provider of broadband services at the regional level and is carrying out the initial phase of the Wi-Max pilot project jointly with Telefonica (the largest Spanish telecommunications enterprise).

The small rural houses that are experiencing an interesting wave of development in their region and that have an important potential market have not yet accessed the network. If they had, the process calls for significant costs (connectivity via mobile phone or satellite) for the communication and publicity of their services that rely on extremely static channels (or Internet). Additionally, in many cases, potential clients do not have the possibility of making reservations directly since those rural houses are rarely part of the selection of the biggest travel agencies. The greater business share of the rural houses is made through telephone transactions (B2C transactions) with no special tools for B2B transactions (management of suppliers, collaboration agreements among different operators, etc.). The rural houses that showed interest in the DBE project, or have been already engaged with it, would need a stable and cost effective connectivity service. Thanks to the Wi-Max project, they will have the possibility to move ahead in the way of making business by being connected to the Web's general market and to the DBE services, consequently amplifying their own business potentialities.

The Table 5 shows the synergies between CN and DE following the CISG definition from the final user point of view: the hypothetical case of a rural house. The outline could be modified if the observation point is changed to a software house (drivers and implementers) involved mainly in the planning phase and in the development of the digital ecosystem. Consequently, a participative process emerges, always guided and pulled ahead by the local public actor through a top-down approach.

	Government CN	**DE**
C	*Citizens, Public Administration, Research Centers, Universities, Science Parks, Enterprises*	*SMEs tourist sector, other enterprises of the tourist value chain, software house and other service providers*
I	Top-down ***Infrastructures*** *Ubiquitous infrastructure*	Top-down ***Infrastructures*** *Service oriented infrastructures adjusted to local needs*
S	Top-down services *Online access, user support, information*	***Top-down high level services*** *Connectivity, advanced market place functionalities, interoperability related services* **Bottom-up services** *Several advanced services for users: from security management to CSM, from communication services to marketing services*
G	***Government regulation***	*To be developed*

Table 5: future possible interplay between CNs and DEs.

The example described before from the region of Aragon clearly shows the double link between the DE and CN. On one side, the CN as a ubiquitous infrastructure; on the other, the DE as a service-oriented platform that allows increasing the access of enterprises to advanced services. Regarding the services, two levels of interoperability have been identified:

- the DE as a knowledge supplier;
- the CN as a supplier of services that connect SMEs and citizens with government/public agencies/bodies.

Regarding the first level, in the core of the OPAALS research the focus is around the instruments and the legal approach to the Web 2.0 phenomenon, i.e. the collaborative creation of knowledge and its sharing through socio-technical tools. This line of research is proposed to connect the enterprises' services already defined in the DBE project with a process of knowledge acquaintance that links enterprises to the research world, promoting the creation of new instruments for innovation.

This development line is in its initial phase and it does not allow till now real modelling. Nevertheless, it is possible to develop and interpretative hypothesis. The problem of innovation capacity of SMEs, universally recognised as evidenced by the attention given by the European Commission in its last two Framework Programmes, comes not only from the use of advanced ICT instruments, but depends also on the inclusion of innovation in all organisational aspects of enterprises. SMEs do not only have to 'migrate' their business models to technologically advanced instruments. They also need cross-sectional competencies regarding managerial innovation, communication and marketing strategies, capacity of mobility through different global scenarios, and maximising the benefits from research outputs. Therefore, innovation of products and processes are strongly linked to the

use of ICT instruments, but cannot be limited to ICT. It is then necessary to link the enterprises to research poles in a way that these poles accompany SMEs towards more advanced business models. In addition to the classic intermediate actors (Chambers of Commerce, entrepreneurs associations and category associations), the digital ecosystem of knowledge emerges as a possible source of advanced training. In this scenario the Digital Ecosystem could provide, besides the services and the business instruments, the knowledge collaboratively built at an international level. Products and processes innovation in the support of SMEs could be provided through the DE technological infrastructure, including new nodes of innovation such as research institutes, universities and individual researchers.

