

Digital Business Ecosystem

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Report on the socio-economics of Free/Open Source

Working together at the intersections between the gift economy and the exchange economy: Sustainability and scalability in F/OS



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EXECUTIVE SUMMARY

This deliverable maps the main socio-economic dynamics of Free/Open Source (F/OS) and provides a framework based on the strategies and practices of three principal groups of stakeholders involved in the F/OS software development process: F/OS communities, businesses and public institutions. This scheme provides a means of organizing debates about the innovative and business potential of F/OS software as well as a way of understanding the opportunities and challenges posed by the convergent and diverging strategies and practices of the F/OS, business and policy-making communities. This wide-ranging examination of the strategies, practices, and stakeholders of the F/OS process is balanced by a more functionalist perspective on how the factors and characteristics of this process can come together as an abstract and self-sustaining system. Both points of view aim to understand the role F/OS plays in the sustainability and scalability of digital ecosystems. Whereas the first is a socio-economic analysis grounded in practice, the second is a socio-economic analysis grounded in language. These two complementary views are not developed to the same extent in this report. The language view is only sketched here and will be developed more fully in the next report (D18.7).

More specifically the report indicates that:

- a. Volunteer communities display both mundane and unique characteristics of software development and social organization.
- b. The boundaries between the gift economy, the purview of communities, and the exchange economy, where proprietary development takes place, are more permeable than was originally assumed. The interconnections between the two value systems are intensified by the progressive commercialization of F/OS.
- c. The business appropriation of F/OS broaches more general issues of software business models. More importantly, there seems to be a considerable gap between the rhetoric about the business potential of F/OS and the barriers to formulating and implementing strategies that leverage it.
- d. The sustainability and scalability of F/OS are dependent on a wide range of policy issues that involve most prominently patents and reverse engineering legislation. At another level of policy intervention, public institutions have shown in recent years an increasing interest in F/OS and a commitment towards open standards, but lack in many cases the social, technical and legal know-how to participate fully in the F/OS process.

The report suggests two distinctive strategies in order to facilitate DBE's take up by volunteer communities. This strategy is founded on the distinctiveness of F/OS communities and their embeddedness in the exchange economy.

INTRODUCTION

This deliverable maps the main socio-economic dynamics of Free/Open Source (F/OS) and provides a framework based on the strategies and practices of three principal groups of stakeholders involved in the F/OS software development process: F/OS communities, businesses and public institutions. This scheme provides a means of organizing debates about the innovative and business potential of F/OS software as well as a way of understanding the opportunities and challenges posed by the convergent and diverging strategies and practices of the F/OS, business and policy-making communities. This wide-ranging examination of the strategies, practices, and stakeholders of the F/OS process is balanced by a more functionalist perspective on how the factors and characteristics of this process can come together as an abstract and self-sustaining system. Both points of view aim to understand the role F/OS plays in the sustainability and scalability of digital ecosystems. Whereas the first is a socio-economic analysis grounded in practice, the second is a socio-economic analysis grounded in language. These two complementary views are not developed to the same extent in this report. The language view is only sketched here and will be developed more fully in the next report (D18.7).

A holistic view of the F/OS process is helpful when examining the challenges entailed in the development of an open source Digital Business Ecosystem. The sustainability of the DBE platform will rely largely on the kinds of relationships that co-evolve between these three groups of stakeholders and the way that these relationships are shaped by social and economic dynamics and by choices made for the governance and regulatory aspects of the DBE project. One of the main challenges posed by the DBE is whether it will sustain a more integrated and reciprocal framework of interaction between firms, F/OS communities and policy makers in a way that promotes the growth of the European software market and fosters SME development, through support for open source code and open standards.

