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Glossary

AAA: Authentication, Authorization, Accounting

AMR: Automated Meter Reading

CISG: Communities, Infrastructures, Services, Governances

CN: Community Network

DBE: Digital Business Ecosystem

DE: Digital Ecosystem

DSL: Digital Subscriber Line

EnoLL: European Network of Living Labs

EOA: Ecosystem Oriented Architecture

GBE: Gigabit Ethernet

IP: Internet Protocol

ISP: Internet Service Provider

LAN: Local Area Network

LL: Living Laboratory

PA: Public Administration

PAT: Provincia Autonoma di Trento (Autonomous Province of Trento)

PDA: Personal Digital Assistant

PPP: Public-Private Partnership

QoS: Quality-of-Service

ROI: Return on Investment

SDP: Service Delivery Platform

SME: Small Medium Enterprise

SOHO: Small Office Home Office

STIs: Socio-Technical Infrastructures

TasLab: Trentino as a Laboratory

UML: Unified Modelling Language

VoIP: Voice over Internet Protocol

Wi-Fi: Wireless Fidelity

WiMAX: Worldwide Interoperability for Microwave Access

WOTBL: Wireless Optical TestBed Laboratory

WLAN: Wireless Local Access Network

3G: third generation (cellular mobile)

1 Introduction

Community Networks provide ubiquitous access, full coverage of the respective territory, and access from a multiplicity of user devices and platforms. On the other hand, a broadband infrastructure is a fundamental requirement for a digital ecosystem. Digital Ecosystems are advanced services enhanced by new software infrastructures that hardly require broadband connectivity. Our first aim is to show how community networks can help the adoption of digital ecosystems in regional settings and illustrate it by a case study of the community network of the Province of Trento in Northern Italy.

When implementing Community Networks, the always-on and ubiquitous requirement requires a significant investment that is generally and most logically provided by the local government which needs to show a Return on Investment (ROI) which is supposed to come from the applications and services that are provided on top of the network infrastructure. Therefore, there is a strong interdependence between the (broadband) communication infrastructure and the higher layers of the architecture, unlike the "normal" Internet scenarios where they are generally independent and justified according to different business models. When applied to regional community networks, digital ecosystems can generate a broad range of positive externalities and interact constructively with the network effects that the community network "kick-starts" but that the digital ecosystem continues to feed.

The objective of this study is (i) to demonstrate that the community network approach could be an efficient means for fostering the creation of digital ecosystems in the respective communities, (ii) to argue that the digital ecosystem perspective could produce positive externalities for the process of creation and sustainability of a public broadband infrastructure, (iii) to identify strategies of DEs implementation and (iv) to demonstrate them by the example of the Trentino region and Trentino Living Lab.

The study of the current phase of the project serves also as a preparation for our planned task in Phase 2 titled “Creation of a living laboratory for service experimentation in DCEs”.

This report is structured as follows.

In Chapter 2, “From Community Networks to Digital Ecosystems”, we start with an overview of community network infrastructures and emphasize the elements and characteristic features of CNs that can prepare the ground for and help the introduction of DEs in regional settings. We will show that basic requirements for the network and IT infrastructures of CNs, such as ubiquitous access, full coverage of the respective territory, access from a multiplicity of user devices and platforms, service delivery platforms etc. and support of mobility, support for location based services etc. are extremely important conditions for implementation of DE services.

Chapter 3 is titled “Sustainability of CNs and how DE services can help CNs become sustainable”. In this chapter, we will show that, even if CNs and DEs could be considered as separate processes, they are only different elements of innovation at the local level. Therefore, CNs may provide infrastructures for DEs, and DEs may provide services and legitimation for CNs. This chapter will also briefly introduce the CISG socio-technical framework for the analysis and understanding of CNs and DEs.

In Chapter 4, “Strategies for implementation of CNs and DEs”, we will address the strategy issues related to the implementation of CNs and DEs as relations and specifications of the CISG framework. The business considerations should provide a basis for understanding that DE services can indeed make CNs profitable and sustainable. We will discuss infrastructure technology choices: what CNs can give to DEs; DE services: what DEs can give to CNs; business models: the specific relationship between the CISG elements and policies: government governance.

In Chapter 5, we demonstrate the application of the general strategies discussed previously by the example of the Trentino region and Trentino Community Network. We will introduce the TCN as a Create-Net vision for local development and will give an overview of the T.Net and TasLab projects. Discussing these projects, we will point out the specific relations between the CISG dimensions.

Our study will conclude with a Summary.

Fig. 1 illustrates the structure of our report. It shows that Chapter 2 and Chapter 3 provide the background for strategies developed in Chapter 4; Chapter 2 from the point of view of technologies while Chapter 3 from the socio-technical perspective. Chapter 5 applies the strategies to the Trentino example.

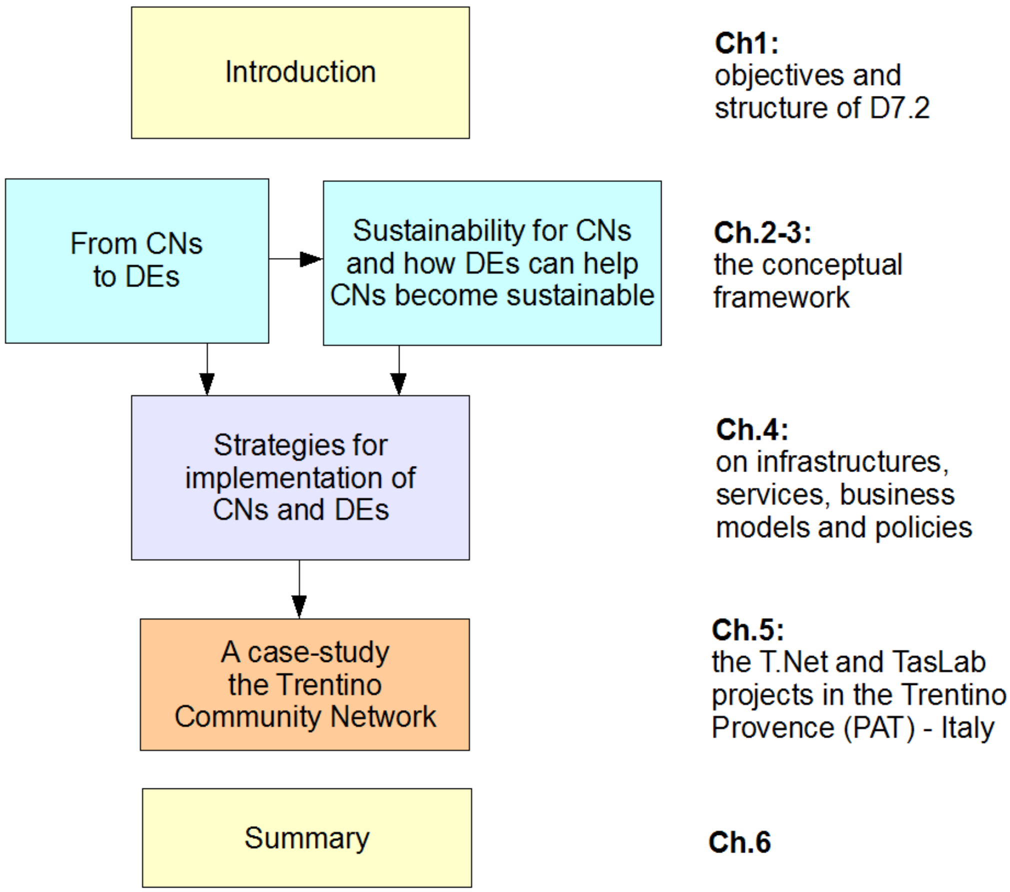


Figure 1: The structure of this report

2 From Community Networks to Digital Ecosystems

In today's global economy, competition does not occur between countries, but between cities and their surrounding regions. This stems from the fact that competitiveness is driven by innovation and cities tend to be the centres of such innovation, see e.g. Martin, R., Kitson, M. and Tyler, P. (2006). Investment in such new infrastructures is essential for cities to remain competitive and retain or attract new increasingly mobile workers and businesses. The establishment of a digital community is an investment by a city in its citizens and businesses so that they can continue to compete in the global economy. The (usually wireless) infrastructure not only helps in breaking down the digital divide among citizens, but also promotes efficiency in the public and private sectors. Finally, the infrastructure is crucial to developing new innovative services for improving citizen satisfaction and also for fostering growth.

Let us first start with a few remarks on why the community network (CN) approach could be an efficient means for fostering the creation of digital ecosystems in the respective communities and for promoting DE implementations in regions that CNs cover.

The term Community Networks generally refers to on-line services created and used with high level of involvement by a community belonging to a specific geographical area. Nowadays it 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 (see the OPAALS D7.1). Differently, Digital Ecosystems are an emerging infrastructural architecture coupled with socio-economic processes aiming to provide advanced services. The relationship between CNs and DEs is therefore characterized by the asymmetry of the two subjects at the maturity level, but some connections could be considered.

Community networks are already existing digital communities, involving different groups of users, (e. g. not only SMEs). For these user communities, moving from some basic CN services such as Internet access or participation in public processes to digital ecosystem services would be a straightforward development step. SMEs, in particular, are strongly connected to their regions and need regional infrastructure and support to implement DBE services, which can be done through CN infrastructures and business/governance models. Community networks are application-driven, and users/members of CNs usually have already collected

(positive) experiences about and benefited from some distributed applications. Therefore we expect that they are more open to the acceptance of DE services than in cases of green field efforts.

In this chapter, we start with a high level view of community network infrastructures and will emphasize the elements and characteristic features of CNs that can prepare the ground for and help the introduction of DEs in regional settings. We will show that basic requirements for the network and IT infrastructures of CNs, such as ubiquitous access, full coverage of the respective territory, access from multiplicity of user devices and platforms, service delivery platforms etc., and support of mobility, support for location based services etc. are extremely important conditions for implementation of DE services.

2.1 Overview of community network infrastructures

For the purposes of this chapter, we use the term "infrastructure" in its narrower, technology-oriented sense, putting aside the social and organizational aspects, more or less, in the sense of a recent National Science Foundation definition (NSF 2006) which states "Cyberinfrastructure integrates hardware for computing, data and networks, digitally enabled sensors, observatories and experimental facilities, and an interoperable suite of software and middleware services and tools."

Figure 2 shows the simple architectural model of community network/digital ecosystems infrastructures. The model is based on the usual approach in infocommunication technology, where "layers" are abstract functional units (that may or may not exactly correspond to separate pieces of hw/sw), that comprise specific functionalities. Layers are constructed so that they represent non-overlapping functionalities with well-defined "interfaces" between the adjoint layers, where an interface is a connecting point through which an "upper" layer accesses the services of the layer situated immediately below it, and this "lower" layer provides services through this interface to the "upper" one.

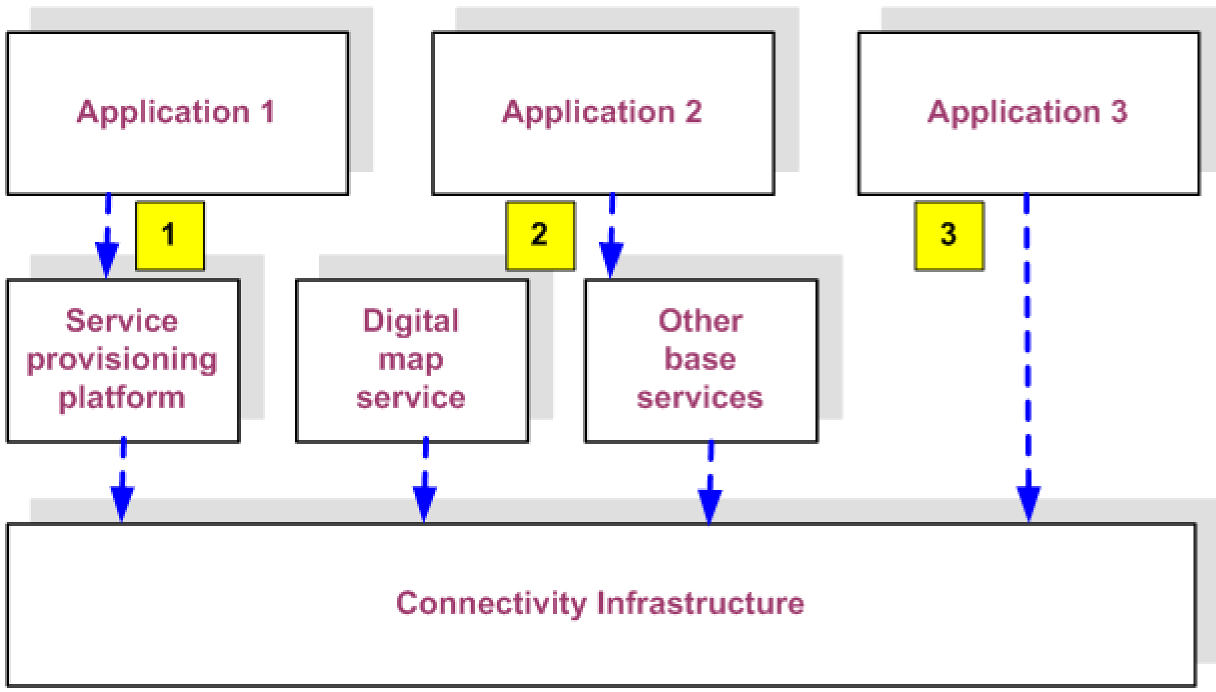


Figure 2: A simple architectural model of CN infrastructure

2.1.1 The connectivity layer

The lowest layer of the architecture is the network infrastructure providing connectivity for all components (humans, organizations, agents etc.) of the community network/digital ecosystem.

Discussing the technology solutions for providing connectivity is outside of the scope of our report. Let us only mention here a few important concepts.

a) IP

The connectivity layer's different functionalities include data transmission over the physical medium and protocols between network nodes to end-to-end connectivity based on the IP or Internet Protocol. As the name suggests, the Internet as well as most of modern telecommunication systems rely on IP, which is a packet-based communication method using specific addressing schemes and formats. Although IP provides just a best-effort type service, i.e. it does not guarantee reliable delivery, it has become the network protocol for current data and telecommunication networks.

b) Wireless

Wireless technologies play a key role in today’s connectivity infrastructures. Although wireless is the oldest form of electronic communications, it became

widespread only in the last decade of the 20th century, due to several important factors including the advances in microwave technology, the cellular principle of network organization and the acceptance of related standards. As of today, the vast majority of community networks is based on wireless technologies. According to Muniwireless.com, one of the well-known portals of wireless community networks, there were 200 regional and city-wide networks, city hotzones and public safety and municipal use networks, alone in the USA (status of August 1, 2007). This number, together with 215 ongoing projects total 415, and shows an exponential growth from 122, the figure two years ago. There are similar initiatives around the globe, and, although Europe, at least the continental part, seems to be lagging behind the US, a similar growth of wireless municipal networks is expected to happen in the next few years, to meet the objectives of ambitious European plans to bring broadband services to citizens and institutions and foster regional development.

c) Mobility

Mobility is an important principle, by which is meant the capability of the network to "keep track" of users that change their locations, or more precisely, the subnetworks they are connected to. Within the framework of IP based communications, there are specific standardized mechanisms (called mobile IP) to ensure that the change of location of a user remains transparent to the applications. Users can change their locations slowly (nomadic) and can be really mobile, moving at vehicular speeds.

d) Ad hoc network architecture

An ad hoc network, and specifically, a wireless ad hoc network is a self-configuring network consisting of mobile nodes and wireless links and form an arbitrary topology. The nodes can be placed and are free to move randomly and organize themselves into a network in an arbitrary fashion. Thus, the network topology may change rapidly and unpredictably. This type of network is particularly suitable for environment and applications where one wants to avoid the high degree of vulnerability of the centralized networks and wants to have a network that can adapt itself to changes such as outage of nodes or links. A practical example of when such a network is useful is a disaster recovery environment.

2.1.2 Service (delivery) platform

The second important component in the architecture of community networks is broadly called "service delivery platform" or service platform or SDP.

SDP has also emerged in the telecommunication world within the context of so-called Next Generation Networks which represents a significant change from the classic telco service model of independent, *vertically integrated* networks to a new architecture that comprises a *variety of access networks and has a new horizontal layer or platform* that supports service provisioning with important functionalities such as call control, quality of service provisioning, media gateways, authentication,

authorization, and accounting (AAA) and the like. This new architecture allows telcos to successfully compete with Internet-based services, and in general, supports the convergence of the Internet, telecommunication and media industries.

This new architecture's key element is SDP or Service Delivery Platform, meaning a set of components that allows an operator of the network to deliver new digital services through a horizontal service network and a multiplicity of access networks. In the narrower (technical) sense SDPs are middleware solutions between the network layer (which is based on the Internet Protocol or IP) and the applications. In a broader sense, it is a system that includes or integrates with the company's business processes.

It needs to be emphasized that open source software platforms play an important role in the implementation of this new service provisioning principle and gains increasing support from government organizations, EU and industry. The DBE platform is a good example, which is software delivered to the open source community by the European Commission-funded Digital Business Ecosystem (DBE) project.

2.1.3 "Base services"

Modules belonging to the layer called „Base Services" are certain functionalities that may be used by several applications. An example is the geo-spatial information service (GIS) which many applications rely on. Defining and implementing this type of services as independent modules prevents application designers from "reinventing the wheel" each time since the alternative would be to build a vertical stack from the necessary modules for each application. An attractive approach to this common intermediate service layer was proposed by Intel (2005) and is called Government Federated Service Bus (GFSB).