Regarding the second level of interoperability, the local digital ecosystems could find advantage from the provision of services to government agencies and public bodies. The example of a small rural house connected to the tourist habitat in a region will help to clarify the previous statement. Thanks to the DE, the small rural house will be able to make visible its services in the 'new' marketplace, will be able to find suppliers and partners in an efficient way, and will be able to finish all the necessary steps to create new advanced services (partner search, making contracts, payments, invoicing). If also government agencies make available their own services, developing their own projects on 'Government CN' and integrating, for example, eProcurement and eGovernance, then the enterprises would be able to use the DE for building business relationships with the public administration (tax payments, signalling the enterprise's competencies and its social assets, complying with legal requirements). Regarding eGovernment, SMEs could participate in online consultations (when available) use the eVoting instruments, take advantage as private citizens to eHealth services, and thus monitoring the actions undertaken by public administrations and by so doing participate in the everyday life of the local community without leaving the DE environment. This possible exchange of services between CNs and DEs could also modify the definition of the DE users by enlarging the community to already existing face-to-face group and single citizens.

Within the last statement, a third level of interconnection between CNs and DEs is introduced: 'participation'. To this purpose, the horizon of exchange necessary to watch this interconnection is that of a 'grass-roots community network'. As has been previously seen, such a network considers the willingness of the users/community in participating in the management as one of its foundations. CNs have developed throughout the years the participation (more or less formalised), sharing some basic principles:

- a bottom-up approach to practical democracy;
- the independent management of services and infrastructures;
- a desire to maintain the autonomy regarding the government plan but, at the same time, having the capacity of influencing political decisions empowered by the community.

Historically, the transition from a grass-roots CN to a government CN marks the beginning of a dialectic that, as might also emerge in the area of DEs, deserves to be taken into consideration. Such dialectic sees the opposition between spontaneous group of citizens and institutions.

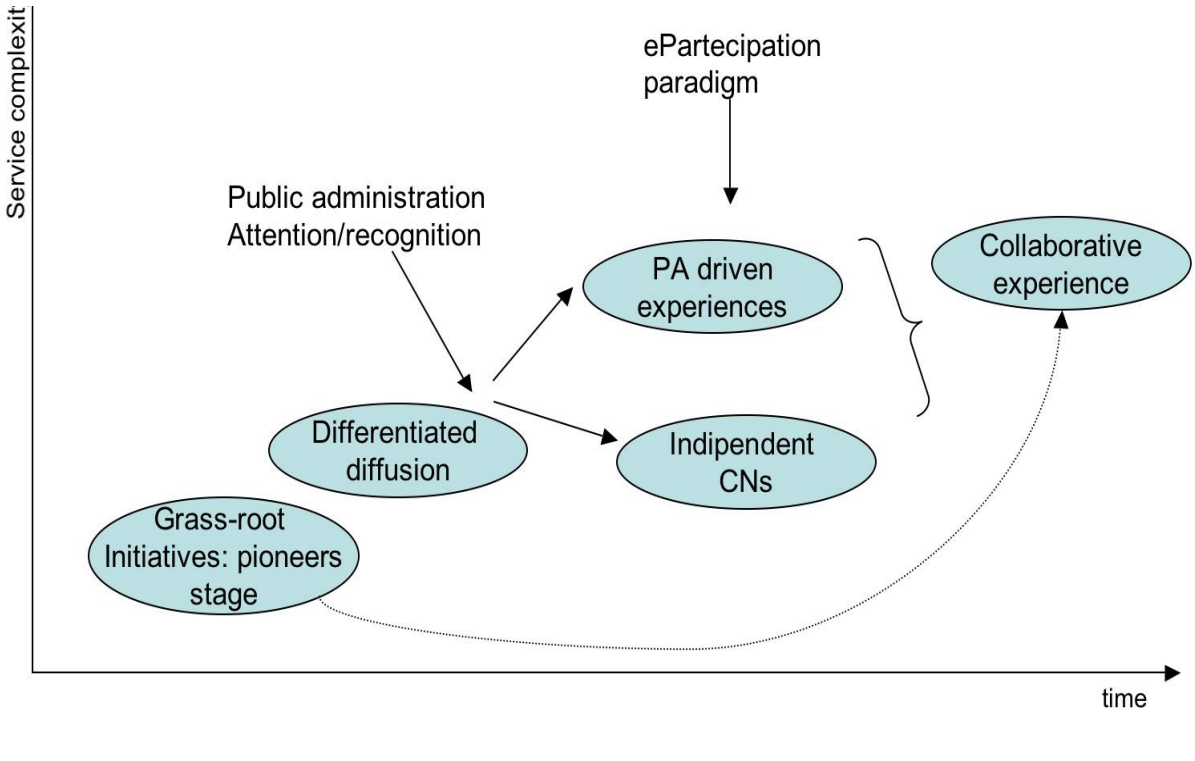

Figure 15: The Italian city-net's experience (Rur-Censis, 2005).