This report draws on the Communities of Practice (CoP) perspective, a theoretical approach that stresses the situated character of knowledge and “draws attention to networks of individuals which help to embed economic interactions in social relations” (Duguid, 2003:81). Although an understanding of the embeddedness of economic interactions in social relations can assist us in establishing more meaningful interfaces between the main stakeholders in the DBE project, we should not underestimate the extent to which new communities and networks of practice emerge and established ones are reproduced within a nexus of social, political, and economic relations and institutions that are often resistant to change. We draw upon a number of empirical studies of the organization and commercialization of mature F/OS communities, including a study conducted during the first year of the DBE project which focused on the dynamics of cooperation and the implicit decision making processes of early SME drivers (Software Developers), Regional Catalysts and BML designers. The research revealed some of the difficulties that arise through the construction and translation of social complexity into business and computing models and practices. In relation to open source the study clearly indicated SME

software producers' concerns about experimenting with business models in a context of software development they know little about.

This report is organized as follows. The first section starts by outlining the importance of F/OS for the DBE. The theoretical approach is then set out and some of the principal challenges involved in creating an architecture of cooperation between the DBE principal stakeholders are discussed in terms of how the lessons learned within each community can be applied. This section also explores the relationship between CoP, language and self-determination within the context of a business environment . This is of primary importance for understanding some of the challenges inherent in the formalization of business through formal BMLs such as SBVR. The second section which focuses on F/OS as a community provides an overview of the reception of the F/OS paradigm, illustrates its main characteristics and synthesizes some of the most important insights into the dynamics of community development. The preliminary elements of a strategy for involving F/OS volunteer communities in the development of the DBE are presented. The third section examines F/OS from a business perspective, providing an overview of the main business strategies that have been developed within its context. Within this part of the report we highlight the findings on the views of early SME software producers about F/OS. We conclude by elaborating another aspect of a strategy for involving F/OS communities, i.e. leveraging the overlapping networks of contacts and partnerships between firms and volunteer communities.

Section 4 focuses on policy and public institutions, providing an overview of policy and legislation that are relevant in the F/OS world. We provide examples of policy initiatives and interventions that aim to leverage F/OS to achieve various goals. This section has an instrumental focus and highlights some of the implications for the deployment of the DBE.

The report concludes with a summary of the unique features of F/OS development and of its embeddedness within commercial, social and institutional relationships and structures.

1. COMMUNITIES OF PRACTICE AND THE PARADOX OF EMBEDDEDNESS: LEARNING AT THE COMMUNITY AND INSTITUTIONAL LEVELS

1.1 Free/Open Source and the DBE

This section presents the theoretical framework. This is intended to contribute to understanding of the approach adopted in this deliverable.

A central concept in this report is that of sustainability¹. From a socio-economic perspective this concept can be addressed in the light of three interrelated questions:

- a. How can different communities of practice and networks of professionals that are involved in the F/OS community work together to fulfill their aims and, at the same time, achieve something bigger than they would be able to do on their own? We draw attention to areas of contestation and 'blind spots' in this process at the level of the F/OS communities and their practices, and at the level of policy, where the actors' divergent interests are brought to bear in the policy making process.
- b. Can language, as understood within the social constructivist tradition, provide a unifying framework for understanding the links between ICTs, codified and tacit knowledge, and different socio-economic value systems as illustrated by the success of F/OS?
- c. How can the DBE design an effective strategy for involving different stakeholders that will ensure the sustainability of the DBE platform after the end of the funded period of the project? The extent to which the technical potential of the platform fulfils its social, business and development potential is one of the main challenges of the DBE project.

The ideas of CoP are leveraged to highlight the importance of language and self-determination within the context of a business environment predicated upon the values of F/OS of cooperation and knowledge sharing. This is of primary importance for understanding some of the challenges inherent in the formalization of business through formal BMLs such as SBVR, another aspect of DBE that is crucial to the take-up and sustainability of the platform.