2.1.4 Applications

Applications that drive the development of community networks can be grouped as follows:

A) Access to public information and services

- Public Internet kiosks for access to public information, e-government services, tourism
- Portals for e-government services, for local communities and for tourists

B) Public safety

- Enhancing public safety by remote surveillance of public areas
- Improving the communication with police, civilian police, fire department and the like

C) Traffic control and transportation

- Coping with traffic congestion by vehicle monitoring and intelligent traffic

light control
- Vehicle management for public transportation (buses)
- Intelligent parking systems with flexible payment
- Monitoring of road conditions, in particular in winter

D) Health care
- Improving the efficiency and cost-effectiveness of health care services by broadband and wireless communications among and within health care providers
- Providing telemedicine services
- Home health care and assisted living

E) Business services
- Business partners/providers/clients searching
- Digital services: search, use and combine
- B2B and B2C transactions
- Advertise product and services

F) Educational
- Internet access, e-learning, administration portal on the campus
- Extending educational network to the home

G) Utility companies (electricity, water, gas, etc.)
- Collecting measurement data and billing information
- Detecting meter anomaly
- Supporting the repair and installation activities with online services

2.2 Basic requirements for CN infrastructures

In Edwards P. N. et al (2007) it is stated: "Historical infrastructures – the automobile/gasoline/roadway system, electrical grids, railways, telephony, and most recently the Internet – become *ubiquitous, accessible, reliable and transparent* as they mature."

While this is certainly true for some historical infrastructures such as electricity networks, road systems, ubiquitous access and reliability certainly cannot be taken for granted in the case of telecommunication networks and the Internet. Indeed, service providers develop their networks and extend coverage according to their specific business models, which don't allow unjustifiable investments in business terms. The well known consequence is the digital divide. And although the underlying networks for public Internet are currently managed by professional telecom companies, as opposed to being still at an early stage of development, their reliability is still a not generally resolved issue.

In a regional environment, however, it is possible to create network infrastructures which, if properly designed, can provide ubiquitous coverage and accessibility as

well as the required degree of reliability plus several more advantages. These and other key requirements for CN infrastructures are outlined in the subsections to follow.

2.2.1 Full coverage and ubiquitous access

Users must be able to connect to the network so that they can use the applications and services from any location and at any time.

2.2.2 Access from a multiplicity of user devices

Users must be able to connect themselves using any device. The network should support a multiplicity of devices such as laptops, PDAs and smartphones.

2.2.3 Mobility

The network should provide mobility support. On the one hand, as was already mentioned, the applications are not supposed to know where the user is (i. e. to which subnetwork the user device is currently connected to). On the other hand, the network should provide seamless service when the user is roaming across the network. This kind of roaming support has become common in cellular telephony, where the neighbouring base stations hand over the user when it moves from one base station to the another (called handover), without losing the connectivity. There is a special form of this capability, called “vertical handover” which is needed when the user moves through different technologies, for example between the cellular mobile network and a Wi-Fi hot spot.

2.2.4 Geospatial capabilities

The success of Google Earth and the increasing number of Web-based applications that rely on its Geoinformation Services is an important example of how pervasive geodata has become in our society. Communities are geographic and geospatial entities. Workers in those communities have come to rely on geographic information in order to perform their jobs. Such information is vital for making decisions in a variety of areas including crime management, business development, flood mitigation, environmental restoration, community land use assessments and disaster recovery.

Advanced Geographic Information Systems have become key tools for both local governments, utility providers, and a variety of other public and private sector organizations. Moreover, citizens and tourists alike want to be able to access maps, get directions, find shops, restaurants and lodging, and learn about local attractions

and programs, all from their mobile device. Unfortunately, a community’s geographic information is seldom housed in one place (at one organization) and information that is available is generally not readily compatible. With this in mind, an important element of the community’s digital infrastructure is a Geodata information infrastructure (GDI).

The underlying location technology is the GPS (Global Positioning System), well known in everyday life. A recent alternative to the satellite-based GPS is based on the network of Wi-Fi access points. Skyhook's Wi-Fi Positioning System (WPS) is the world's first location platform to use the Wi-Fi capability already present on a mobile device to deliver positioning. The service is currently available across the US and being extended to other parts of the world. One of the advantages of this technology is that it provides a high degree of indoor availability.

2.2.5 Quality of service

State-of-the art CNs represent also a more advanced platform in terms of network services, as opposed to the ubiquitous Internet. For current and emerging applications, the network has to provide not just connectivity but also a certain set of technical parameters that are called Quality of Service, or shortly QoS. Based on these parameters, we can tell what kind of information delivery could be expected from the network. An example is delay or loss of information units. Classic Internet does not provide any quality of service, or, from a formal point of view, its QoS is called “best effort”. Best effort means that there are no guarantees whatsoever for the delay, delay variation or loss of information units, just to name a few but maybe the most important QoS parameters. This should be kept in mind when assuming just general Internet connectivity when designing DE services. CN technologies, on the contrary, represent a shift from best effort to guaranteed services.[1] This is important for some CN applications (e. g. video surveillance, IP telephony, video conferencing, telemedicine and e-health applications) and these possibilities can be advantageously used for DE services, too.

2.2.6 Service support, service delivery platforms

Within our context of the community networks, the role of an SDP is even more important. It is critical to support those members of the communities that are not only users but can also act, permanently or occasionally, as service providers, too.

1 CNs can offer QoS beyond best effort because they can be designed to provide QoS based on application requirements and carefully selected network technologies. A network management system is used to provide the necessary bandwidth, limited delay and information loss as required by the different applications.

These members are typically SMEs but can be also individuals who need a platform to put their service on the network. The aim is to provide such entities with a platform that allows for creating new services in an easy way through user-friendly interfaces.

2.3 CN technology enables DE

In this chapter we intended to show how CN technologies can enable implementation of DE services. A few summarizing remarks are as follows.

- CNs infrastructures are particularly relevant for companies and citizens for two reasons. First, they help bridging the digital divide in both developing and developed countries where infrastructures are not provided by private operators. Second, since the local government is interested in creating value for local companies and citizens, providers could be forced to enable services that they would not allow otherwise (i. e. community bandwidth sharing like FON or SparkNet services)
- Important conditions for the implementation of DE services are ubiquitous access, full coverage of the respective territory, and access from multiplicity of user devices and platforms. These conditions are often implicitly assumed to be met when saying that for DE services one needs nothing more than Internet access. Unfortunately, public Internet service providers don't ensure these conditions, while they represent basic requirements for CNs as network infrastructures – as opposed to publicly available infrastructures of network and intemet operators.
- As discussed, community networks are driven by applications and services so it is quite straightforward to see that CNs are an ideal environment for implementation of DE services such as the DBE platform.

In the next chapter, we discuss how DE services can provide positive externalities and thus help making CNs sustainable.

3 Sustainability of CNs and how DE services can help CNs become sustainable

In this chapter we will dispell the view of Community Networks and Digital Ecosystems as separate entities. On the contrary, CNs and DEs could be seen as highly interrelated elements of the whole of the local broadband-enhanced innovation process. Therefore we will look at CNs and DEs as socio-technical infrastructures[2] in order to consider the main elements and processes that constitute this particular kind of innovation process. If DEs are software architectures that enhance advanced services, the broadband infrastructure is not yet considered in DE research. The digital divide suggests us to avoid taking for granted the connectivity for any specific area. Therefore we will consider (a) public CNs as local public broadband infrastructures that could enhance DEs, and (b) grassroots CNs as models for community participation at the local level. The interconnection of those elements suggests the local broadband-enhanced innovation process as the best unit of analysis to consider and analyse the relationship between CNs and DEs.

We will first briefly introduce the Socio-Technical Infrastructures (STIs) theory that will be used to relate CNs and DEs. Second, we will present the CISG framework as the specific socio-technical tool to describe STIs. Finally, we will consider how CNs and DEs should be seen as part of a local sustainable innovation process.

3.1 Socio-Technical Infrastructures

In our companion study (OPAALS deliverable D7.1) we describe Socio-Technical Infrastructures (STIs) as the core theory to understand CNs and DEs inside the local broadband-enhanced innovation process. STIs are one of the socio-technical theories that grew out of the social studies of science and technologies. They are particularly interesting for our purposes because of the multi-dimensional, relational and longitudinal research attitude. This attitude allows us to adopt this perspective in order to understand how socio-technical innovation processes grow and how they can become sustainable.

While a technology is usually understood as a discrete artefact, Star and Griesemer (1994) suggest to consider technologies as infrastructures, as transparent sets to be analysed also from an ethnographic perspective. Differently from the pure technological point of view, infrastructures are artifacts that emerge in practice between the social, the technical and the other elements that we would like to consider. Therefore, one can consider artefacts like the sink or the draining infrastructure as merely technological tools, but we can also understand the draining infrastructure as something that is defined in the practice of everyday life.

2 CREATE-NET developed this idea in OPAALS Deliverable 7.1

STIs theory drives us to consider infrastructures like something that emerges when local practices are made possible by larger-scale technologies. Since everyday life is made of very context-sensitive and specific relationships, Star and colleagues (Star and Griesemer, 1994 Star and Ruhleder,1996; Star, 1999, 2002) suggest to study infrastructures as highly relational things with an ethnographic sensitivity[3]. Therefore there are at least two concepts of the STIs theory that we should underline:

- multi-dimensionality: we should consider the many relevant dimensions that are involved in the infrastructure, like the social and the technical or any other sub-dimension.
- relationality: we should try to catch the co-generative process of every STI by underlining how every dimension co-generates and is generated by the others in specific situations.

3.2 The C.I.S.G. framework

Since in OPAALS we are not yet involved in ethnographic research, in Deliverable 7.1 we developed a C.I.S.G. *(Community – Infrastructure – Services – Governance)* framework (Figure 3) that will help us in the pre-ethnographic understanding of STIs like CNs and DEs.

3 The following dimensions are suggested by Star (1999) and Star and Ruhleder (1996) for an in-depth ethnographic-based understanding infrastructures: embeddedness, transparency, reach or scope, learned as part of membership, links with conventions of practice, embodiment of standards, built on an installed base, becomes visible upon breakdown, fixed in modular increments.

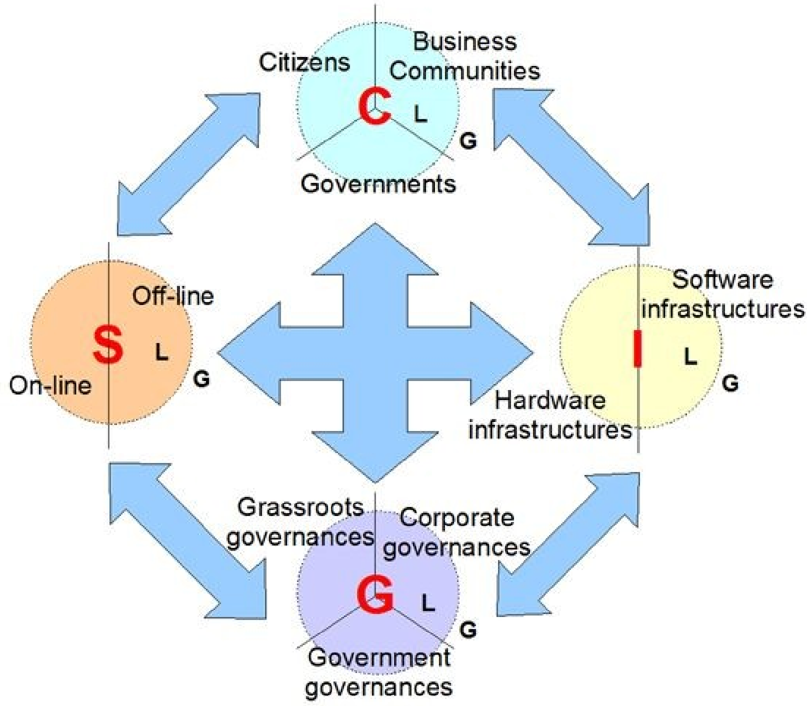


Figure 3: CISG framework for Socio-Technical Infrastructures (Source: CREATE-NET).

The CISG framework underlines the four main dimensions that we should consider when analysing broadband-enhancement local innovation as STIs:

- Communities: stakeholders, like initiators and users, that contribute to an innovative socio-technical infrastructure. Sub-categories: grassroots, businesses and government institutions.
- Infrastructures: the core technological part of a STI composed by networked infrastructures and the web of hardware and software that enhance it. Sub-categories: hardware and software infrastructures.
- Services: the different services that are provided and enabled within the STI. Sub-categories: on-line and off-line services.
- Governance: the regulation activities of communities that control and/or coordinate the use of infrastructures and services. Sub-categories: grassroots, corporate and government governance.

Since the CISG is not a model, the role of the four categories is to remind us of their generative role in a STI. Sub-categories are only indicative and could be enriched or modified in a specific analysis if more informative dimensions emerge. This framework is highly relational (Figure 4) and case-sensitive as the STI theory is. Therefore, the more relevant message attached to the framework is: “try to consider every dimension as contextually defined within CISG relationships”. For

example, this means that a technological infrastructure inside a local innovation process should be understood as generated by and co-generating communities, services and governance processes.

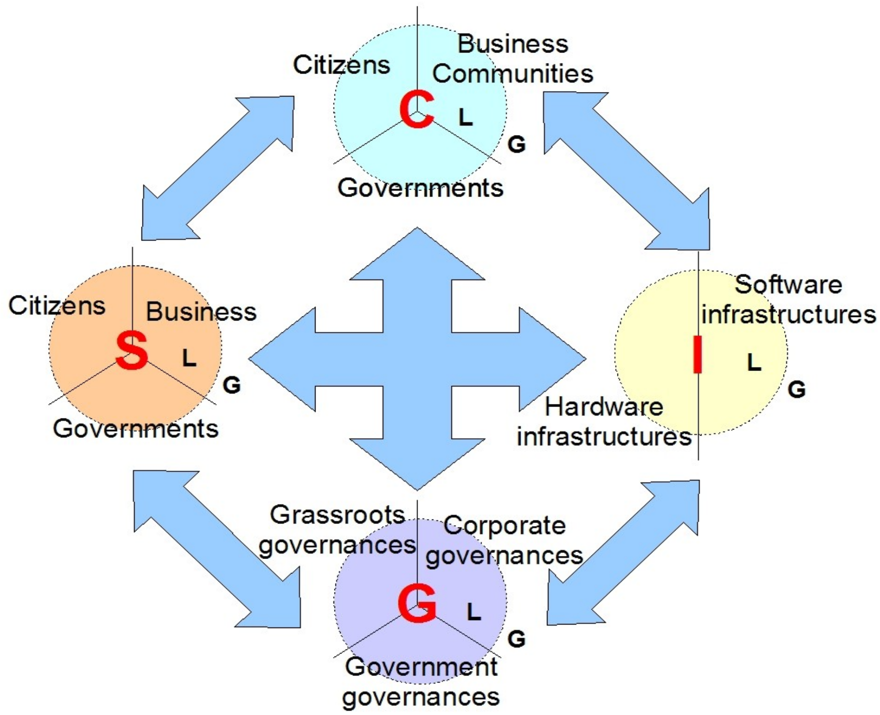


Figure 4: the relational character of the CISG framework (Source: CREATE-NET).

3.3 CNs and DEs as part of a sustainable innovation process

If we adopt the local innovation or development process as a unit of analysis, we should decide to avoid considering Community Networks and Digital Ecosystems as independent objects. This unit of analysis allows us to consider the sustainability of innovation processes. Since broadband communication is the key element of both, we consider CNs and DEs as related elements of broadband-enhanced local innovation and development processes.

The main points of this view are underlined in the OPAALS deliverable D7.1 (Figure 5):

- Nowadays CNs are underlining the networked infrastructure dimension. Local government and grassroots initiatives are co-generating a web of networked infrastructures that goes through the ubiquitous access to the net.
- DEs are a new model that could provide advanced services for future local broadband-enhanced innovations.
- The CN tradition also creates a dynamics through deep community participation in local decisions and innovation.

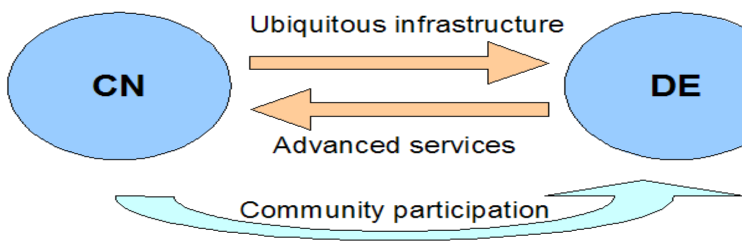


Figure 5: CNs and DEs core relationship

Under the CNs and DEs integration idea, we can envisage sustainable innovation processes as follows:

- Communities, like citizens and government agencies, at the local level are undertaking the responsibility for their own infrastructure upgrades. The grassroots community is participating in the decisions. The business community is involved through local government;
- Infrastructures are therefore created under locally sustainable business and social processes;
- Services could be developed because of the ubiquitous access and the cooperation processes enhanced by DEs and other frameworks;
- At the governance level, the creation and management of infrastructures and services could be improved by the business and grassroots participation that belong to the CNs tradition and DEs perspective.

4 Strategies for implementation of CNs and DEs

In this chapter, we will address the strategy issues of the implementation of CNs and DEs as relations and specifications of the CISG framework. The business considerations should support the proposition above that DE services can indeed generate a return that could be reinvested to make CNs sustainable. The chapter is structured as follows:

- infrastructure technology choices: what CNs can give to DEs;
- DE services: what DEs can give to CNs;
- business models: the specific relationship between the CISG elements;
- policies: government governance.

4.1 Infrastructure technology choices

4.1.1 Overall requirements

In this section, we give a high level description of how the technology selection for wireless community should be carried out.