In order to describe such a dialectic we will start by considering the evolution of city-nets in the Italian case[25]. The study made by Censis-RUR (2005), which follows the city-nets phenomenon since its beginning, divides the story of Italian city-nets in 4 phases:

- *The pioneers* (1994-1997): small groups of citizens, self-organizing their initiatives, start to use the emerging ICT instrument to foster participation at local level and assure a better access to information for all. Milan and Bologna are two different examples of this first phase: the Milan CN followed in the steps of civic society, especially the University. It was inspired by the American free-nets. The Milan CN wished, since its first years, to engage the administration as an interlocutor, looking for recognition but wanting, at the same time, to maintain its independence. The Bologna Iperbole network, on the contrary, emerged from a public administration initiative or, better, from a group of administrators and civic servants. Iperbole has been, since the beginning, an integral part of the Internet: as a first action it opened a web-page. Of course the efforts of Iperbole in connecting the citizens have been equally strong. Currently Iperbole is implementing a Wi-Fi network for Bologna citizens merging together the theme of participation, institutional communication and community empowerment with that of connectivity.

25 Italian city-nets have more than ten years of experience (the first city-net emerged in 1994) and a variety of typologies are still in place. The story of Italian city-net has been described by Censis-RUR that annually evaluate their evolutions.

- *The un-organized diffusion* (1998-1999): In 1998, local community networks appeared in various cities, some came from public administration initiatives, others from associations and local groups. The differences between them were not so strong in this phase, because in both cases the city-nets were developed by single or small groups of innovators interpreting ICT instruments as a driver for participation and self-organization. In this phase the city-nets represent also an instrument for accessibility: the costs of the connection were high and represented a barrier for access. Consequently, many city-nets offered free access to their services and content and some PA developed public access points.
- *The institutionalization* (1999-2001): The institutionalisation phase starts at the end of the '90s. In this phase we see the multiplication of Public Administration initiatives, the content becomes more concrete and systematised, but the spirit of the first experience often was lost. Often the website aspect of city-nets sacrificed the community part, the effort being addresse towards institutional communications. As Rur researchers put it: the city-net becomes less network and more shop windows for the public administrations (Rur-Censis, 2004). In some cases, as in Rome, the public administration's initiative strongly conflicted with pre-existing community networks. In the Capital city the municipality opened up a sort of consultation process about the role of community networks. The round tables were characterised by reciprocal misunderstanding. Particularly the problem was that of free speech: the administration was afraid of the possible content of totally opened forums and posts, because the civic society's communities were hosted in the institutional portal. The breaking point arrived when the Municipality shut down some communities' pages that were accused of distributing satanic material when, in fact, the community was discussing documents circulating in the Internet and expressing their opinion on a political basis. This determined a definitive division, the communities got a different URL an became independent.
- *The cooperation and service-oriented period* (2001 -): The co-operation phase has been influenced by a Minister's initiative: the first tender for eGovernment plan (2001). The call promoted the development of collaborative project among different local players (institutional and non-institutional) for creating territorial portals able to aggregate existing initiatives and foster democratic participation. This ministerial initiative gave the possibility to PA to re-work their presence on the Internet overruling the institutional communication approach that characterised the last phase. This process in still ongoing and it's not possible to evaluate at the present stage, nevertheless it contributes to assigning a partially new role to the PA, that of catalysing grassroot initiatives, building a systematic approach over the main communities, addressing local issues and developing a common project.