The theoretical approach in this deliverable is intended to provide a background for understanding the challenges entailed in addressing the issues raised above. We develop the Communities of Practice (CoP) approach and the idea of 'embeddedness', both with respect to knowledge and in the context of material exchange relationships. And we outline a theoretical research path for the remainder of the project that adopts a more systemic view of F/OS and examines its constitutive elements from the perspective of the debate on the

¹ Broadly speaking sustainability is predicated upon the continuity of economic, social and environmental aspects of society. Prevalent economic tradition has associated sustainability with the notion of intergenerational allocation, the idea that development should take into account the needs of future generations by preserving our natural and social capital (Anand and Sen, 2000). Amartya Sen couples the idea of sustainability with that of human development, more specifically, the effort to enhance "people's ability to generate for themselves the real opportunities for good living" (Ibid: 2039). In practical terms sustainability connotes self-renewing development.

relationship between private and public goods, on the one hand, and ICTs and language, on the other. This view is premised upon the idea: a) that F/OS has achieved a balance between the values embedded in the exchange and the gift economy and b) that a social constructivist framework for understanding technology, with the emphasis that it places on language and power, can provide a unifying framework for understanding F/OS.

1.2 Communities of Practice and Networks of Practice: A theory of learning, knowledge and innovation

The theory of CoP has its roots in social constructivism, a perspective that emphasizes the importance of culture and context in understanding what occurs in society. Lave and Wenger (1991) argued that a society's knowledge is situated in relations among practitioners, their practices, and their social organization and political economy. Communities of practice, which may include such disparate groups as teams of fire-fighters, office secretaries and hackers, are formed mainly through the pursuit of a shared enterprise and act as repositories of experience and knowledge.

The CoP perspective offers a distinctive view of learning, working and innovation. Whereas more traditional approaches to learning, such as the ones adopted more frequently in some traditions in education, training and technology design, favour abstract representations of knowledge, the CoP perspective emphasizes the interrelated character of work, practice and innovation. More specifically, proponents of the perspective argue that practice is central to an understanding of work, and that situated learning, learning-in-work and learning practice are the primary drivers of innovation. Brown and Duguid (1991:41), who extended Wenger and Lave's original framework, argue that it is: "through the constant adapting to changing membership and changing circumstances that evolving communities of practice are significant sites of innovation". One of the most interesting aspects of the CoP perspective is the significance that it attributes to action for learning and theorizing.

One of the examples that these researchers use concerns the community of technicians in training and at work in the Xerox corporation. Faced with the dilemmas, inconsistencies and unpredictability of their everyday tasks, the corporation's representatives had developed tactics that allowed them to bridge the gap between the unpredictability of the photocopying machines and the formal descriptions of their work as reflected in official company policies, manuals and training programmes. One of the most important tactics the technicians developed was the creation, trading and understanding of highly referential and informative 'war stories' about problems encountered in the field. Brown and Duguid (2001) later expanded the notion of community of practice to that of a network of practice. Whereas communities of practice are highly localized, networks of practice are characterized by: a) looser connections among their members, b) are usually identified with more formal occupational and professional networks (Brown and Duguid, 1991), and c) can span the boundaries of organizations.

As Brown and Duguid's example illustrates language is a central element of how CoP are created and sustained. As with practices and routines, words, stories, and concepts, in short the particular ways in which members of a CoP create meaningful statements about the world, form an integral part of the repertoire that they employ in order to organize participation and reify membership. In addition, language plays perhaps an even more important role in networks of practice, which are less locally dependent than CoP and hence more difficult to coordinate through shared routines. The section on "The role of F/OS as mediator of socio-economic value systems and the self-determination power of language" begins to examine under what conditions ICTs can best facilitate communication across different communities and networks of practice through their function as media of shared processes of formalisation and codification of knowledge.

The more sociological focus of the approach on what practice is, how it evolves and how it is reproduced has been supplemented in recent years by a focus on the economic importance of CoP and, in particular, on their implications for performance and operations in organizations and for policy. The range of contributions varies from accounts grounded in the knowledge management literature (Lesser and Storck, 2001; Wenger, McDermot and Snyder M., 2002) which are primarily concerned with issues of community design and management, to studies in the science and technology innovation field (Steinmueller, 2003; Steinmueller, 2004). The latter sometimes couple the CoP perspective with the notion of 'social capital', which suggests that the potential of societies to achieve democratic participation is influenced by the density and structure of their social networks. The two approaches are characterized by an important difference. Whereas the former approach usually assumes a direct link between the CoP and organizational effectiveness, the latter approach examines the necessary conditions and barriers to the fulfillment of organisational potential and links CoP with broader social processes. This is useful when we consider how the lessons learned by disparate community actors can be applied to inform the strategies of organizations and institutions.