Let's start with the overall requirements. Intel suggests that the following requirements be met when defining technologies for digital cities [1]:

- Ubiquitous Wireless Local Area Network (LAN) Connectivity — Allow users to easily connect wirelessly to applications and services in the wireless community from any location, at any time, on any device.
- Multiple Device Support for Both Connectivity and Application Access and Usage—The network must support a variety of devices including laptops, PDAs, and similar .
- Support for Industry Standards—When possible, the network should support industry standards to ensure interoperability with different vendor equipment.
- Scalability and Adaptability—The network must be able to arbitrarily grow without affecting required performance levels.
- Broadband Connection Speeds—The network must ensure adequate bandwidth for typical applications and services.
- Reliability and Durability—Critical infrastructure must not have a single point of failure. Fail-over and redundancy mechanisms must be included to ensure high availability of the infrastructure.
- A Centralized Management Solution—Tools must be available to efficiently manage the infrastructure and ensure for critical maintenance with minimal

disruption to the network.

- Roaming—The network should support full Internet protocol (IP) mobility, including the ability for users to roam between wireless nodes and IP subnets without losing connectivity.
- Quality-of-Service (QoS)—The network should support latency-sensitive applications such as Voice-over-IP (VoIP) and streaming media, as well as have the ability to dynamically allocate bandwidth based on priorities assigned to different applications.
- Security—Robust but friendly security solutions that are, where possible, transparent to the user should be woven throughout the infrastructure to ensure confidentiality and integrity of all data passing over the network.

4.1.2 Available technologies

As for technologies for community networks, all infrastructure options that are common in telcos' networks are in principle suitable for building community network infrastructures, depending on specific conditions of a given city or region. Fiber has been an attractive solution for many cities, first of all in North America. Terms like "municipal fiber" or "condominium fiber" refer to fiber infrastructure built by a municipality or an association of users such as school boards. While building a fiber network is technically viable where a local government or some of its utility companies own ducts and support structures which are "free" assets, for economic feasibility it is necessary to have a few large customers (e.g. ISPs) which buy the lion share of the fiber capacity from the local government. Some cities hosted successful pilot projects with power line communication (PLC), which is a technology allowing data transmission over medium and low voltage electricity distribution networks. However, the future of this technology is still unclear.

Wireless technologies are particularly suitable for building community networks for several reasons: ease of installation and expandability, usually low costs, and the availability of a range of technologies, starting from the ubiquitous *Wi-Fi* through the emerging *WiMAX* and *3G mobile* gaining worldwide penetration. The following paragraphs will give a brief overview and a comparison of these technologies.

Wi-Fi mesh

Wi-Fi (Wireless Fidelity) mesh networks are peer-to-peer multi-hop networks, where the nodes cooperate with each other to route information packets through the network. They present an alternative to "infrastructure based" networks. Mesh networks have some attractive features: they are "organic", and nodes may be added and deleted freely. The mesh principle means also fault tolerance: nodes

may fail and packets will still be routed; mesh networks are manageable in a distributed way. There are also challenges: if there are too many nodes, the need for routing other node traffic decreases the access throughput of a given node; if there are too few nodes then routing could be a problem. Security is also an issue. A practical problem is that presently there are no interoperable products as the WLAN (Wireless Local Access Network) mesh standard (IEEE 802.11s) is relatively new. In spite of the aforementioned shortcomings, the majority of existing wireless community networks are based on the Wi-Fi mesh principle and it is the most likely option to consider when someone is planning to create such an infrastructure. Current products feature dual and multiple radios to significantly compensate the throughput decrease when traffic is routed through a chain of nodes. Most recently combined products have been developed that feature WiMAX capabilities to use the latter technology as a backbone.

WiMAX

WiMAX's (Worldwide Interoperability for Microwave Access) flexible architecture is based on the family of IEEE 802.16 standards. The topology can be point-to-point, point-multipoint or mesh. The area coverage is up to tens of km in LOS (Line Of Site) environment, at limited data rates. An attractive feature is operation in NLOS (Non Line Of Sight) conditions. High capacity and data rates up to 100 Mbps makes WiMAX a viable option for backbone and distribution network segments. It provides a high level of security due to AES and 3DES encryption standards. Quality of service is an inherent feature of WiMAX. It has several service classes including support of real-time data streams. The mobile version is based on the IEEE 802.16e standard, approved at the end of the 2005, and products are already available based on this standard. Its deployment is easy, quick and relatively inexpensive. Different spectrum allocation possibilities exist in licensed and license-free frequency bands. Implementers of wireless community network infrastructures are cautious regarding WiMAX, mainly due to the currently high costs of WiMAX subscriber stations. However, a WiMAX-based backbone for Wi-Fi mesh networks seems to be an attractive option. And mobile WiMAX will be definitely the solution when mobility is of key importance.

3G cellular mobile

3G cellular systems together with enhancements like HSDPA/HSUPA, also due to the smaller cell sizes, offer per-customer data rates that would satisfy the requirements of most of the applications. Nevertheless, there are no community networks, at least to the best of the authors' knowledge, that are based on cellular mobile service. The reason might be a simple one: municipalities did not take this option into account, but on the other hand cellular operators might be also reluctant to work out a specific offer for a city, with very special pricing, and specific solutions in addition to cellular coverage to support large institutional users (e.g. a combination

with WiMAX). So this option is included here for completeness only.

4.1.3 Planning guidelines

Planning, deployment and operation of community networks have been challenging tasks. As opposed to telco networks, there is a specific set of services that the cities or regions want to implement, suitable technologies have to be selected, the applications and services have to be made accessible by a wide range of geographically diverse users, no matter where the user is located. As opposed to telco networks, communities can more freely choose communication technologies, including emerging ones as they do not have the stringent business requirements the telcos have to meet: e. g. short ROI (Return On Investment) or totally risk-free adaptation of new technologies. And last but not least, suitable business models have to be defined with clever constructions of involving both the public and private sectors, while satisfying legal and regulatory requirements.

Let us only summarize the guidelines for technology selections based on Szabo C. A. (2007). The key points to consider are as follows.

A) Application requirements

We have discussed above in detail.

B) Timeframe

Wi-Fi mesh is available now, however we should keep in mind that currently there is no interoperability between different vendors of mesh products, the standard is only now emerging . Fixed WiMAX is in the market, but prices will go down. Mobile WiMAX is not in the market at the time of writing of this report (end of 2007).

C) Frequency issue

In many countries or regions, mainly in Europe, it is difficult to obtain licenses required for WiMAX. Using unlicensed ISM band can result in weak QoS and low bandwidth because of disturbance of other devices and providers.

D) Costs

A careful calculation is needed for each individual project. Equipment price is not enough to take into account (a Wi-Fi node is much less expensive at this point). Required density of Wi-Fi mesh nodes should be considered vs. number of WiMAX base stations.

To summarize our possibilities we can say that, for a number of applications, Wi-Fi mesh could be the solution, but for applications that require QoS and high bandwidth, WiMAX is the best choice. Because of the low penetration of WiMAX devices, we have to use a widely preferred access technology, which is the Wi-Fi. On the other hand, the backbone or distribution network should be robust and should have sufficient capacity. The combination of WiMAX and Wi-Fi technology, and the combination of mesh, ordinary access and transfer can be the optimal

solution for every wireless community network. Wi-Fi will remain the only feasible customer access solution for the next 2-3 years (until mobile WiMAX cards will be as ubiquitous and cheap as expected by major market players).

Network design is outside of the scope of this study. Let us only outline the main steps Figure 6 (Szabo C. A., Horvath Z. and Farkas K. 2007).

1. Identifying applications and services. First, we should select the key applications and services which raise requirements toward the network.
2. Identifying network technology requirements, based on applications. We should analyze the requirements of the applications and services selected in the first step. This analysis should contain QoS (delay, jitter) and bandwidth parameters.
3. Identifying coverage requirements and the possibilities and limitations of the environment. Preparing the network technology selection, we should determine the area which is supposed to be covered by the network, with its topography, natural obstacles such as hills or trees as well as buildings, availability of support structures, towers etc.
4. Choosing network technology. Selecting the right technology is one of the key parts of the network planning. This decision should be based on identified requirements and conditions of the environment. We should choose optimal solutions both for the access and the backbone network.
5. Planning of network topology This complex part of the methodology uses the results of the coverage requirement analysis as well as the network technology selection. We should plan the network topology according to the topography and the optimal station placement strategies.
6. Verifying original requirements. Last, but not least, this step stands for verifying the results of planning. We should recognize the differences between the original requirements and the capabilities provided by the planned network.

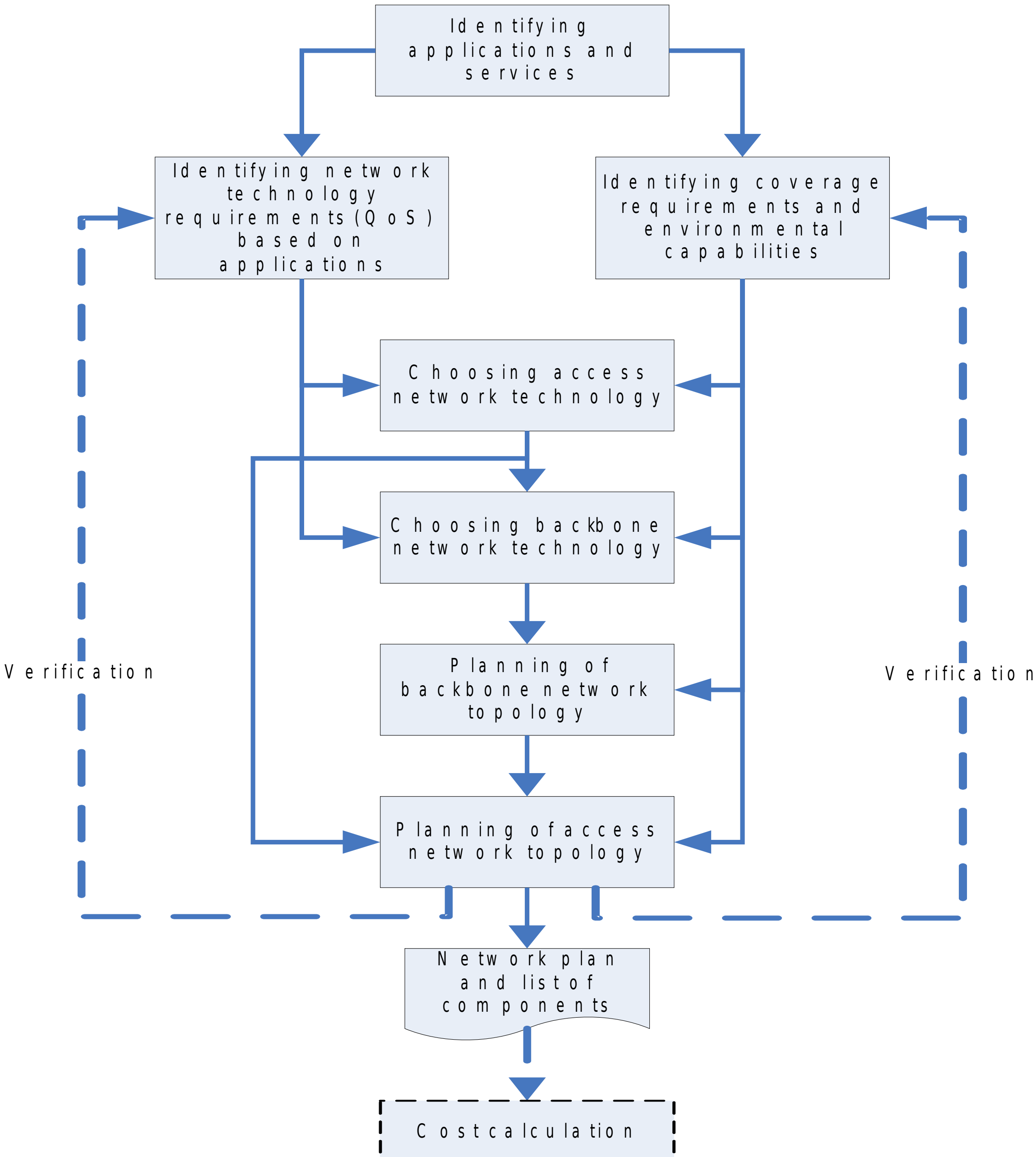


Figure 6: The design process

4.2 Digital Ecosystems services: what DEs can give to CNs

From the previous sections it should have become clear that, without basic CN services, the DE, with all its set of 'digital organisms', couldn't exist. A simple

counterexample of this assertion is that without an efficient internet access no e-business transactions can take place. CNs are systems aimed at supporting different kinds of geographical communities by supporting, augmenting, and extending already existing social networks (SNs). The convergence of ICT networks and social networks is a common aspect for CNs and DEs, and is the outcome of the merging process between the architecture described in Figure 2 and the graph designed by social relationships, where *nodes* and *ties* are the main entities (see Figure 7). *Nodes* are the main actors inside the network, and ties (or edges) are the relationships between the actors. So, for example, students of the same University are related to each other by the affiliation to a particular University Students' Association. In this case students are the nodes and the association is the relationship between them. The topology of this graph is dynamic and multi-layered.

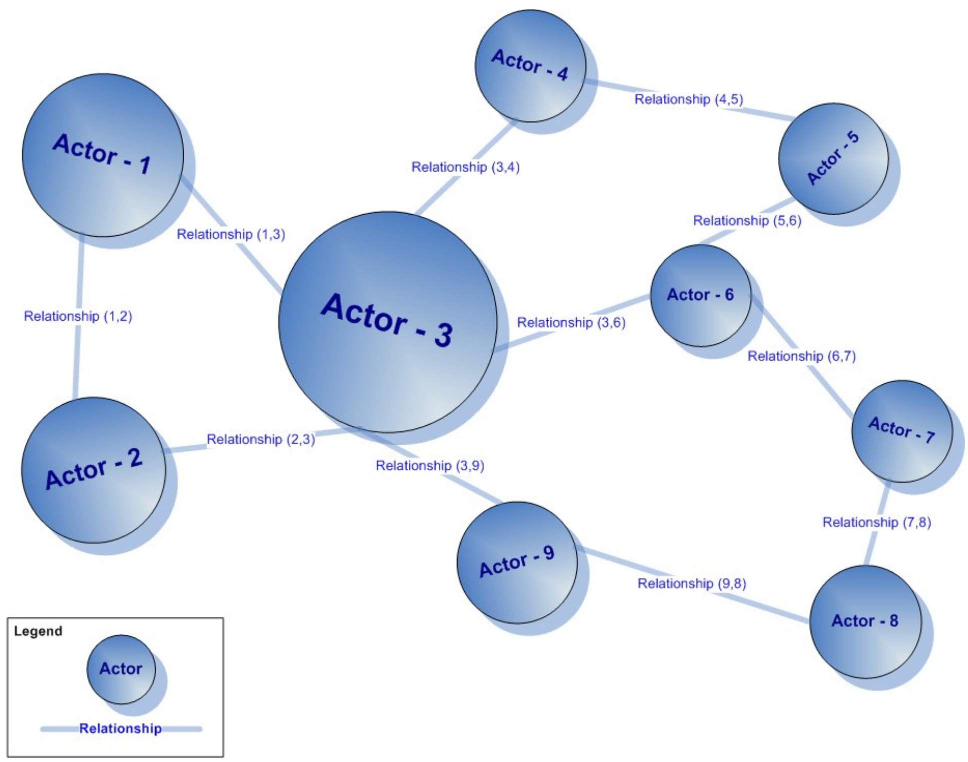


Figure 7: Graph representation of a Social Network

The dynamic nature is easily explained by the fact that nodes and ties, reacting to specific events, appear and disappear over time, following different rules that are not easily understandable and predictable. In the previous example students graduate and for this reason they disappear from the graph. The next year new students will join the network, but at the same time some students will leave the university before the regular termination of the studies.

The multi-layered aspect is described by the different levels at which a node can be seen: a student can be described inside his/her school, or, at a higher level, as a

member of the whole university population. Also nodes and ties could have several representations expressed by different languages (formal or natural) that evolve over time. For example a student can be represented by the IP address of the laptop he uses to access the university intranet; in this case the node is a digital and formal representation of a student. Digital computable representations of a SN are used for search and discovery, for aggregating services, or for reorganising the social network (see Figure 8). For this reason the digital representation influences the structure of the SN and vice versa.

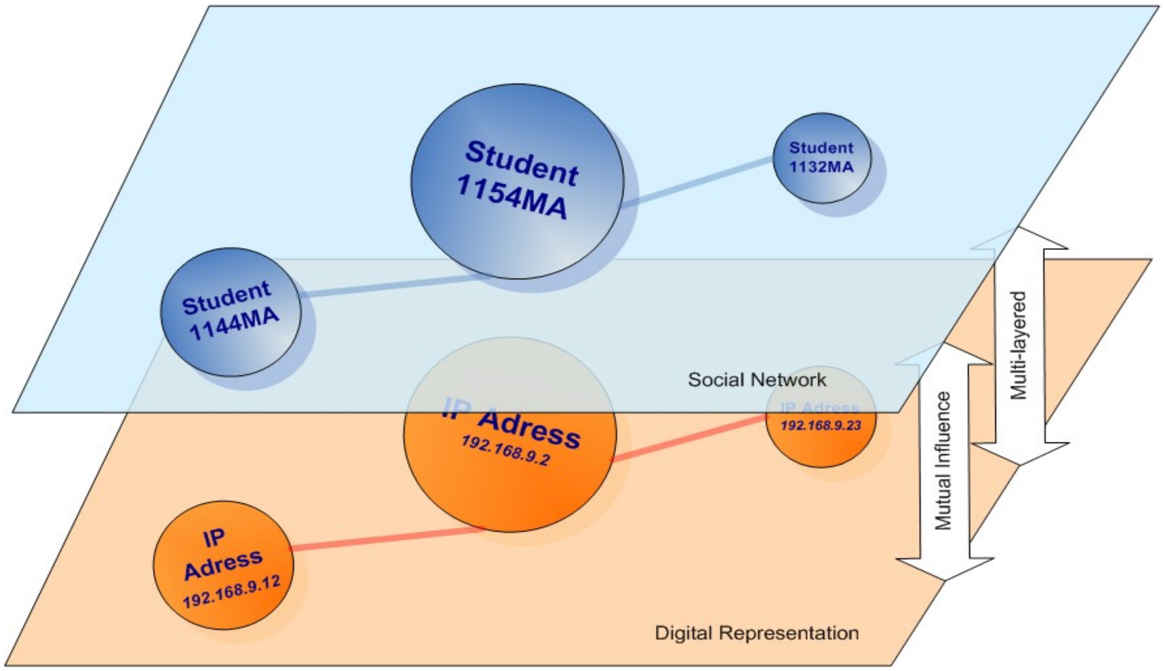


Figure 8: DE and SN mutual influence

From both technical and social perspectives the scenarios described by such evolutionary graphs have a high degree of complexity. The networks are composed by heterogeneous and autonomous users, companies and resources which interact in a complex, distributed and dynamic environment. The complexity of interactions between different actors is increased by the fact that actors sometimes compete against each other and at other times collaborate with each other and form stable and unstable federations. The mere convergence between ICT networks and social networks creates a context where the amount of data and information increases day-by-day, and they are perceived like digital *commodities*.