The grass-roots initiatives demonstrated to public authorities how to use ICT to answer citizens' need, to facilitate their relationship with administration, to open up new channels of communication and participation. The Italian case briefly summarised here is not an isolated one. The free-networking and CNs around the world, as we have already seen, have changed their approach in the last years under different pressures, one of which was the new protagonist of Public Administration, another Internet development.

What has become clear here is that the multiplicity of functions of a CN can be managed by different players collaboratively; different drivers can co-ordinate their efforts and reach a win/ win equilibrium situation. We are not speaking about a synthesis of different experiences that may converge in a minimum shared environment but, on the contrary, a wider multiplication of actors recognising each other and co-operating on specific projects. This is something that we have to take into consideration when we are speaking about DE implementation at the local level. As we have seen DEs build up new communities but, hopefully, they can also integrate already existing communities (SMEs clusters, for example). In so doing we have to take seriously into consideration pre-existing approaches to community governance, and the long experience of CNs can help us in developing feasible scenarios for DE governance.

We dedicated a wider description to this third possible inter-link between CNs and DEs in order to indicate a possible line for future filed research. Given this general picture, in fact, we will then need to analyse at micro-level the different pragmatical ways in which each community manages the participation. Probably, in order to be able to talk about participative models for DEs, it will be necessary to go beyond the dichotomy top-down/bottom-up, and conduct further research on concepts such as collaboration, co-decision, participation and representation.

7. CONCLUSIONS

In this deliverable we described and discussed the interaction between Community Networks and Digital Ecosystems through a theoretical framework (C.I.S.G.) inspired by the theory of Socio-Technical Infrastructures (STI). Such framework is based on the study of broadband-based phenomena by analysing the relation among these four dimensions: communities, infrastructures, services, governances. The following paragraphs will deal with the importance of the socio-technical approach within OPAALS, as well as briefly present the results of the deliverable, suggesting some open issues to be considered in Phase 2 of the project.

7.1 The importance of the socio-technical approach for OPAALS

At least two reasons show why the theoretical socio-technical approach we used is useful for OPAALS: (1) the pre-ethnographical analysis level of phenomena related to CNs and DEs, and (2) the suggestions meant to enrich the systemic approach supported by the OPAALS project.

A proper comparison between CNs and DEs should be based on their thorough analysis, where the ethnographic investigation should emphasize the characteristics and paradoxes (Star, 1999), supporting phenomena of socio-technical innovation. Nevertheless, due to the lack of time[26] and resources, we resorted to the analysis of literature and the identification of models. The pre-ethnographical condition of such study required the formulation of the C.I.S.G. framework as a suitable tool for such level of analysis, in order to understand and compare CNs and DEs in the common context of local innovation.

Before understanding the relation between CNs and DEs through the systemic approach supported by the OPAALS project, we asked ourselves how to define and then compare the two phenomena. The socio-technical perspective already has both a decennial tradition in the analysis of multifaceted innovation contexts and theories – as the infrastructures theory by Star et al. – useful to understand relations among phenomena in a pragmatical way. In our opinion, the systemic-autopoietic and associative approach used in OPAALS needs the socio-technical approach to operate on CNs and DEs: (a) a first phase of definition and comparison, useful to single out dimensions and cases, and (b) a theoretical-methodological direction for an thorough empirical investigation.

A reason for such need may be the characterisation of infrastructures within the DBE approach. In fact, in DEs research we talk about software, but never about the hardware and networked infrastructures that support the services, all elements that in the end would be taken for granted within the systemic approach of OPAALS. On the contrary, STI considers the assumption that the infrastructure system supporting a socio-technical phenomenon is

26 In order to avoid simplistic interpretations, a proper ethnographic analysis needs a longitudinal presence on site and a theoretical framework able to overcome biased visions on the phenomena observed.

invisible – because it is hidden or it has not been analysed in detail – and its objective is to analyse such system. Therefore, no matter how different the STI approach and the systemic-autopoietic one might be, our proposal has been to interpret such diversity as a positive aspect. Thanks to the research done so far in this deliverable, in the second phase of the project we will be able to use the systemic-autopoietic and associative approach to analyse CNs and DEs.