The reasoning behind the latter approach is succinctly outlined by Steinmueller (2003:51): "Translating the processes of knowledge generation and exchange into improvements in economic performance and employment is, however, a complex social process, even the most brilliant and original idea will languish without an extensive process of development engaging hundreds or thousands of individuals in refining, adapting and commercializing the idea for the market as well as supporting the products and services that result from the application of this idea".

These observations are particularly useful for understanding some of the dynamics of the F/OS community that has been examined frequently as a community of practice (Edwards, 2001; Madanmohan and Navelkar, 2002; Samer and Wasko McLure, 2002). Although to some extent, F/OS communities are cohesive, the F/OS movement has relatively weak means of achieving overall coordination. Take for instance the case of bugs, faults in the program, across projects and distributions. Both firms and F/OS communities have processes for recording, processing and solving them. These processes, however, are not integrated. When a developer

wants to find out whether a bug has been fixed, she needs to search across the different bug tracking systems. At the same time, this process makes it difficult for the communities to keep track of how the code tree evolves and to decide which patches and fixes need to be integrated upstream. The same problems occur with translations and with other issues related to the lack of coordination and standardization of technical, legal and social processes.

The situation is more complicated when we consider the levels of cooperation between different F/OS communities, networks of practice and institutions. Section 3 discusses business aspects of F/OS highlighting barriers to its adoption by companies. Some of the reasons for SME apprehensiveness about adopting F/OS are related to uncertainty about how the framework for action by volunteer communities can be translated into a business context. For example, companies are frequently concerned about how an open source license will protect their intellectual property and about the skills and know-how needed to interface with volunteer communities.

In short, the CoP perspective suggests that F/OS practice is highly localized and knowledge is inextricably connected to the social processes that create and maintain it. Although this social character of knowledge facilitates learning processes within the same communities, it poses significant challenges for cross-community and cross-network cooperation. Nevertheless, people do frequently work within different frameworks of action. Our observations about the embedded character of knowledge and practice would be misplaced if we failed to take into account the overlapping character of many of these communities and networks within the context of material exchange relationships². In the next section we complement the insights from CoPs about the distinctiveness of communities of practice with the idea of the 'embeddedness' of economic action in social relationships.

1.3 Transcending communities of practice: learning at the level of organizations and the challenge of embeddedness

The idea of the embeddedness of knowledge³ in social relations is consistent with a social constructionist perspective. In this section we complement it with the idea of the embeddedness of economic action, where 'embeddedness' is: "principally concerned with how the quality and network architecture of material exchange relationships influence economic activity." (Uzzi, 2001:208). This notion of embeddedness is not inconsistent with the CoP perspective. Both uses of the concept of embeddedness are helpful in understanding the socio-economic dynamics of F/OS and the challenges in transferring the lessons learned by communities to organizations and institutions.

² The term 'material' signifies here relationships initiated by and sustained through economic transactions.

³ The notion of embeddedness of knowledge, the importance that is given to context in meaning generation and production, is also prominent in other areas of study. In linguistics, the field of Pragmatics examines, for example, the generation of meaning through context.