This *commoditization* of the information is two-fold:

- positive: increases the efficiency and lowers the costs
- negative: loses the qualitative differentiation

In all the *commoditization* processes, those related to industrial or agricultural products, organizations, companies and SMEs try to differentiate from each other by providing value added services to the underling products.

In a broad sense, a DE approach permits to design architectures and systems that are able to create added value by extracting knowledge (quality) from the overwhelming quantity of raw data available today.

DE forms a complex and dynamic environment that realizes the *actionable information*, adds knowledge to the graph, identifying nodes and ties with the organizational/business processes (see Figure 9).

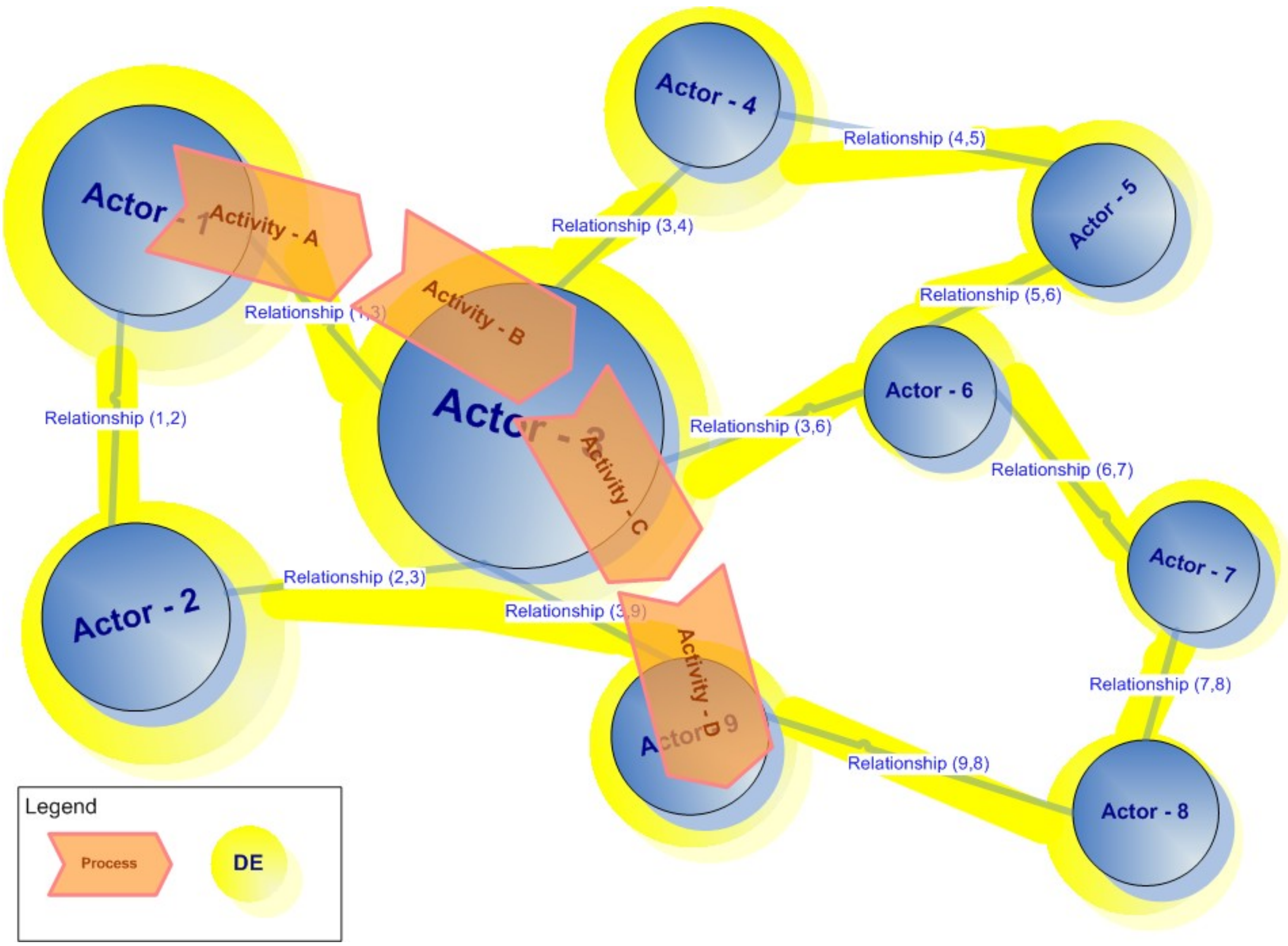


Figure 9: DE as knowledge enabler

Actors, managing their relationships over DEs, use a broad set of digital components, such as:

- Software products and services
- Business services
- Digital content

- Data structure representing concrete objects

All these components interact together, crossing the organisation boundaries and realising the "*ecosystem metaphor*" that connects different systems, exchanges information with several formats and tries to make the integration of communication and the execution of processes easier. To enable this a new architectural style is required; it has to be adequate to face the unique challenges in the context of DEs. In decentralized architectures for DE a new approach is proposed by the Ecosystem Oriented Architecture (EOA) (Pierfranco F. 2007).

All the EOA services are deployed on a distributed, peer-to-peer platform, they are described by business and functional models (UML) adding semantics to the service description. The decentralized architecture defines a topology and a replication schema that depend on a set of collaborative peer nodes. A peer-to-peer network supports this topology and the data replication across the network takes place in a smart way. The final picture is a peer-to-peer and service oriented architecture (P2P Service Bus, see Figure 10) with high integration capabilities offered by the adoption of open standards where the gap between process abstraction and software implementation is bridged by the adoption of UML models.

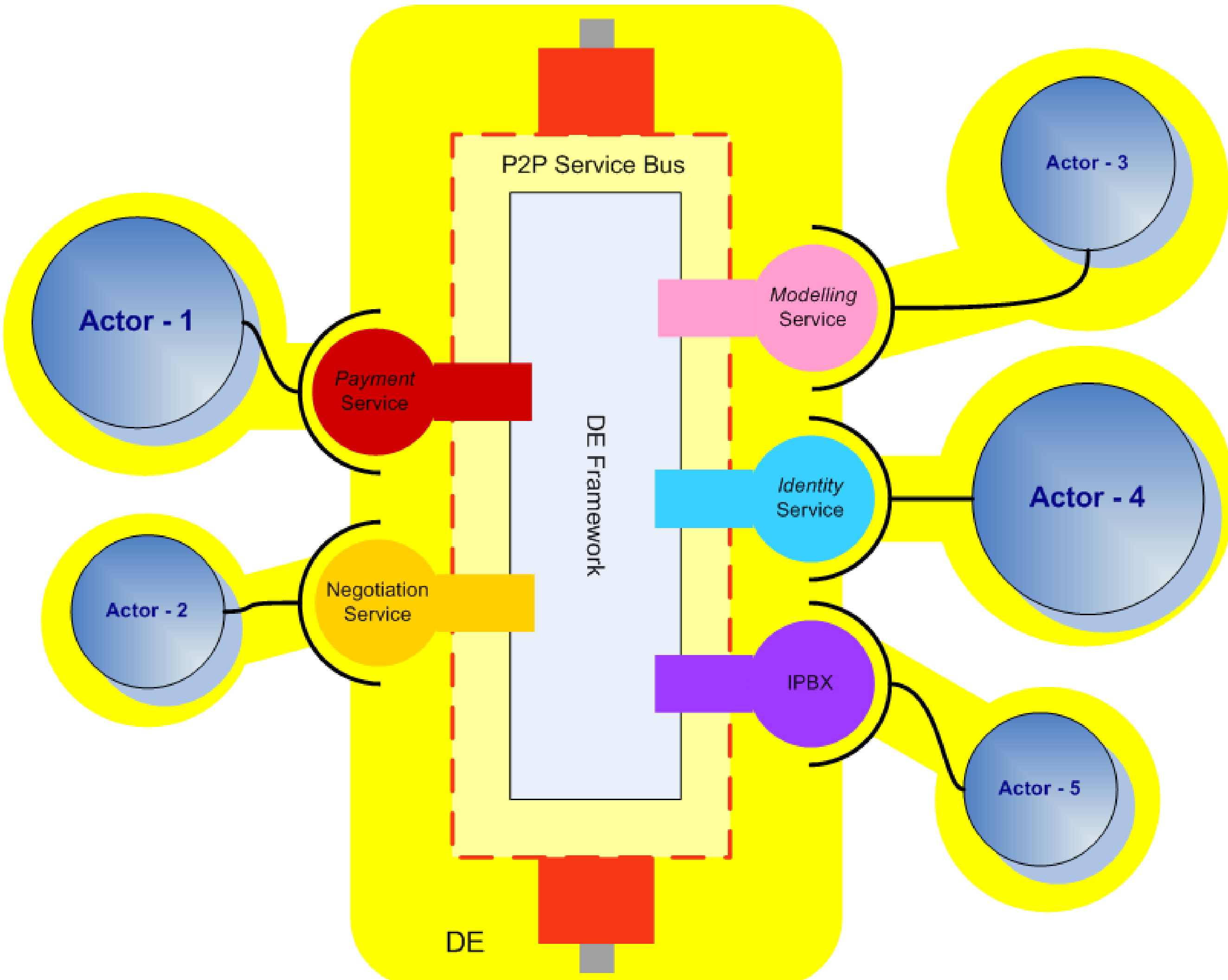


Figure 10: DE and the P2P service bus

From this quick overview it is clear that an architecture for DEs needs to consider different categories of services at different levels of the service stack (Heistracher et al. (2004):

- structural services: p2p middleware, modelling tools, identity and access control systems, trust & reputation mechanisms, etc.;
- support services: mail transfer agent, certification authorities, IP based Private Branch eXchange (IPBX), information carriers, event-driven infrastructure, etc;
- basic services: integrated services for payments, business negotiations, billing, booking, etc;
- service chains: composition of services.

EOA could be a new architectural style useful to design advanced service-delivery

platforms for future local broadband-enhanced practices that take place in the CNs context.

Each actor should model its presence and activities as a small portion of the whole graph.

For each element of the SN the digital representation is provided by a P2P network where content, products, services and knowledge in a more general sense are offered from the provider to the consumers. The adoption of the EOA principle should produce the following benefits.

IT-related benefits are as follows.

- Ease of integration of services and information assets in a single networked service bus.
- Elimination of rigid point-to-point integration of applications.
- Quick adaptation to new requirements in a flexible way.
- Embedded mechanisms for the players' growth and evolution.
- Additional value creation from existing services and applications.
- Reduced software development and ad-hoc coding.

Business benefits are as follows.

- Enabling the creation of virtual enterprises/coalitions whose life span is dictated by business opportunities.
- SMEs can devise tactical and strategic alliances with same size partners in order to act collectively as a large enterprise, reaching the same scope and scale.
- The technological enabler is a de-centralised platform, easy to customise and free of charge, open to any organisation (public or private, small or large).
- Large enterprises can quickly modify their supply chain in order to take advantage of best business opportunities.
- Decreases time to market improving the quality and the quantity of information and knowledge exchange, positively impacting process efficiency, the trust on the value chain and the cost of new services.
- Reduces risks ad protects investments with an incremental adoption approach.
- Eliminates manual process errors.

4.3 Business models

The title of this section is certainly broad and we use it for simplicity. We start by explaining what we mean by it and what specific questions will be addressed, in a non-exhaustive way.

As opposed to traditional infrastructures such as roads, railways, water distribution systems, which have been often considered as public goods and, therefore, the related investments have been made by the governments, the development, investment, ownership and operation issues for community network infrastructures are much more complex and heterogenous. Within the framework of this study, we can only address a few, perhaps most important aspects, to answer the following questions in a concise way:

1. In what form should the public entity (government, local government, municipality…)participate in deployment and operation of a community network infrastructure? We discuss this in Subsection 4.3.1.
2. What business models seem to be appropriate for the implementation of applications and services? We will try to answer this question in Subsection 4.3.2.
3. How can citizens and organizations be made part of the development of CNs? We briefly comment on this issue in Subsection 4.3.3.

Based on these considerations, we will answer the question: can DE services make CNs sustainable?

4.3.1 Infrastructure creation and operation

There are different models according to the level of involvement. Figure 11 shows three basic models (there is a more precise structure containing more layers) and a fourth one called demand aggregation which represents the lowest possible level of public participation. The next one is when a public entity provides a passive infrastructure ranging from physical structures to optical (“dark”) fiber. The highest level is when the public entity acts as a service provider; it should be applied carefully since it creates a conflict of interest. Usually it is feasible when the local government provides services only for internal purposes, i. e. for public institutions, thus avoiding competition with service providers in the marketplace for whom the government is a wholesale infrastructure provider. The model in-between is a pure wholesale model when the CN operator acts as a “carrier’s carrier”.

The aforementioned models differ in terms of ROI, too. The higher is the level of the participation (moving up in the figure) the longer is the ROI.

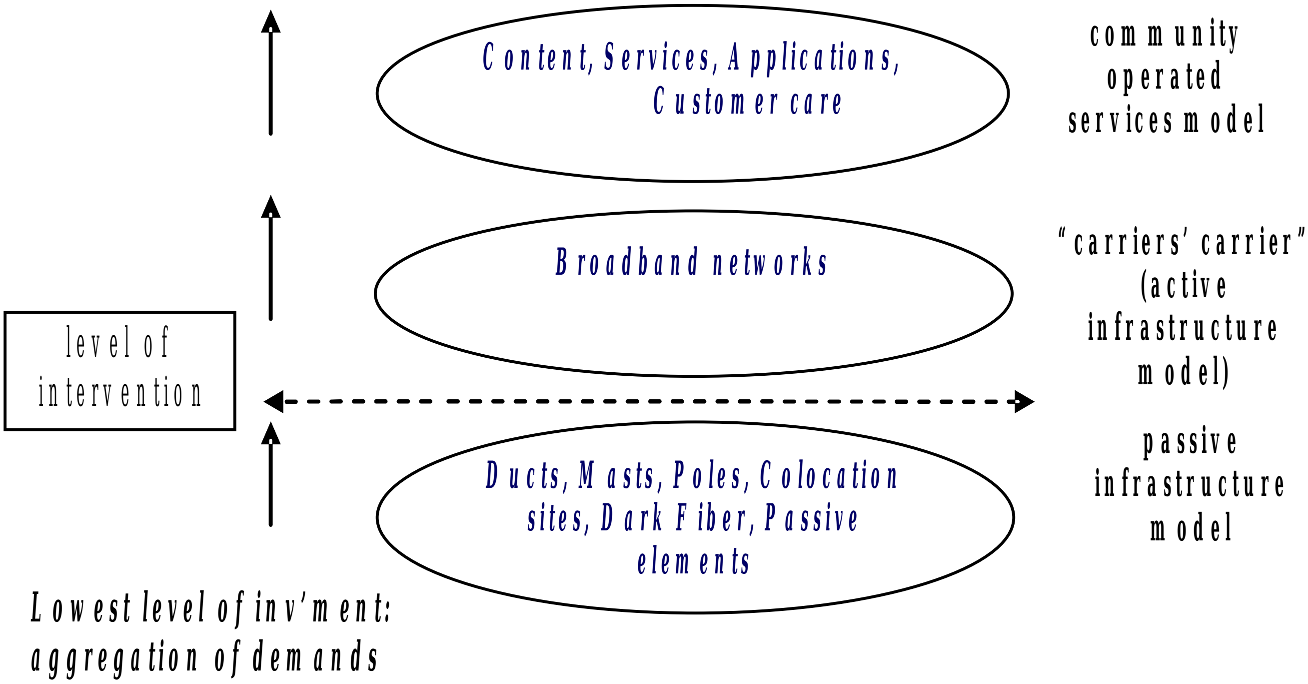


Figure 11: Basic models of public involvement

The participation of a public entity in creating and operating a CN is often accomplished in a kind of public-private partnership (PPP). There are different models according to the structure of public-private cooperation. Some basic public/private models are as follows (Digital Gyor 2007):

1. Publicly owned and operated
2. Privately owned and operated
3. Non-profit owned and operated
4. Publicly owned, privately operated
5. Owned and operated by a public utility
6. Privately owned and operated jointly with the municipality

The choice of the appropriate model is also influenced by regulatory issues, namely on the laws and rules that regulate, allow and restrict the different ways and levels of how a public entity can participate in providing telecommunication services. Regulatory issues are beyond the scope of this text.

Selection among the possible models can be based on 1) cost and 2) complexity of management for the public entity. The different models are arranged in a cost/complexity coordinate system in Fig. 12.