7.2 Results of D7

CNs group together experiences deployed in ten years of research and have been defined in different ways: from off-line communities that meet on-line, to local government broadband infrastructures. DEs, on the contrary, are a new field of research characterised by few exemplary experiences that has not been analysed in detail yet. This deliverable, by considering the broadband-based local innovation as a common point for the two phenomena, firstly defined CNs and DEs and secondly compared and analysed their prospective relations.

CNs constitute a heterogeneous group of experiences that has been described in the literature in different ways according to the specific research field. The C.I.S.G. analysis allowed us to identify and compare the different definitions and typologies. Among the latter, the most important for CN have been identified with the following labels: *Traditional CN*; *New grassroots CN*; *New government CN*; *New government 2 CN*.

Nonetheless, we can identify two tendencies among CNs:

- *Government CN*: typically top-down and based on the creation and management of networked infrastructures by local governments, with the participation of business agencies (telecom providers, Internet service providers, etc.) in order to facilitate the local development for citizens and at public and business level;
- *Grassroots CN*: characterised by a deeply rooted bottom-up tradition, this tendency is based on the self-management of services and infrastructures by citizens, so as to generate *democratic technology* through which to facilitate community networking and influence public decisions.

DEs have been observed through two pilot experiences: Aragon in Spain and Midlands in the UK. The C.I.S.G. analysis emphasized a tendency to top-down initiative characterised by the following dimensions:

- *Communities*. The roles of influences, regional catalists, adopters, and – on the global level – researchers are recognised. Government agencies promote the initiative;
- *Infrastructures*. The focus is on the *service-oriented infrastructure* composed by three macro-blocks: Service Factory, Service Execution Environment, and Evolutionary Environment. The hardware infrastructure for transmission and information access is not considered.
- *Services*. These are services for companies, or better, there is the service provided by

the *service-oriented infrastructure*. This gives SMEs the possibility to exchange information, services, software components and, more generally, other services by way of a common standard language. The objective of the DE is to allow at local level the creation of new on-line services. These are based on the *service-oriented infrastructure* and on standard Open Source.

- *Governances*. At present, the scientific community defined the Open Source approach and the service architecture. Nevertheless, given the different and numerous actors involved, 'governance' remains the most complex aspect for the future development of DEs and deserves to be studied (see Task T12.2 in Phase 2).

Once the pilot phase is finished, one can assume that DEs can: include bottom-up oriented approaches (communities); focus more on new access hardware as mobile phones (infrastructures); support the creation of services automatically generated by a *service oriented infrastructure* (services), and facilitate the self-management of the service infrastructures by users themselves.

The analysis of the relations between CNs and DEs emphasized on a general level some sort of orientation of CNs towards the dimension of hardware infrastructure, whereas DEs tend towards services. Both phenomena represent cases of broadband-based local development that can intertwine and generate useful synergies at local level. Both the *government CN* typology and the *grassroots CN* typology showed three interplay vectors with DEs that led us to pose questions on the future scenario (Figure 16):

1. *Ubiquitous infrastructures.* Government CNs, by providing broadband and ubiquitous access to the network, might facilitate the performance and participation to DEs within a specific territory.
2. *Advanced services*. DEs can offer added-value services for CNs.
3. *Community participation*. Grassroots CNs can provide useful models and participation practices for the future evolution of DEs.

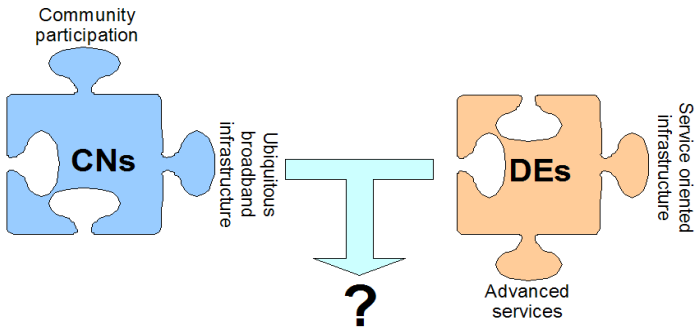

Figure 16: the future interplay between CNs and DEs.