One of the most compelling accounts of this view of the *embeddedness* of economic action has been provided by the sociologist Mark Granovetter. In his seminal article on 'Economic Action and Social Structure: The problem of embeddedness' (1985:490), he argued that "continuing business relations often become overlaid with social content that carries strong expectations of trust and abstention from opportunism. Granovetter defined economic embeddedness as the: "argument that the [economic] behaviour and [economic] institutions to be analysed are so constrained by social relations that to construe them as independent is a grievous misunderstanding" (ibid: 482). Granovetter developed this idea partly as an answer to what he regards as "undersocialized" and 'oversocialized' accounts of human action. The first, is consistent with the perspective of neoclassical economics that: "disallow by hypothesis any impact of social structure and social relations on production, distribution and consumption." (Granovetter, 1985:483). The second type of accounts is more common in some branches of sociology and emphasizes, for example, the importance of social processes, norms and values, at the expense of the political and economic structures permeating many aspects of economic life.

The notion of embeddedness as defined by Granovetter is helpful in highlighting the links between different stakeholders in the F/OS community and in drawing attention to the many dependencies between the gift culture and the exchange economy. Despite the many unique characteristics of the F/OS community that inform its distinctive community of practice, an increasing number of studies draw attention to the different ways in which it is connected to commercial developments in products and services, and through the involvement of those who are involved in both worlds. This is, for example, the case for F/OS contributors who are hired by companies with an interest in the development of F/OS projects to hack applications they have been contributing to as volunteers.

These groups of people who move seamlessly between different spheres of activity can be considered to constitute a community of practice of their own. A crucial element of any strategy that aims to connect different communities of practice involves identifying the players who operate at the boundaries of these social and professional groups. Although this strategy may be effective in certain circumstances, it also presents a challenge: leveraging overlapping networks can be substantially limited by their bounded character, i.e their structural limitations⁴. These may hinder attempts to scale them since this involves addressing a wide range of issues connected with their historical, cultural and socio-economic specificities. A thriving network of F/OS practitioners operating, for example, within a specific region, may not necessarily or readily be expanded to others. And the knowledge and insights accumulated from the actions of one network may not be easily translated into lessons that are transferable outside its context. These observations highlight the challenge

⁴ Structure refers to the persistent patterns of social rules, norms, relationships and sets of resources that empower and constrain social action. The notion of structural limitations refers in this case to the characteristics of social networks, such as their reach or density, which can have a direct effect on the relationships of actors moving within them as well as the possibility to connect to other networks.

created by embeddedness. The same processes through which embeddedness creates a fit with the dynamics of a specific environment, can also reduce the potential for the actors to transcend their boundaries, to connect to other CoP and networks of practice and to inform the policies and strategies of institutions that can influence related developments.

In this respect the role of public policy is crucial in:

- Formulating a framework of collaboration that may help to translate some of the insights gained by F/OS communities to organizations.
- Assisting these collaborators to evolve into sustainable partnerships that may contribute towards changing institutional and organizational outlooks and practices.
- Affecting more fundamental changes, i.e. through policy and open standards that might radically influence the dynamics of collaboration and the structural limitations of embedded communities.

1.4 The role of F/OS as mediator of socio-economic value systems and the self-determination power of language

This section begins to develop a functionalist perspective of how the broad concept of mediation can enrich our understanding of the role of F/OS in digital business ecosystems. This discussion will only be sketched here and will be developed more fully in the next report (D18.6). We apply the concept of mediation to socio-economic and linguistic contexts, stopping short of the mediation of contracts and agreements on the side of social science and of the mediation of mechanical stresses, signals, and waves in physical media on the side of natural/physical science. “Functionalist” here is meant in the sense of Burrell and Morgan (1979:25) i.e. “... a perspective which is firmly rooted in the *sociology of regulation* and approaches its subject matter from an *objectivist* point of view” (Italics in the original). Burrell and Morgan proposed a conceptual map by which to organise much of the literature in sociology and organisational studies whose two main dimensions are conflict-regulation and objectivist-subjectivist tradition. More recently, Hollis (1994) has proposed a similar map by which to organise social science (i.e. with a greater emphasis on economics rather than organisational studies, and a similar emphasis on sociology) whose two main dimensions are naturalistic-hermeneutic tradition and individualistic-holistic tradition. In this section, therefore, we begin to investigate how the factors underpinning the F/OS phenomenon **could** come together in such a way as to reinforce its sustainability and scalability characteristics, rather than describing how this many-faceted phenomenon is **actually** taking place in its many forms. This functionalist approach is close in spirit to model construction as it is pursued in the reductionist scientific tradition, and is motivated by the desire to define a best-case scenario as an important part of the policy development process. A complementary and at least as important part of policy development is grounded in a more empirical and applied perspective that balances the functionalist approach and that is emphasised in the rest of this report.