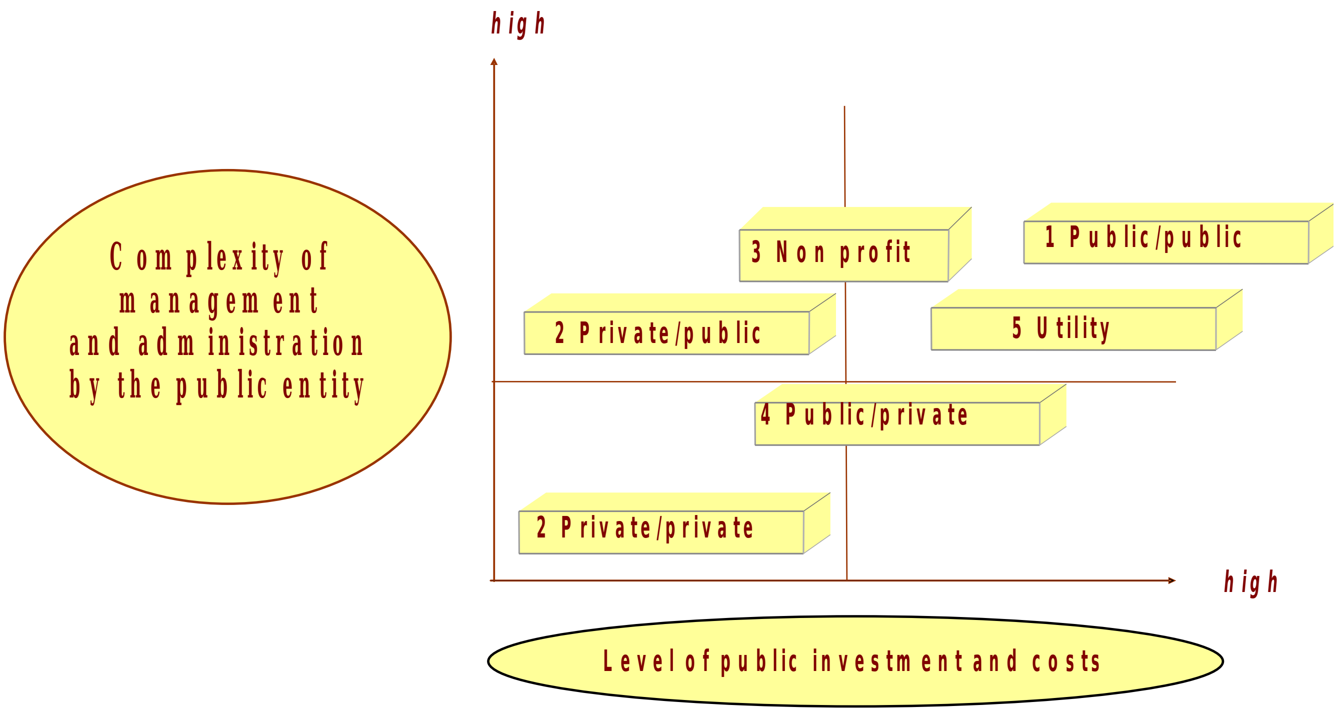


Figure 12: Comparison of PPP models

4.3.2 Development of new applications

In many cases there are a few “anchor” applications and “anchor tenants” in a community network. Worldwide examples show that indeed at least one anchor tenant is needed for a healthy business case for the CN infrastructure investment. Providing internet access is often the primary driver, however, the sustainability of CNs that are based solely on an ISP role is questionable. (There are several cases in the USA where the service provider has withdrawn or is trying to withdraw, resulting in a critical situation for the local government, see e. g. recent problems with Wireless Philadelphia.) On the other hand, we see success stories where a city carefully planned one or two key applications with the respective anchor tenants which resulted in a healthy business case and acceptable ROI.

Application projects are usually being implemented as separate efforts from the infrastructure project and although they are interrelated and inter-dependent, it is

important not to mix them. In the two cases, the investors or sponsoring agencies are different. As for the infrastructure, the investor is often the local government. Roads are an appropriate analogy: although demands for a road connection, its possible users and expected traffic load are estimated in advance, the future users are not investing in building the roads. They are supposed to pay for the usage, either directly (road tolls) or indirectly, through taxes. To be able to pay taxes, users are engaged in their own businesses, trying to make them profitable. Similarly, the actual customers of the community connectivity infrastructure, e. g. a local electricity company, a parking company or an association of tourist agencies, just to name a few, are interested in developing their own businesses, in particular in creating new applications, based on the community-wide connectivity infrastructure, the availability of which they assume. Other stakeholders involved in creating such new applications are their own customers i. e. the citizens in the above cases, the local government, the sponsoring agencies and suppliers of the technology. The new applications are supposed to improve productivity, result in a better utilization of assets of the company and improve customer satisfaction.

Financing of application projects can come from different sources: the company’s own resources, the public administration (especially when the company is a public sector entity) and local, national and international sponsoring agencies. In fact, the last is probably the most important, as there are many calls for proposals in different application areas e. g. in health care, or in transport control. Note that these primary funding sources are indeed application-oriented and the funding agencies expect that the necessary telecommunication infrastructure is available for the proposers.

Application projects are highly inter-related with the infrastructure: Planning of infrastructure should be based on the identification of requirements of key applications and services immediately to be implemented, and the estimated requirements for future applications. Requirements include the basic ones such as coverage, bandwidth and quality of service parameters. The capabilities of the infrastructure have to be taken into account when planning new services, and the infrastructure should be extended both in quantitative and qualitative terms, taking into account the requirements of new applications.

To ensure the proper governance of application projects is not an easy task, but it is a very important one since the objectives of creating CNs can be reached through the applications that are implemented on top of the infrastructure. Governance can be achieved in several ways; let us mention only two which seem to work well in practice (i) direct control exercised by the local government (Corpus Christi, USA) or (ii) through a non-profit organization the local government creates so that it can serves as an “arm” representing the local government's interests and acting on behalf of it (Trentino, Italy).

To conclude our considerations regarding the models for infrastructure creation and application development, let us mention the case of a US city *Corpus Christi* in Texas.

The city first invested in building the wireless infrastructure. After three years the city sold the infrastructure to Earthlink, a service provider which now owns and operates it and provides services both to the city and the inhabitants.

Corpus Christi, which has about 250,000 inhabitants and an area of over 500 sq. km., has decided to implement an Automated Meter Reading (AMR) system for water and gas customers. Overall, the city spent $20M on the AMR system and on the wireless network, which yields a saving of $30M over the estimated $50M costs within the next 20 years without AMR. In addition to savings, the project resulted in a higher level of customer service and support to citizens. After the rollout of the project, it was realized that the AMR application uses only a fraction of the bandwidth of the wireless network. Therefore, the city is planning to implement other applications, including the support for public safety, health inspection, animal control, public works and utilities personnel.

The city is now paying a yearly fee to Earthlink for using the network for the city's applications such as AMR, building inspection and portal. Earthlink has also agreed to pay to the city a fraction (currently 5%) from its profit. Earthlink is making money from providing Internet access for a fee and for hosting applications for the city.

4.3.3 Citizen's participation in creating and operating the infrastructure

At the beginning of the development of community network movement, there were many grass-roots initiatives while at present most of CN projects are publicly-driven. At present there are only a few examples of citizens' participation in creating and operating the infrastructure. In this section, we briefly present two recent examples: FON, a global Wi-Fi bandwidth sharing community, and Sparknet which is based on the same idea but implemented in a small area of an university campus and science park.

FON

FON is the largest WiFi community in the world. Its mission is to stimulate the growth of Wi-Fi internet access around the world by creating a global community of "Foneros" (consumers who agree to share their Wi-Fi in return for free access to all other Wi-Fi access points in the Community) and offering low-cost access to non-community members (called "Aliens"). FON's business model is based on the money that is generated from Aliens purchasing FON Passes to access the Internet from FON's user-generated Community.

FON is collaborating with various cities, municipalities, and communities all over the

world to build citizen generated Wi-Fi access throughout city centres, neighborhoods and vicinities. It also has a number of cooperation agreements with ISPs in several countries, among them some of the big ones such as British Telecom in the UK.

FON is not a solution for green field coverage, rather it extends the network of existing wired or wireless Internet access points to a number of additional users at no extra investment. Thus it is like *refining* an existing *coarse* network, making it (arbitrarily) denser.

The FON network does not meet some of our basic requirements such as reliability.

Sparknet

Sparknet and OpenSparknet was implemented in Finland in a university campus of the Turku University and the neighbouring science park environment where the entities participating in maintaining Sparknet do have a (wired, ADSL) Internet connection and just extend that to a number of additional users using bridges. In a science park environment, the reliability is less of an issue as here we deal with “professional” users who can keep on their routers all the time.

4.4 Policies

4.4.1 The interplay between institutional and grassroots initiatives

In this section we consider the dialectics between grass-roots initiatives and publicly-driven ones to enter the discussion about CNs and DEs policies of implementation. We will start by considering the evolution of city-nets in the Italian case[4]. RUR-Censis (2005) divides the story of Italian city-nets in 4 phases:

- *The pioneers* (1994-1997): The Milan CN takes the steps from the civic society, especially from the University. It has been inspired by the American free-nets. 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. Iperbole has been, since the beginning, an integral part of the Internet: as a first action it opened a web-

4 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 RUR-Censis that annually evaluate their evolutions.

page. Of course the effort of Iperbole in connecting the citizens has 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.

- *The un-organized diffusion* (1998-1999): In 1998, local community networks appeared in various cities, some came from public administration initiatives, others from association and local groups. The differences among them were not so strong in this phase, because in both cases the city-nets were developed by a single or small group of innovators interpreting ICT instruments as drivers 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 represent a barrier for access. Many city-nets offered free access to their services and contents and some public administrations develop public access points.
- *The institutionalization* (1999-2001): The institutionalization phase starts at the end of '90. In this phase we see the multiplication of Public Administration initiatives, the content becomes more concrete and systematized, but the spirit of the first experience was often lost. Often the website aspect of city-nets sacrificed the community part, the effort is addresses towards the institutional communication. As the RUR[5] 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 is strongly conflicting with pre-existing community networks. In the capital city the municipality opens up a sort of consultation process about the role of community networks. The round tables have been characterized by reciprocal misunderstanding. Particularly the problem was that of free speech: the administration was afraid of the possible content of totally open 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 community 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 and became independent.
- *The cooperation and service oriented period* (2001 -): The cooperation phase has been influenced by a Minister's initiative: the first tender for eGovernment plan (2001). The call promoted the development of collaborative projects 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 public administrations to re-work their presence on the Internet, overwhelming the institutional communication approach that

5 Rete Urbana delle Rappresentanze, an Italian research center engaged in urban development

characterised the previous phase. This process in still ongoing and it's not possible to evaluate it at the present stage. Nevertheless it contributes to assigning a partially new role to the public administrations, that of catalysing grass root initiatives, building a systematic approach over the main communities, addressing local issues and developing a common project.

The grass-root initiatives demonstrated to public authorities how to use ICT to answer citizens' need, to facilitate their relationship with the administration and to open up new channels of communication and participation. The Italian case briefly summarized here is not an isolated one. The free-networking and CNs around the world, as we have already seen, have changed their approach in recent years under pressures such as of public administrations that want to lead the process of Internet development.

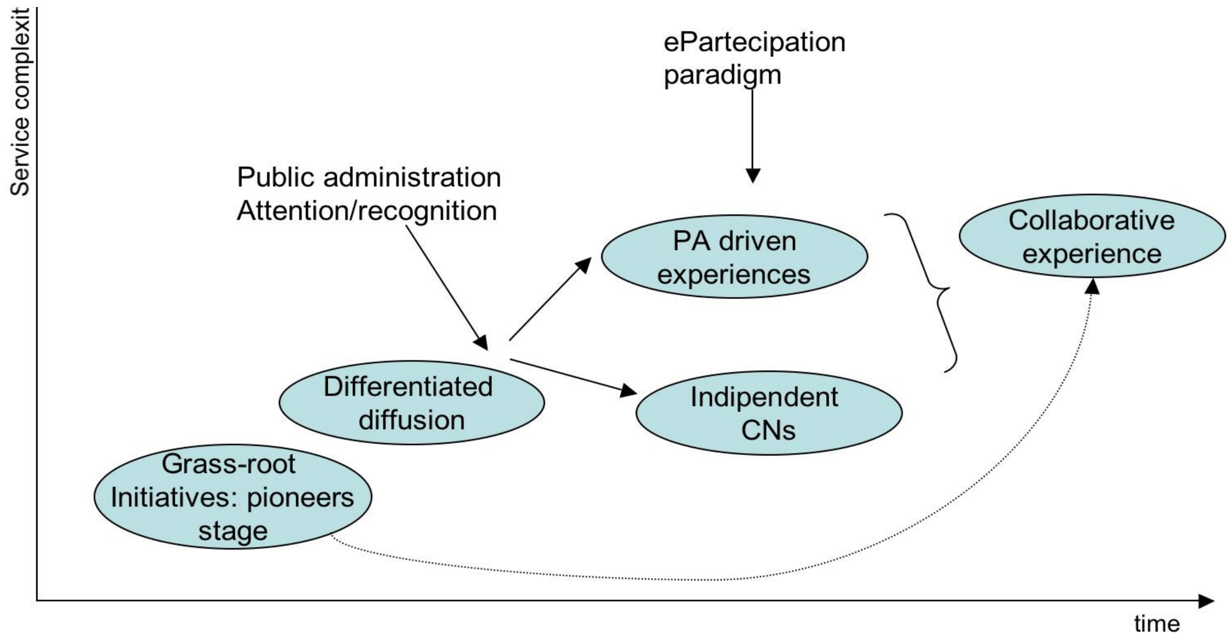


Figure 13: The Italian city-net's experience (RUR-Censis, 2005)

The Cleveland CN was shut down in 1999 and, in 2003, also the Kansas City sunflower CN was closed. The latter was not sustainable because as the Internet grew providing information, services and almost free access, its paid services were no longer competitive. The services provided by Sunflower CN cost 40 dollars eight years ago and reached 120 dollars in 2003, when most of them were almost free on the Internet.

The institutional website aggregated the information about the local community and many mailing lists and chat lines, not necessary locally based, became the space for new communities. This does not mean that the CNs experience is over but that as the possibility gets multiplied we have to be open to a multiplicity of models. What has become clear here is that the multiplicity of functions of a CN can be managed by different players collaboratively; different drivers can coordinate 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, to the contrary, a wider multiplication of actors recognizing each others and cooperating on specific projects (this is partially what we delineate when discussing the relationship between CN and DE).

4.4.2 Policies supporting CNs creation, growth and sustainability

Here we introduce some police-related issues in the form suggested in Figure 14, i. e. starting from CNs goals. The thesis driving the present chapter can be synthesized using a Schuler quotation.

"What I was trying to suggest are two things: one is that the government should get involved in helping to seed civic projects, but the other is that people shouldn't wait for the government, and that they need to be thinking about how to be more autonomous and independent and empowered". (Schuler interviewed by Horvath,1997)

In other words local policies are seen here as facilitating instruments, able to create the condition for CNs and DEs creation, growth and sustainability, but the community's leading role is equally stressed. Basically, policies may assure preconditions such as: knowledge creation and exchange possibilities, cooperation, ICT diffusion and communication freedom; policies in this area should be seen as systematic levers for local innovation, development and growth.

Particularly important is, in the knowledge society, cooperation. As we have already mentioned when dealing with DBE and Italian City-nets, government policies could play an effective role in the networking, improvement of local social capital and building multiple, interconnected, trusted communities.

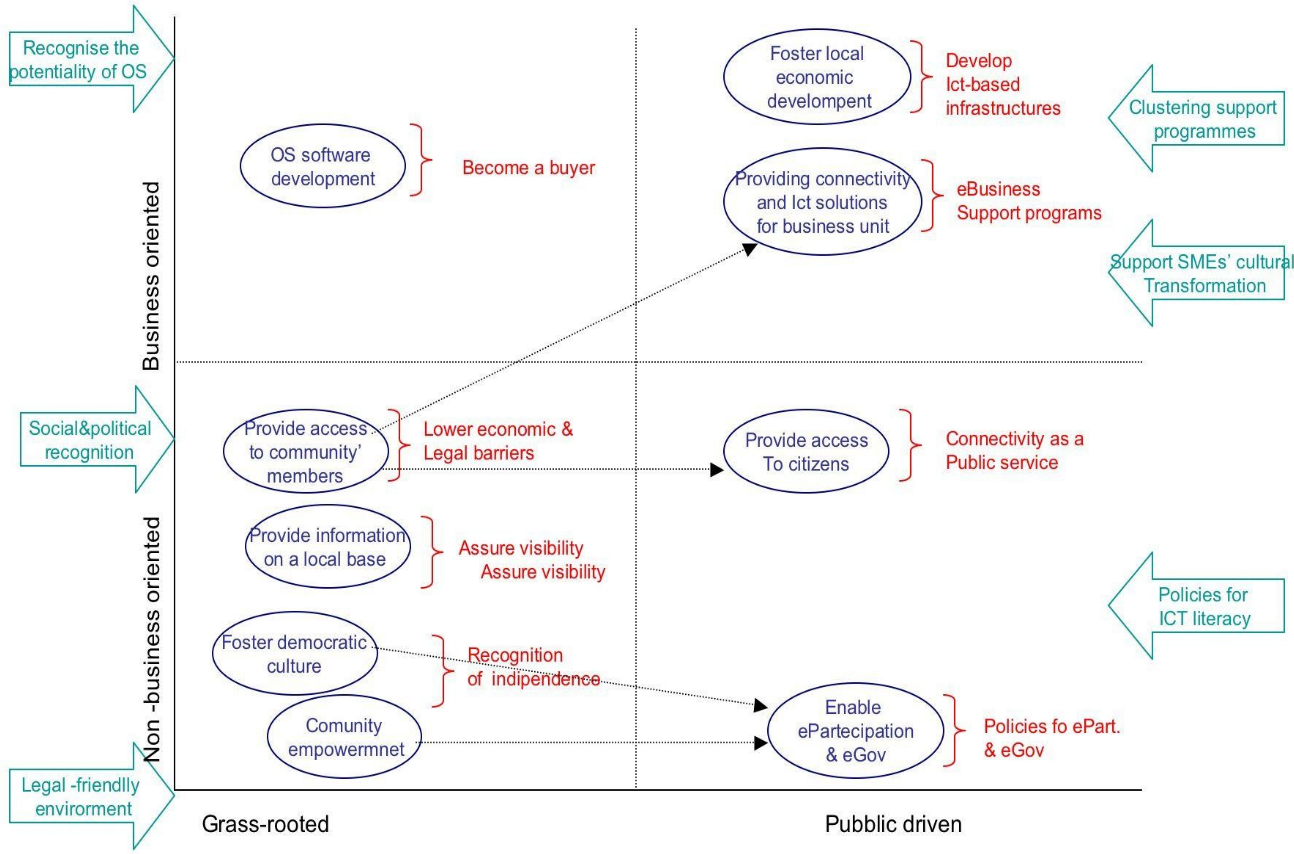


Figure 14: CN objectives and related possible policies initiatives (Source: t-6, 2007)

The following describes the policy-related issues visualized in Figure 14; the diagram is based on two variables:

- CN initiators/leader (i. e. the dialectics between public and grass-root approaches we have already described).
- The more or less strong relevance of economic aspects.