Imagining future scenarios of CN and DE interconnection is an operation which would require careful and targeted ethnographic research aimed to observing in detail (and from the point of

view of different users), the micro-practices of the two phenomena. A field research would explore, among other things, the level of transferability of different experiences. This would examine to what extent a virtuous process in a specific area could then be replicated elsewhere, identifying the relevant variables to be included.

Some research towards this direction has been done during the DBE project but, when the research took place, the technological infrastructure was still under development. Therefore, the research outputs cannot be seen as an indicator of a mature DE because only scenarios have been developed providing a first approximation. It can be said that once a mature 'Government CN' and an efficient DE emerge with a full technological development, it will be populated by a cloud of services and players. Once this happens, three possible synergies between CN and DE will emerge (these will be specified and verified with field research in WP12, phase 2):

a) *CN and DE as a synergic regional development strategy* that implements both a government CN and a DE, providing communities affected by the digital divide with ICT access and advanced services simultaneously.

b) *DE and CN as sources of different but possible complementary services*. As it was developed, DE can be interpreted as an instrument for providing users with advanced services; by providing the possibility to make already existing B2B services interoperable, and by providing SMEs with an effective path for ICT uptake and collaboration boosting. Besides this, DE can be interpreted as an important knowledge provider. The research community currently studying the DE could become, in the near future, a 'knowledge provider', (using the same technological infrastructure) making available advanced knowledge, supporting SMEs, and developing a territorial necessity towards innovation. CN, as 'government CN', could provide, through the DE, those services now available through the web, related to fostering citizens and SMEs participation to the Information society (i.e. eGovernment, eProcurement, eHealth and eInclusion services). Merging CN and DE services would also lead to the enlargement of the number and the typologies of communities, and thus augmenting the possibility of populating the ecosystems. This would then reduce one of the gaps that now separate the DE and the CN.

c) *CN as a source of well-tested experience related to community participatory practices*. Starting from the history of the development of Italian civic networks, an action-research could start by taking into account the possible dialectics between grass-roots CNs' pattern of participation (commonly replicated in communities of practice) and government governance. This can guide the DE research community in developing further a participatory process for defining models of governance applicable to the DE at the local and global levels.

7.3 Open issues

To sum up, we would like to present some open issues that might prove to be fundamental for

phase 2 in the OPAALS project.

The first issue concerns the *need to undergo a phase of detailed empirical research on DEs*. Despite some initial cases[27], DEs have not been analysed thoroughly yet, in order to define more specifically both actors and activities, not to mention background processes. The C.I.S.G. framework has been helpful for this deliverable in order to analyse DEs and CNs through literature and some case studies. Even then, the socio-technical approach used suggests to analyse more in depth phenomena through the dimensions presented in section 2.2, emphasizing structures and paradoxes that define and support the specific located practices (Star, 1999). What is still missing in the research on DEs is a continuation of the empirical analysis, that is the shift from the analysis of specific practices through which it is possible to improve the model. To ethnographic technique one can add other tools – even quantitative tools like the social network analysis (SNA) – provided the research tends to emphasize and not hide the characteristics and problems in specific DEs.

The second issue is related to the *need to analyse DEs by taking into consideration other aspects of the broadband-based local innovation* as CNs. In this deliverable we have emphasized the level of the broadband-based local innovation, in which context both CNs and DEs play different but potentially synergistic roles. This leads us to two elements. The first is that, both empirically and theoretically, it is possible to analyse DEs effectively even on a different level of analysis. The second suggests that some elements deriving from other local innovation cases might eventually relate to DEs, thus modifying the model in some cases. For example, this could bring about DEs typologies that were not meant for business but are characterised by particular dimensions and processes.

The third issue concerns the need for a more in-depth study of policies for DEs at a regional level. We have already focussed the attention on this void in Chapter 5, whereas the supporting policies for CNs belong to the same definition of Government CNs. Since DEs represent real aspects that must be adopted and facilitated at regional level, the time has come to take advantage of the interplay between empirical research and theoretical modelling to study which actors and processes in regional policies can help the growth and sustainability of DEs.