Economic perspective

Granovetter's concept of embeddedness of economic action in social behaviour can be seen as one half of a wider and symmetrical mediation framework: just as economic interactions are in part mediated by social interactions, so can social interactions be partly mediated by economic interactions (Fig. 1). In addition, different levels of mutual dependence between these two systems of interaction can be recognised. For instance, at one extreme a strong dependence can manifest itself through the initiation of an economic relationship as part of a social relationship, or through the development of social ties within the context of a business relationship. However, to a first approximation the opposite extreme of complete independence is more common, i.e. the motivators of social interactions tend to be social and the motivators of economic interactions tend to be economic. From this point of view, we could say that much of the current debate on socio-economic development is concerned with a middle ground characterised by more indirect and more complex feedbacks, i.e. how a social investment may bring economic advantage, how an economic investment may bring a societal advantage, or how social and economic systems can interact constructively and reinforce each other. The line of research to which this report belongs is motivated by the belief that F/OS can play a central role in this constructive dynamic, and by the desire to understand how digital ecosystems can take advantage of this fact.

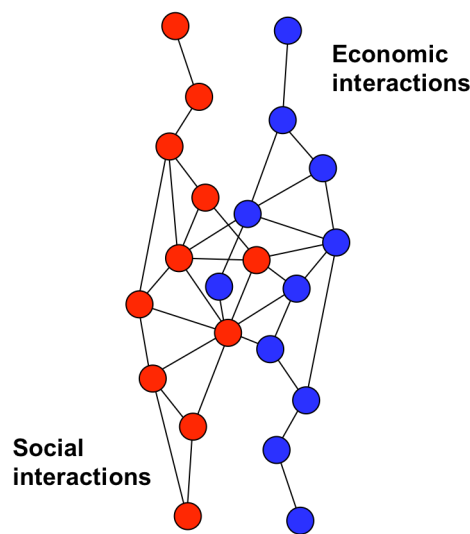


Fig. 1 Mutual mediation of social and economic interactions

A great deal of work has been done to address these issues, even if it is not usually framed so symmetrically. Examples range from theories of social capital to traditional “atomised” business models, with discussions of civil society, communities of practice, and notions of embeddedness in between. Understanding the economic potential of F/OS is a particularly challenging research area. Views of F/OS which describe it as “far-from-market” as opposed to “near-to-market” are limiting, and economic and business models surrounding F/OS standards and software development are not yet well understood, as has been argued in a growing number of social science journals and initiatives (Benkler, 2004; Simon Forge, 2004). Benkler (2002), for instance, looks at

F/OS from the point of view of New Institutional Economics and characterises its rise as deriving directly from the lower transaction costs afforded by certain implementations of ICTs. Since F/OS, in turn, potentially decreases transaction costs, its role as an economic mode of production is self-reinforcing. This view, however, is not universally agreed even among academics and F/OS supporters, who generally invoke some aspects of the gift economy as equally if not more important (the “value vs. values” debate), as discussed throughout this report. A common conceptual framework can in fact be built from the point of view of economics by organising these discussions around different value systems, generally referred to as the exchange economy, the gift economy, the moral economy, etc. Much of the excitement brought by ICTs over the last few decades has been motivated by the broadly shared perception that by dealing with goods or content of various levels of “immateriality” ICTs have the potential to intersect all these economies, catalysing the growth of the much celebrated Knowledge Economy.