By crossing those two variables we have four quadrants in which we position different CN goals. Those goals are, in a clockwise order:

- Foster local economic development.
- Providing connectivity and ICT solution for business entities (especially SMEs).
- Provide access for citizens.
- Enable eParticipation and eGovemment initiatives.

- Community empowerment.
- Foster democratic culture.
- Provide information on a specific local area.
- Provide access for community's members.
- OS software development.

A more general goal recognized by different CNs and addressed by different policy initiatives is that of reducing the digital divide intended as an access gap among different social actors, among different territories and among large enterprises and SMEs. All the polices we mention are related to this more general goal.

For each of the above mentioned goals we recognized possible policy-related actions (in red):

- Develop ICT-based infrastructures.
- Develop eBusiness support programmes.
- Consider connectivity as a public good and act accordingly.
- Develop policies and projects for sustaining eParticipation and eGovernment.
- Recognise CN's autonomy.
- Consider CNs as important local actors and assure social and political visibility to them.
- Lower economic and legal barriers for the development and the sustainability of CN.
- Become a buyer of OS products and services.

The first two policy-related actions, namely the infrastructures and support programmes listed above will become central in the next chapter. We then recognize (in green) other policies that are at a more system/general level, those generating the prerequisites for putting into practice more specific policy actions. These include:

- Programs for supporting collaboration among SMEs and other local actors (clustering support).
- Address the cultural dimension of SMEs difficulties in collaboration and using ICT solutions.
- Facilitate ICT literacy among citizens.
- Develop a legal-friendly environment.
- Assure social and political recognition to CNs.
- Recognize the potentials with administrative, legal and political initiatives.

As is evident, we list many different policy measures. Some of them are specifically

for CN development and sustainability; others refer to more general approaches of ICT local diffusion that represent a *sine-qua-non* asset.

5 A case study: the Trentino community network

In this chapter, we show how the general strategies discussed in the previous chapters can be applied to the practice, by the example of the Trentino region and Trentino Community Network.

5.2 The T-Net project

5.2.1 Short overview

T.Net Community Network is an initiative which has been pushed by the local government of Trentino and whose main aim is to provide broadband connectivity not only to all public administration offices but also to citizens and companies.

Compared to other Italian regions, Trentino is characterized by several areas with low population density and a strong digital divide due to the fact that the incumbent operator is not willing to provide DSL connections in these areas which constitute about two-third of the province's territory. Providing a capillary network to give equal access to opportunities offered by the Information Society has been, for a long time, a priority for the Province, considering that participation by private companies in this field isn’t removing the isolation of large areas of Trentino. Broadband appears to be a key issue for the development of Trentino, and so a pragmatic and operational project plan has been outlined to interconnect the entire territory with optical fibers by 2010.

Furthermore, given the necessity to pursue immediate solutions for outlying areas, some short-term projects have been outlined: e. g., use of Telecom’s infrastructure for a backbone network through a specific agreement and wireless coverage of municipalities currently not reached by DSL services. With a view to achieving major efficiency, in terms of costs as well, the Province is integrating its initiatives with the ones autonomously managed by the municipalities. Such a network, once completed, will enable the connection of all local public administrations and will supply citizens and enterprises with high level services, thus encouraging competitiveness across the entire system of Trentino.

Total investment for the completion of the network by 2010 is more than 100 millions Euros, which will specifically be used to set up both an optical transport network infrastructure and to complete the wireless network.

T.Net project is part of a wider strategy based on ICT technology development known as the “eSociety” project, whose main objectives are the innovation of the local economy, the improvement of Public Administration efficacy and the reduction of the gap which keeps many of its citizens from participating in the Information and Knowledge Society. The development model is based on a strong collaboration

between public authorities, the private sector and local university and research institutes, which lead to technological experimentations (e. g. WiMAX and fiber optics) on Testbeds integrated to the public network, and participation in European initiatives (e. g. IANIS+ and OPAALS).

The project is innovative from many viewpoints:

- The governance model adopted, where the public authority provides the funds for the investment and coordinates the project through some publicly owned companies.
- The infrastructure deployment methodologies, which leverage the usual civil works on public roads to deploy ducts to carry optical fiber cables, thus minimizing the deployment costs.
- The business and network management model, based on the long-term forecasts of covering the management costs through a fair leasing of the infrastructure to any service provider.
- The joint combination of several initiatives in the ICT sector, for providing innovative services while minimizing the deployment costs:
    - Deployment of the optical fiber backbone made of 92 nodes and more than 700 km optical fiber cabling
    - Leasing of a third-party Gigabit Ethernet network for the temporary provision of broadband services by Telecom Italia until 2010
    - Deployment of a wireless network to areas where broadband connectivity is absent (500 HiperLAN/WiFi access points planned)
    - Deployment of a Tetra-based mobile network for civil protection
    - Migration of all PA toward VoIP for cost-efficiency reasons as well as for the furnishing of advanced services

The main impact of this project is on the socio-economic side: the access to information society for all citizens of the region, even those living in remote areas, where business driven investments of private operators are not sustainable. It will drastically reduce the need for them to move to the main cities of the province to access basic services, such as health care. By doing that, small businesses will have more chances to remain in their villages, reducing the marginalization of those areas. Moreover, the approach will benefit the end users by facilitating competition among the providers in offering connectivity to public administration, companies and citizens.

Finally, the incremental deployment of the infrastructure, based on the gradual introduction of fiber and wireless connections, will not only allow to supply core services in a short time frame, but will also incentivise the development of new advanced services later on. For example, telemedicine services have been deployed thanks to the migration to the Gigabit Ethernet backbone connecting hospitals,

while mobility services will be soon available in all the villages not covered by ADSL.

5.2.2 The CISG in T.Net project

In this Section a short description of the four dimensions inside T.Net project according to the CISG framework, described earlier, is given.

Community

The stakeholders participating in T.Net infrastructure development are:

- *government institutions*: the main government institutions involved in T.Net development is the local government, known as Provincia Autonoma di Trento (PAT), interested in creating the infrastructure. PAT has been involving three further public-owned entities:
  - Tecnofin Immobiliare, the entity responsible for the infrastructure deployment and which will own the infrastructure itself
  - Trentino-Network, the entity responsible for running the infrastructure, by providing broadband connectivity to all PA offices throughout Trentino province and by renting the infrastructure to private service providers
  - Informatica Trentina S.p.A., the entity responsible for managing the IT services for public administration
- *businesses*: they have not been involved in the feasibility study nor in the deployment phase of the broadband infrastructure, however they are going to be an important stakeholder during T.Net operational phase. Two main kinds of businesses can be identified:
  - ISPs which are going to rent part of the infrastructure to provide broadband connectivity to private companies and to residential users. An initial set of ISPs is composed by the following companies: Alpikom, BT, Fastweb.
  - Local companies (generally SMEs and SOHOs) which are going to leverage on T.Net to develop part of their business.
- *citizens*: even if there was no direct involvement of citizens or association of citizens (grassroots) in the decisions regarding T.Net, their pressure on the local politicians (e. g. majors, advisors) for their right to broadband connectivity has been very important to push for the investment of the local government in this direction.

Infrastructure

The technological part of T.Net can be divided in two sets: a hardware and a software infrastructure. However, since the software infrastructure is not a specific part of the CN development, but instead refers a set of services to improve PA processes, it is not described in detail in this Section.

The hardware infrastructure is basically composed of two co-existing networks, which refer mainly to two different segments of the network:

- Backbone optical infrastructure (see Figure 15): in order to foster the process of providing broadband connectivity in wide areas of the Trentino region, two sequential phases have been envisioned by the local government:
  - Initial phase: set up a "basic" backbone infrastructure from incumbent operator Telecom Italia, based on 63 nodes, running at 8 Gbps, and whose main aim is to ease the process of setting up the wireless infrastructure, plus providing broadband to hospitals for their advanced telemedicine services
  - Second phase: set up a proprietary backbone network, first through the deployment of 700 km of optical fiber cables all along Trentino regions, second by equipping up to 93 Point of Presence with optical transport network nodes and thus dismissing the contract for the basic backbone. The technology which, most probably, is going to be used is called Carrier Grade Ethernet.

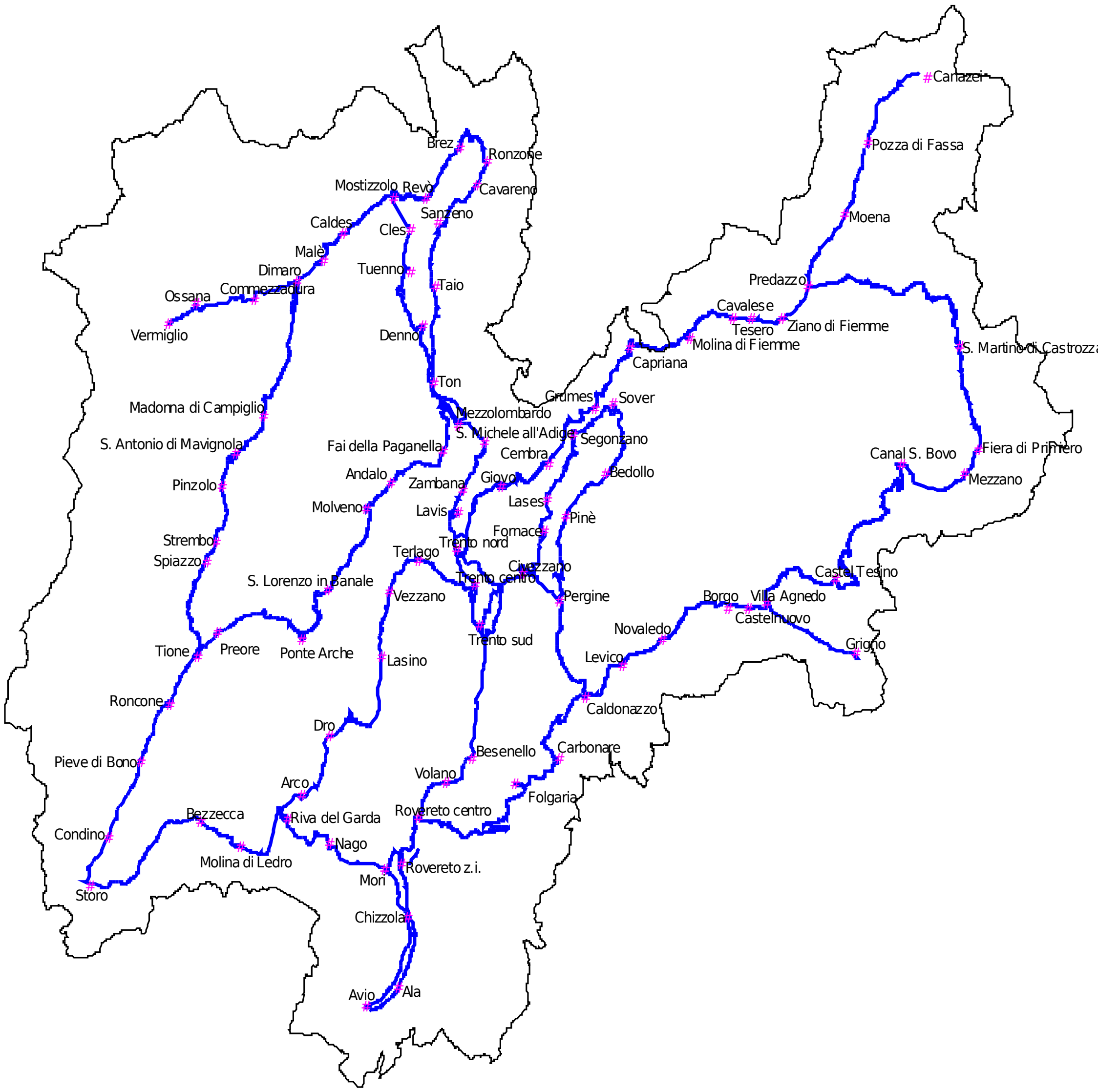


Figure 15: Deployment of the optical network infrastructure in the second phase

- Wireless access infrastructure (see Figure 16): this network (called WiNET) is realized through license-free wireless technologies like Wi-Fi and HiperLAN. It is realized to provide broadband connectivity to 150 (out of 223) municipalities and to the large fraction (65%) of peripheral zones of cities where DSL services are not available yet. This infrastructure is currently under deployment; some section of the network are already in operation, but the final delivery of the network is expected by the end of summer 2008.

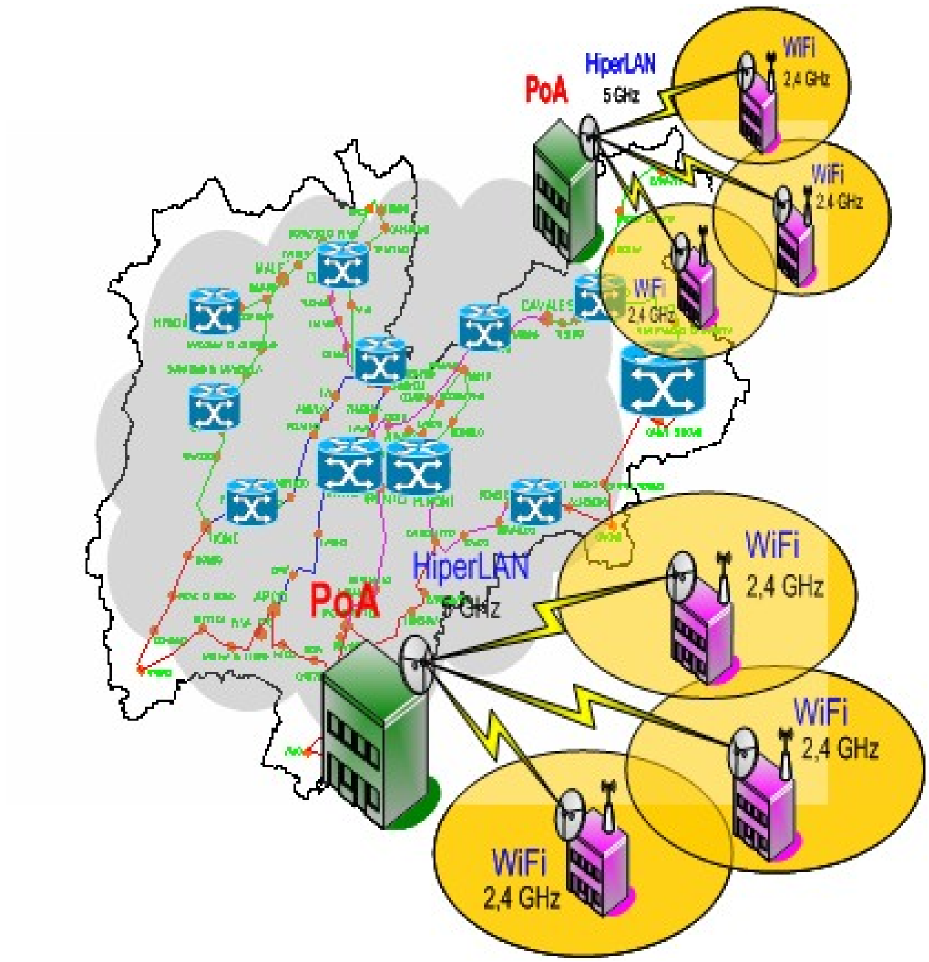


Figure 16: WINET: the wireless access infrastructure

Services

The deployment of T.Net is enabling a number of both on-line and off-line services.

- On-line:
  - broadband connectivity (reducing digital divide in rural areas)
  - e-government
  - telemedicine
  - e-tourism
  - e-library
  - VoIP and video-conference facilities in all PA offices
  - e-inclusion
  - tele-assistance

    - e-learning
- Off-line:
    - increase SMEs productivity, open new markets in ICT
    - reduce traffic through telecommuting both in PA and private companies
    - improve road and tunnel safety
    - experimentation lab throughout Trentino through University/IRST/other research centers (WOTBL testbed)

Governance

In general, governance refers to the regulation activities of communities that control and/or coordinate the use of infrastructures and services.

In T.Net the government governance has been the most important one, since the local government has been playing the main role for setting up rules for both the deployment of the infrastructure as well as for its usage. In particular, the local government has been providing the funds for the investment in T.Net and it is currently coordinating the infrastructure deployment through some publicly owned companies.

In order to minimize deployment costs, the local government has been leveraging the usual civil works on public roads to deploy ducts to carry optical fiber cables for the backbone infrastructure. For the deployment of the wireless infrastructure, all the municipalities have been involved in the deployment project with the objective of minimizing the costs and roll-out time by asking them to provide a set of public-owned buildings for the installation of antennas and wireless equipments.