27 See Deliverable 27.2 and 27.3 of DBE project.

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APPENDIX

Appendix 1. CN example: Seattle Community Network

<table>
<tr><td colspan="2">Initiator: It is a free public-access computer network that started with the partnership of the Seattle Public Library (1994). It was originally a project of the Seattle Chapter of Computer Professionals for Social Responsibility (CPSR). In 1995 the Seattle Community Network Association (SCNA) was incorporated as a separate non-profit organization.
Initiated: 1994
Motivation: “free democratic technology for all”
Other main stakeholders: volunteers and citizens
Development style: participated
Objective: eParticipation, social responsibility
Webpage: www.scn.org</td></tr>
<tr><td>Communities:
Seattle (USA) citizens and associations</td><td>Infrastructures:
-</td></tr>
<tr><td>Services:
● Free access and hosting: e-mail accounts, web sites, mailing lists, community pages, calendars and usenet news, classes for using e-mail, help desk.
● Services are free. SCNA is a volunteer-run, donation-funded nonprofit providing SCN. [vision: Powering communities with technology]</td><td>Governances:
free speech, free access, right to privacy, due process, SCN has both registered and non-registered users</td></tr>
</table>

Appendix 2. CN example: Seattle Wireless

<table>
<tr><td colspan="2">Initiator: citizens
Initiated: messages are posted since the 1970
Motivation: believe that ordinary people can build a network without recurrent fees that is not beholden to any commercial telecommunications provider
Other main stakeholders: citizens
Development style: participated and cooperative
Objective: creation of (a) a broadband wireless metropolitan area network and of (b) tools that help us achieve that goal.
Webpage: www.seattlewireless.net</td></tr>
<tr><td>Communities:
Seattle citizens</td><td>Infrastructures:
self-deployed and managed antennas</td></tr>
<tr><td>Services:
voluntary managed wiki with info on how to self-connect to the Net</td><td>Governances:
only not for profit initiatives</td></tr>
</table>

Appendix 3. CN example: One Manchester

<table>
<tr><td colspan="2">Initiator:
● the local authorities of Manchester, Tameside and Salford,
● other local authorities from Greater Manchester
● partners from the public, private and voluntary sectors.
Initiated: 2006, with the 16y experience of the Manchester Telematics Partnership
Motivation:
● provide broadband access for all residents, businesses and other institutions,
● provide improvement of the public service delivery,
● provide promotion of job creation, business growth and economic development,
● enhance education/training; improve the teachers/students/parents interaction,
● improve healthcare through telemedicine and remote patient care.
Other main stakeholders:
● led by Manchester City Council
● co-ordinated by the Manchester Digital Development Agency (MDDA) which is part of the Chief Executive’s Department (Regeneration Division) of the City Council
Development style: supposed to be developed in a bottom-up direction
Objective: to generate ideas about how a ubiquitous “IP-City” network could best be developed offering free basic level access for everyone across the city-region, together with premium services. The ambition for the project is covering the whole City-Region. Since February 2007 One Manchester is on Second Life as well.
Webpage: www.manchesterdda.com/onemanchester/</td></tr>
<tr><td>Communities:
● areas in Manchester and Tameside, UK
● citizens and local institutions</td><td>Infrastructures:
● broadband infrastructures
● owned/managed by the PA</td></tr>
<tr><td>Services:
● free access to basic Internet/Mobile services
● user consultation/engagement: with imaginative uses of mobile and social technologies (blogging/ podcasting etc.)
● community-based digital access centres
● personalised Access, Application, Service packs.</td><td>Governances:
-</td></tr>
</table>

Appendix 4. CN example: Virtual Helsinki

<table>
<tr><td colspan="2">Initiator: Helsinki telephone company (HPY).
Initiated: the Helsinki Arena 2000 project started in 1996.
Motivation: build the next generation metropolitan network and a 3D virtual city.
Other main stakeholders: the Arena 2000 consortium involves the city government and various companies including IBM and Nokia. ARCUS Inc. developes the 3D virtual city.
Development style: top-down
Objective: create a virtual city as human interface for new broadband network services
Webpage: www.virtualhelsinki.net</td></tr>
<tr><td>Communities:
Business agencies and the city government</td><td>Infrastructures:
public & business driven broadband infrastructure</td></tr>
<tr><td>Services:
Now only virtual tourist tour, in future the 3D virtual city will be the interface for more advanced services</td><td>Governances:
-</td></tr>
</table>