Acknowledging that in this paper we can only begin to discuss what this overloaded term might mean, the aspect that is more immediately relevant here is the distinction between codified, explicit, or formalised knowledge on the one hand, and tacit knowledge, on the other. As we have previously indicated, despite initial predictions, ICTs have not lifted the barriers to the codification and formalisation of knowledge to the extent that has sometimes been envisaged. At the same time, however, digitization is underlined by the effort to expand control over previously more narrowly commodified spheres of human knowledge and creativity (Lessig, 2001). This is connected to the increasingly contentious intellectual property and software patents debates, characterised by such statements as, “Built to promote innovation, the intellectual property system may rather be strangling it” (Duguid, 2003:82)⁵. An example for how commodification by itself might be insufficient to realise the full potential of ICTs in the knowledge economy is provided by a brief discussion of the tension between media and content within the media industry.

The media stack

A recent article in an Institute for Prospective Technological Studies Report discusses the likely evolution of the online media industry based on an analysis of its recent past (Punie, Burgelman and Bogdanowicz, 2002). The article begins by observing that, “At the height of the Internet boom, the fact that digital technologies had made customised on-demand media content possible suggested there might be a shift from pre-packaged content to content defined by the users themselves.” In other words, the predominant assumption was that there would be a shift from “content push” on the part of broadcast companies to “content pull” by the users. Content pull originally involved little more than localisation of content (i.e. BBC programming for Northern Ireland is different to London’s), but with the increasing adoption of interactive TV viewers are able both to personalise the content specifically delivered to them (using DVRs like TiVo) and to participate in democratic processes through real-

⁵ This is not just an academic position. As reported in the 22-28 October 2005 issue of *The Economist*, on 11 January 2005 IBM released 500 of its software patents to the open-source community, to be placed in a “patents commons”: “The company’s motive ... is fear that patent rights have swung so far towards protection that they risk undermining innovation”

time polls and voting events. The perception remains, however, that the introduction of the Internet has empowered everyone to become a content producer and to respond to the pull from geographical or virtual communities of consumers by producing customised content to a level of granularity that is unlikely to be achievable even with interactive TV.

This initial perception of the potential of the Internet was however based on a faulty assumption; namely, that the *possibility* of greater access to channels of expression afforded to everyone by the new technologies implied a *high probability* that such channels would actually be used. As the article goes on to explain, the further implication of this view was an expectation that demand-related drivers would overturn market structures in the media sector. Unfortunately, while it is true that “the Internet could potentially lower the barriers to entry for content distributors, [...] this does not imply that everyone will be able to survive and make a business out of it.” In other words, more traditional market drivers have in fact been found to be relevant. These are, in order of importance: (1) Finding a revenue model; (2) Branding; (3) Technology innovation; (4) Dominance of a push model (point-to-multipoint); (5) Consolidation/Co-existing development models; (6) Customisation and new, emergent (content) demand and flexible delivery strategies; and (7) Everyone can become a content producer.

The position of the two market drivers at the end of the list reflects the faulty expectations of the Internet boom. After the Internet boom we appear to be living through a period where monopolies are winning out over more dynamic markets of smaller players, or markets where small and large players coexist. The IPTS article discusses this within the context of an integrated framework to describe change in the online media sector built around the dimensions push-pull, free content-pay for content, consolidation-coexistence, and weak-strong demand. The conclusion of the analysis is that “Media markets have not been overturned by digital technologies and the dominant ‘broadcast’ model is not likely to be replaced by a peer-to-peer or point-to-point model in the near future”.

How could the intuition of so many people have been so far off the mark? People tend to make decisions based on what they intuitively feel is of value. It takes training and discipline to “synchronise” one’s intuition with the appropriate metric (school marks, share price, electoral polls, etc). Such metrics however are not cast in stone, they evolve through a social and consensual process. They can therefore be seen also as commonly grounded symbols that provide a counterpart to intuition not unlike the contrast between formal and natural language. Like language they are influenced by power relations and mediate power relations but, like language, they are more plastic than they may at first appear. Thus, while the article quoted above is right in stating that a new technology will effect change only to an extent supported by a sustainable business model, the failure of the demand-based drivers to effect change has not necessarily been caused by their lack of value. Such failure only suggests a mismatch between the drivers and the business models. Maybe we need to rethink the business models—and the metric we use for “value”.