Last but not least, the business model by the local government has been based on the long-term forecasts of covering the management costs through a leasing of the infrastructure to any service provider with fair, clear and non-discriminatory conditions.

5.2.3 Specific relations between the CISG dimensions in T.Net project

According to what has been described so far, the main entity responsible for the CN deployment is the government agency PAT, the local government of Trentino.

Since the initial feasibility study in 2001, PAT has been spending a lot of effort on the deployment of this broadband network infrastructure, not only through a significant capital investment but also by coordinating the infrastructure

deployment in collaboration with a number of publicly owned companies and by leveraging the technical competences inside research centers and the local university. PAT has been furthermore identifying the minimal set of services to be delivered through this infrastructure and the set of policies to be implemented for coordinating the access to the broadband network, from both the Public Administration, the citizens of Trentino and the private companies.

An interesting relationship between the government agency PAT and the citizens should be highlighted here: when the local government decided to deploy a wireless network, a set of public meetings with the citizens in all the remote Trentino valleys was set up in order to explain the importance of having access to the Information Society but also to prevent possible controversy about the installation of radio antennas close to residential buildings. In fact, years of “fear campaigns” against GSM/UMTS installations have had the result of convincing most of the public about the high danger of any kind of radio installations. During these meetings the experts explained that one of the advantages of using license-free wireless technologies resides in the very limited amount of power emitted by the corresponding antennas. The objective of this public dissemination was to prevent the possibility of introducing delays in the roll-out of the wireless infrastructure due to the opposition of the public opinion.

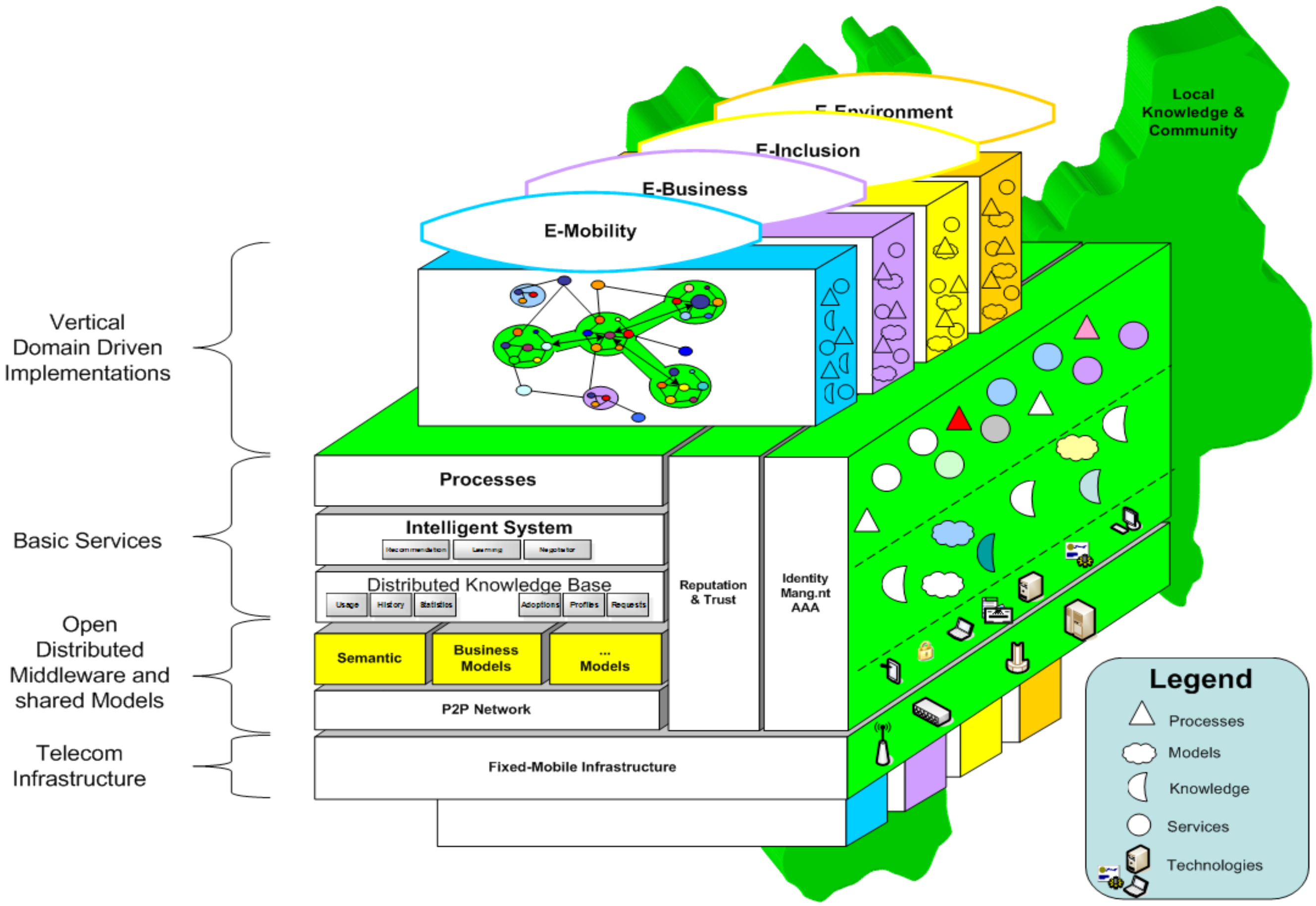
5.2.4 Historical and longitudinal presentation of the T-Net project

The set-up of a broadband infrastructure has been mainly triggered by local government (PAT) through a series of initiatives, in line with the general planning of PAT government (PAT XII, PAT XIII).

1. Setting up of a “Comitato Provinciale per le Telecomunicazioni”, a team of experts to realize a feasibility study of a CN broadband network (PAT 2001).
2. Approval of the feasibility study and set up of a “Gruppo misto di progettazione con il compito di progettare la rete di dorsale in fibra ottica”, a team of experts to actually design the optical fiber network (PAT 2002a, 2002b, 2003c).
3. Approval of the guidelines for CN deployment (PAT 2003b).
4. Definition of the stakeholders (and their role) to realize the CN in Trentino (PAT 2005a, 2005b).
5. Approval of final plan for CN deployment (PAT 2006b).

The deployment of the CN is proceeding through two subsequent steps: the first step was leasing of a backbone network infrastructure from Telecom Italia with the objective of creating an initial broadband infrastructure to connect the main municipalities and all the hospitals of Trentino. The agreement was signed in 2005, the delivery of the 63 nodes has been finalized in 4Q/2007, and the operation and

management of the infrastructure has been given to Trentino Network. The agreement will expire in 2010. By that time, the deployment of a 700 km fiber-based infrastructure deployed all along the main roads of the province should be



concluded, and the network fully owned by the local government made of 100 Gbps optical switches should be already up and running.

By this time, approx. 200 km of fiber have been deployed so far, and a tender for the deployment of the remaining optical cables (and the set-up of 93 shelters which will host the network equipment) is to be held by the end of 2007.

As described in the previous Sections, in order to cover the needs for broadband connectivity in the short term, the local government decided to deploy a wireless-based access network infrastructure to provide broadband services to more than 90% of the citizens. The winning proposal is based on the deployment of 500 Access Points to provide connectivity at 2.4 and 5.6 GHz through 802.11b/g (Wi-Fi) and HiperLAN technologies. The delivery of 80% of the network equipment is forecast by the end of 2007, while an experimental service provided to selected municipalities is in operation since November 2007, through a couple of private ISPs. The project is facing about 6 months delay mainly due to the very stringent time schedule required by the local government for the network deployment

(around 600 sites in 5 months!) but also to problems of getting access to the public-owned buildings in some municipalities.

By the end of 2008 (most probably beginning of 2009), a tender for the installation of the optical network nodes to realize the pubic-owned backbone network described before is going to be held. This means that most probably the set up of the backbone network will be delayed compared to the original schedule, and the full network won't be up and running before the end of 2011.

A concurrent initiative is the creation of a territory-wide testbed called WOTBL (Wireless Optical TestBed Laboratory), based on an agreement between the local government and the local university. This testbed consists of four fibers, which cover all the Trentino province, will be used to experiment so-called Next Generation Internet technologies, not only for research objective but also to test emerging technologies that could be later adopted by the operational network, both in the backbone and in the access segment.

5.3 Trentino as a Lab (TasLab) project

5.3.1 Short overview

The Trentino as a Lab (TasLab) geographical Living Laboratory (LL) initiative started almost 3 years ago. TasLab covers the whole territory of the Province of Trentino. Thanks to the "B*roadband and digital divide plan***"** developed by the Autonomous Province of Trento (PAT), the TasLab will be able (before the end of 2008) to interconnect Trento, the capital and largest city of the Province, with all the others 223 municipalities spread over the Province, located mostly in the Trentino's valleys[6]. The "natural" evolution of what the PAT have done in the past years as part of the TasLab effort is the application to the European Network of Living Labs[7] (ENoLL). Quoting from the EnoLL website:

"Living Lab is a new concept for R&D and innovation to boost the Lisbon strategy for jobs and growth in Europe. So what are Living Labs? The answer depends on who you ask because of the big differences between running Living Labs. But one thing is common for all of us; the human-centric involvement and its potential for development of new ICT-based services and products. It is all done by bringing different stakeholders together in a co-creative way."

PAT have focused its application to ENoLL on the following areas:

- eMobility: Trentino has around 150 tunnels, it is very close to the planned Brennero Tunnel which will connect Austria and Italy, and has lots of roads with major mobility problems, e.g., ice during the winter.
- eInclusion: Trentino has a long history in this field; as an example, the expenditures in this area are more than double the Italian average.

6 More than 70% of the surface area is at a height of more than 1,000 m asl, however ¾ of the population lives in the main towns in the valley bottoms.

7 http://www.openlivinglabs.eu

- eBusiness with a focus in specific areas such as Tourism (one of the main local industries), Environment and Quality of life (among the main assets of Trentino, which are also at the basis of the tourism industry).

Notice that, in these areas, the user involvement is important at two different levels: as a key actor in the innovation process and as a user of the results of the innovation process itself.

As part of the TasLab mission, innovation will become for Trentino and its citizens "*the way of being, thinking and evolving*".

To this extent, TasLab have developed new forms of partnership and Intellectual Property Rights (IPR) management which allow to exploit this double role of users.

The core reasons behind the TasLab LL were social, economic and political. The main goal was to create an advanced innovation infrastructure capable of responding to present and future user needs, not only from an ICT perspective but also from a cultural and sociological point of view. The plan was to reduce the digital divide, and at the same time to experiment with new ICT solutions, with deep user involvement, all over the Trentino mountainous territory. As a natural consequence of this long term vision, the main objective of TasLab is to support the never ending evolutionary, sometimes diverging process which local communities, users and enterprises (especially SMEs) are facing.

5.3.2 The CISG in TasLab project

Communities

The target users of the TasLab are the Trentino Public Administration, all the Trentino citizens and also all the people who happen to spend some time in Trentino (e.g., tourists). Each vertical area involves different users; thus, for instance, in eInclusion an important focus is on the elderly ("ageing well" is one of the core topics in this area) while, in eMobility, the users are the car drivers but also the people in charge of the tunnel and road monitoring and maintenance.

The co-creation approach is also empowered by a relational and conceptual model, the "Innovation Tripole" (Figure 17), that puts the users at the center of the innovation processes together with enterprises and research players.

The more we move into the everybody, everywhere, all-the-time paradigm the more we will have to put the user's lack of specific ICT-related skills at the center of the technology design. The tripole also addresses the issues of the management of intrinsic diversity which exists not only across the different stakeholder groups, but also within the groups themselves (and users in particular). This approach is based on the key assumption that diversity is a feature which must be preserved and exploited in order to obtain better innovation through the co-development of new innovation products and not a problem which must be absorbed in a unique framework.

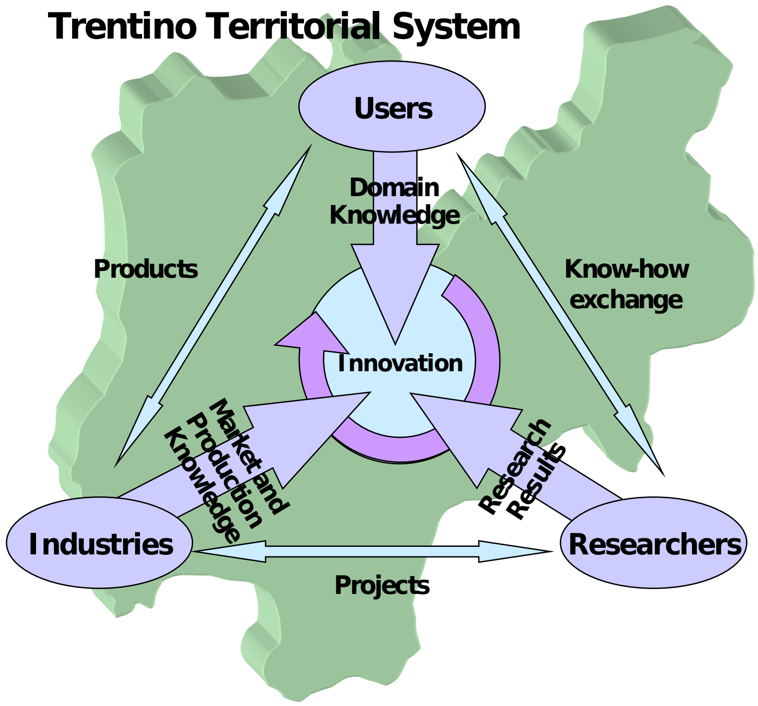


Figure 17: Tripole Model

The approach TasLab follows in the user involvement is based on the tripole model (see [www.taslab.it/framework.htm).](www.taslab.it/framework.htm) The tripole is instantiated in each area, thus allowing for the direct involvement of users and their consequent co-creative participation to innovation. The effective coordination of the actors involved is reached following a participatory action research approach.

Participatory action research proceeds through iterative cycles. It begins with a reflection on some actions; then it progresses around with some questions and fieldwork; then it motivates an analysis which then evolves in a new round as a reaction to a new action which is then further analyzed. Within this general scheme, inside each project various techniques for requirement elicitation are used, also based on this kind of user involvement.

Informatica Trentina, the IT and Innovation Agency of the Autonomous Province of Trento, is the "regional catalyst" of the tripole and is responsible for hosting, managing, co-developing and sponsoring all the tripole activities. Informatica Trentina can be seen as an innovative user and also as process coordinator that drives innovation and involves the other stakeholders. These are:

- *users* (including the Public administration, the Health agency and other institutions)
- *local enterprises* (mainly SMEs) and

- *research centres*.

Through Informatica Trentina, the provincial government will be able to support the LL initiative, the innovation and all the related research activities with the objective to become a cooperative and competitive territory ready for the future. In Figure 19 the communities are represented by the blue circles, the users are the key actors of the co-creation process.

Infrastructures

To this extent the approach has been to take an ecosystem oriented perspective where different actors (citizens, public administrations, enterprises and research entities), the organisms of the ecosystem, interact with one another evolving on the base of the local/global conditions. This ecosystemic model is characterized by quality (of interactions and activities), knowledge (creation and sharing) and openness (towards different territories and cultures). TasLab has also the ambition to bring all the actors inside the digital world, thus becoming a Digital Ecosystem. This will be achieved through an open interoperable collaborative and business platform. This platform provides a reference and distributed framework which can be exploited to develop interoperable and vertical software. It will be reusable in different application and service domains providing a great level of flexibility.
Within TasLab, the approach is articulated in a multidimensional view (horizontal and vertical, see) following the CISG approach.

In the horizontal dimension, the goal is to develop a digital ecosystem which allows for a continuous ecosystemic evolution of organizations and community networks. In this ecosystem, the different actors interact with one another and evolve their competences and roles, crossing their organization’s boundaries and exploiting the local environment and boundary conditions.

The transversal multidisciplinary ecosystem driven approach is coupled, in the vertical dimensions, with a focus on the Trentino’s vocation areas, namely those areas which are core in the Trentino value system (e.g., eInclusion, eMobility, eBusiness and eTourism, and eEnvironment).

Figure 18: Ecosystem driven approach

TasLab, thanks to its open ecosystem oriented architecture, and with the collaboration of all Tripole's stakeholders, offers different communication and testing infrastructures, spanning from high speed networks to interoperable and distributed services. One such infrastructure is the CREATE-NET testbed. This is an open, ecosystem-oriented environment, implemented on a real-life city-wide communication infrastructure deployed in the city of Trento. CREATE-NET's testbed is a close relative of the LivingLab type testbeds[8] and it spans the range of the most advanced communications technologies all the way to sensor networks and technologies for smart spaces. The testbed is connected to the Italian R&D network (GARR), and the European research infrastructure (GEANT). Furthermore, as mentioned in the previous section, an agreement has been approved by the local government which allows for the creation of a territory-wide testbed called WOTBL (Wireless Optical TestBed Laboratory). This testbed, that will extend the CREATE-NET one, consists of four fibers which cover all the Trentino Territory and population, for a total length of 800 kilometers, plus the access network. A third testbed, on Tunnel Monitoring**,** is currently being instantiated as a joint venture between the

8 M. Eriksson, V.-P. Niitamo, S. Kulkki, "State of the art in utilizing Living Labs approach to user-centric ICT innovations – an European approach", Report, Dec 15, 2005, available at www.cdt.ltu.se.

Trentino research institutes, Siemens and various local companies. The first instantiation consists of three tunnels and the issues at stake are energy control and saving and increasing people security. This testbed will run on top of WOTBL.
In Figure 19 the yellow represents the TasLab infrastructure that enables the innovation process.

Services
Informatica Trentina, in its role of Regional Catalyst for innovation, will coordinate and provide the main LL services. Some services are and will be centralized at the Informatica Trentina premises; others will be provided by the other members of the Tripole. Informatica Trentina hosts the offices of the LL, and soon will take the role of regional observatory for innovation and will support some pilot projects together with the provision of training services. Other services will include the innovation and project management and the support to user institutions and SMEs for their participation to European projects. The training services will be offered by Informatica Trentina together with the University and the research partners. In particular a joint laboratory (Lego: Laboratory for Interoperability and eGovernment) involving the stakeholders has already been created and a new master on eGoverment is now in its first year. The LL will be soon offering IPR and legal support for joint exploitation by all the members of the LL. As far as the LL data, information, data and knowledge management is concerned, a TasLab portal is being activated. This will be used as the central point for the collection of the relevant data and pointers to relevant data. So far, these data have been managed by the testbeds and/or institutions running the projects. In Figure 19 the services are the synthesis between the infrastructural aspects (yellow network) and the results of the co-creation process, each user can access all services that are built by the different communities.

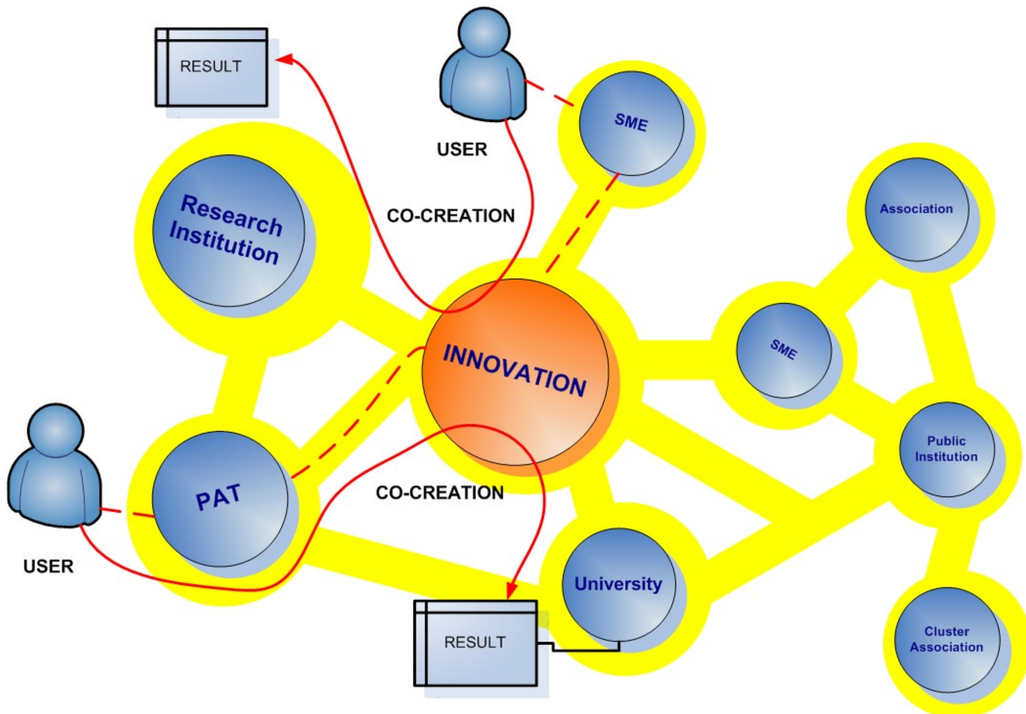


Figure 19: User as key actor of the co-creation process

Governance

Informatica Trentina, will act as catalyst and coordinator of the TasLab LL. To this extent Informatica Trentina has received commitment letters from a large number of organizations. The research centers which in Trentino do research in ICT: University of Trento (DISI)**,** "Fondazione Bruno Kessler" (FBK), GraphiTech (a joint venture with Fraunhofer, CREATE-NET and CNR), Laboratory for Applied Ontology (CNR-LOA) and CREATE-NET, counting for around 800 researchers in ICT.

Various enterprises: Informatica e Servizi, Cogito, Sinergis, Trentino Network, GPI, Delta Dator, Heidi, Centro Ricerche Fiat (CRF), Siemens. Various end-user organizations, more precisely: the Autonomous Province of Trento (PAT), the Public Health Agency (APS), *Trentino Riscossioni* (TrRis), and the Consortium of the Trentino Municipalities (CCT).

This initiative is supported by the local government formalized by the letters from the President of the PAT and from the Consortium of the Trentino municipalities and many agreements are already in place among the various actors (see, e.g., Lego, the testbeds, and the master in eGovernment).

These organizations participate in the following vertical LLs:

- *eMobility*: DISI, FBK, CREATE-NET, Siemens, Heidi, Algorab CRF, Trentino Network, PAT;
- *eInclusion*: DISI, FBK, CREATE-NET, CNR-LOA, LEGO, Cogito, GPI, PAT, APS, Trento, CCT;
- *eBusiness*: DISI, FBK, CNR-LOA, LEGO, CREATE-NET, Delta Dator, Informatica e

Servizi, PAT, CCT, TrRis;

- *eEnvironment*: DISI, FBK, GraphiTech, Sinergis, Heidi, PAT.

In its role of coordinator, Informatica Trentina will be supported by CREATE-NET and the University of Trento. As explained above, the TasLab approach and policies are based on the innovation tripole. Further methods, tools and processes are provided by the (digital) ecosystem approach, architecture (Ecosystem Oriented architecture - EOA) and platform, while the effective coordination among the actors involved is obtained following a participatory action research approach**.** Finally, one of the strategic goals is to enrich ICT (both at the education and at the research level) with a strong interdisciplinary component which accounts for all the user related issues and in particular: cognitive science with an emphasis on usability, organization and social sciences and, to a lesser extent, law, in its connections to, e. g., the Open Source software production and the management of IPRs.

5.3.3 Specific relations between the CISG dimensions in TasLab project

The TasLab project in its deep meaning is a conceptual framework for enabling the interactions between communities (end-users and firms), technology and knowledge. The *Tripole* model embeds a vision in which the relations between the different CISG dimensions are the drivers for the evolutionary and self-organizational nature of this framework.
In TasLab the co-creation approach puts the users at the center of the innovation process , and for this reason the relations between the different CISG elements are analyzed having the Community as the pivot dimension.

Community and Infrastructure
Infrastructures are constructed by communities for communities. The *Tripole* model states the involvement of the end-users in the infrastructure creation process, trying to shape the outcomes of the vertical LLs accordingly to the user needs. This is a key point that should be reached by establishing working local solutions supporting the community's practices, rather than by designing global solutions and subsequently implementing them. This approach empowers local players and is consistent with the digital ecosystems vision, which tries to move the way of thinking about infrastructures from closed external “tools” to environments where users are part of an open and “pluggable” infrastructure (see Figure 20), Ciborra, C., and Hanseth, O. (1998).

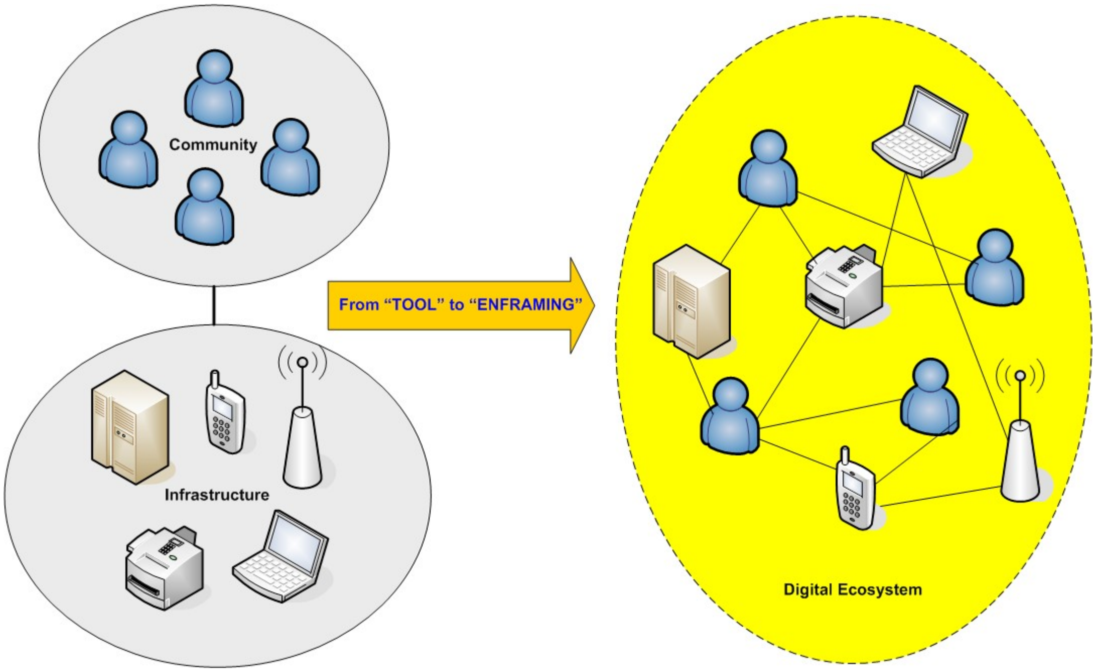


Figure 20: Community as part of the Infrastructure

Community and Services

It is clear that market-ready solutions, different from research projects, are thought and planned to satisfy the immediate user needs (either expressed or not). At the same time companies, especially SMEs, try to put off risks, uncertainties, and the long time scales required for research activities. Taslab wants to reduce the innovation gap between research and exploitation, providing to the SMEs community the basic DE services described in Chapter . Other services should include the innovation and project management, the support for the participation to European projects that aim at facilitating the creation of strategic collaborations and incubating project ideas. Informatica Trentina, together with the University and the research partners, will offer also the training services. From the end-users community perspective, the plan is to reduce the digital divide, and, at the same time, to experiment with innovative services, with deep user involvement. Creating innovative services, with the participation of those three main communities (Researchers, Enterprises, Citizens) is a big challenge. For this reason especially enterprises and research institutions should join forces to foster research and innovation in the key area of advanced citizen services, striving to accomplish the users involvement.

Community and Governance

The involvement of Researchers, Entrepreneurs and Citizens communities implies the need for a balanced and decentralized governance model. The power

relationships between those three communities should be managed with a balance between "*order*" and "*chaos*", considering the contribution of the different members with the same weight, otherwise the TasLab, as a whole "organism" composed by all its components, should die. At present a governance process that can maintain the dynamics of the different communities "near to the equilibrium" doesn't exist. In fact this is a big issue for all the initiatives started by the public administrations that aim to involve partners with different interests. Actually the governance is managed by Informatica Trentina, with more weight on the "*order*" side of the balance. The project is in the early phase, and a top-down governance model can avoid divergences, but for the next phases we think that an open community governance should be proposed. This approach will allow a constant flow of members and ideas to influence the development of new policies, democratizing the decision-making processes.

5.3.4 Historical and longitudinal presentation of the TasLab project

The TasLab project, as stated before, is in the early phase, and due to its new approach it could raise a lot of issues during the next months. The first phase of the project (initiation phase) is terminated: scope , purpose and objectives of the project are defined. At this stage all the members are enthusiastic, they share the same vision, but after that an operational plan is required, otherwise the risk is to lose concreteness and to start divergences. Different actors will monitor and track the project's life cycle, each of them with more interest on their specific interests. A possible scenario is that University and Research Centers will push on innovative products, SMEs on ready-to-apply technologies and the citizens in the usability aspects. The success of the project will be measured by the convergence, after many iterations, of all the communities' interests. The growth of the project could be accelerated if the development of new applications starts with the contribution of all the actors, providing demonstrations and even early-stage support for user communities. The real exploitation potential starts to be seen only after the early use of the "*promised"* technologies.

6 Summary

This deliverable is addressed to four objectives:

1. to demonstrate that the Community Network (CN) approach could be an efficient means for fostering the creation of digital ecosystems in the respective communities,
2. to argue that the digital ecosystem perspective could produce positive externalities to the process of creation and sustainability of a public broadband infrastructure,
3. to identify strategies of DEs implementation, and
4. to demonstrate them by the example of the Trentino region and Trentino Living Lab.

We showed that CNs are already existing digital communities, involving different groups of users, (e.g. not only SMEs). For these user communities, moving from some basic CN services such as Internet access or participation in public processes to digital ecosystem services would be a straightforward development step. SMEs, in particular, are strongly connected to their regions and need regional infrastructure and support to implement DBE services, which can be done through CN infrastructures and business/governance models. CNs are application-driven, and their users/members usually have already collected (positive) experiences about and benefited from some distributed applications. Therefore we expect that they are more open to the acceptance of DE services than in cases of green field efforts.

We started with a high level view of CNs infrastructures and emphasizing the elements and characteristic features of CNs that can prepare the ground for and help the introduction of DEs in regional settings. CNs infrastructures could be divided in three layers:

- Connectivity infrastructure: it provides connectivity for all members (humans, organizations, agents etc.) of the community network/digital ecosystem;
- Services Delivery Platform (SDP): the new architectures support service provisioning with important functionalities such as call control, quality of service provisioning, media gateways, authentication, authorization, accounting and the like. The DBE platform is a good example of open source software platforms that play an important role in the implementation of this new service architectures;
- Base services: specific functionalities that may be used by several applications.

CN technologies can enable implementation of DE services as follows:

- CNs infrastructures are particularly relevant for companies and citizens for two reasons: because they help bridging the digital divide and, since the local government is interested in creating value for local companies and citizens, providers could be forced to enable such services that they would not allow (i.e. community bandwidth sharing)
- The basic requirements for CNs as network infrastructures - ubiquitous access, full coverage, and access from multiplicity of devices and platforms - are extremely important conditions for the implementation of DE services.
- More advanced community networks employ a kind of service provisioning platform. Based on this approach, the DBE platform could be easily incorporated and accepted.

We presented the CISG framework[9]. It underlines the four main dimensions that we should consider when analysing broadband-enhanced local innovation – like CNs and DEs - as socio-technical infrastructures: communities, infrastructures, services and governance. The framework suggests to consider every dimension as contextually defined within CISG relationships. Then we suggested to consider CNs and DEs as part of a broadband-based regional innovation sustainable process. This process could be positively influenced by both CNs ubiquitous infrastructures and participative models, and DEs model for advanced services. An idea of the sustainable local process is the following:

- Communities, like citizens and government agencies, at the local level undertake the responsibility for their own infrastructures upgrade. The grassroots community participates in the decisions. The business community is involved by the local government;
- Infrastructures are therefore created under locally sustainable business and social processes;
- Services could be developed because of the ubiquitous access and the cooperation processes enhanced by DEs and other frameworks;
- At the governance level, the creation and management of infrastructures and services could be improved by the business and grassroots participation that belong to the CNs tradition and DEs perspective.

We addressed the strategy issues of the implementation of CNs and DEs as relations and specifications of the CISG framework and our conclusions are as follows:

- Infrastructure technology choices:
    - *Overall requirements*: Ubiquitous Wireless Local Area Network (LAN) connectivity, multiple device support for both connectivity and application access and usage, support for industry standards, scalability and

9 The CISG framework is a specific socio-technical conceptual tool that has been presented in OPAALS D7.1.

adaptability, broadband connection speeds, reliability and durability, a centralized management solution, roaming, Quality-of-Service (QoS), and security are the main requirements both for CNs and services.

- *Optical fiber and wireless technologies:* wireless technologies first of all Wi-Fi Mesh, WiMAX are particularly suitable for building CN infrastructures and, at the same time, provide an excellent infrastructure for implementing DE services;
- *Planning guidelines*: several important issues should be considered (requirements, timeframe, frequency and licences, costs and Return on Investment) and the main steps are: identifying applications and services, identifying network technology requirements, identifying coverage requirements and the possibilities and limitations of the environment, choosing network technology, planning of network topology, verifying original requirements.

- DE services: the mere convergence between ICT networks and social networks creates a context where the amount of data and information increases day-by-day, and they are perceived like digital commodities. DE perspective adds qualitative differentiation to the information commodities because it forms a complex and dynamic environment that realizes the actionable information, adds knowledge to the graph, identifying nodes and ties with the organizational/business processes.
- Business models: we considered many models and issues related to the infrastructure creation and operation, the development of new applications, and citizens' participation in creating and operating the infrastructure. Using these models and considerations as guidelines, suitable business model can be tailored to each individual case.
- Policies: we considered the interplay between institutional and grassroots initiatives, and the policies supporting CNs creation, growth and sustainability.

In the last part of the deliverable, we demonstrated the application of the general strategies by the example of the Trentino region and Trentino Community Network.

First we presented T.Net, a community network infrastructure initiated by the local government of the Province of Trento with the main aim to provide broadband connectivity to all public administration offices, companies and to citizens. We briefly summarized the topology and technology choices and described the four dimensions inside T.Net project according to the CISG framework, introduced in our companion deliverable D7.1 and discussed within the context of this deliverable earlier. Applications and services are being planned within the framework of the the “Trentino as a Lab” (TasLab) geographical Living Laboratory (LL) initiative started almost 3 years ago which is now part of the European Network of Living Labs.

Finally, a comment on the planned further work. This preliminary study will serve as a basis for our activities in Phase 2 within the framework of Task 12.6 titled

“Creation of a living laboratory for service experimentation in DCEs”. The main objective of this task will be to put in the practice what we learned in the first phase of the project by developing a distributed living laboratory for CNs and DEs interconnection (DCEs) in Trentino. This task will provide the possibility to link the testbed developed by CREATE-NET, with the Trentino Regional Catalyst (Informatica Trentina) and end users (Public Administrations and SMEs) through the innovation programme that the Province of Trento is developing following a Digital Ecosystem approach. This activity will profit from the research activities carried out during Phase 1, as well as from the results of Task 12.5 and a socio-technical analysis will be provided. The laboratory will offer an open innovation space where Public Administrations, local industries (in particular small and medium business) and research institutions (CN) will share knowledge and tools in order to develop DE components to be used for local innovation.

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