The concept of the OSI (Open System Interconnection) protocol stack may be helpful here. As shown in Fig. 2, whether a particular representation of a communication event is medium or content depends on the point of view. The figure also shows that whereas in the lower layers we have clear ways of measuring and charging for the content, in the higher layers it becomes increasingly difficult to assign a monetary value to the traffic. Ironically, the higher we move in the stack the greater the perceived value of the content is likely to be to human users. Thus, while, strictly speaking, new media refer to new devices that can interface to new technologies of communication (such as wireless), this discussion is based on the observation that when we talk about new media we are not talking only about a new technology or a new product. This is because content is not always product. Content encompasses the whole context of its productive cycle: the technology that is used for the production of the content, the actual content that is to be transmitted and the receiver's part. However, whereas bandwidth or net bytes transmitted can always be clocked and charged, different types of content can vary widely in cost, from free to very expensive. The higher revenue potential of content over bandwidth has been recognised for some time (Kyriakou, 1998). We are suggesting that we should go one more step in this differentiation and introduce a new layer in the media stack, the "pink layer" in Fig. 2. The pink layer can be associated with free content that is not limited just to F/OS but can also include narrative, eGovernment information, shared business models, community postings, free music from local bands, course notes, historical heritage, etc.

We contend that, while the concept of return on investment remains fundamentally important to achieve sustainability, business models that optimise the ROI from a product development perspective are bound to fail when applied to what people actually exchange and communicate, i.e. to the pink layer. Such models strive to calibrate an appropriate charge distribution for different types of content and for different access modalities but are blind to the value of free content. Trying to put a monetary value on every conceivable type of content is indeed a futile task: we are left with the only option of generalising the concept of business model. This is one of the main aspects of the gift economy or the moral economy.

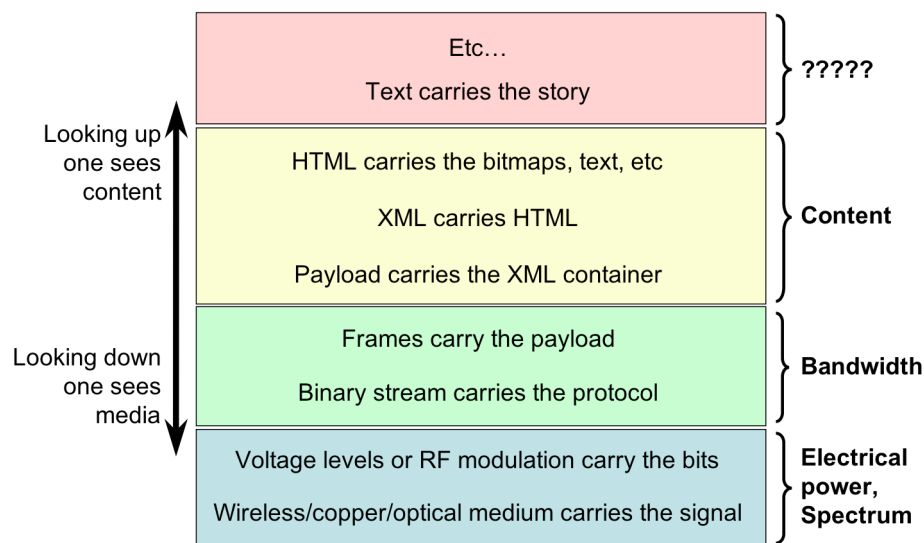


Fig. 2 The media stack

If we take a more utilitarian view and limit the content to “knowledge” in a business context, the media stack argument remains useful because it highlights the connections between technology and language, to which we turn next.

Linguistic perspective

The nested media of the OSI stack are layered in order of increasing abstraction. Although each layer is not in general a formal transformation of the layers adjacent to it, it certainly can be, as exemplified by software radio or by ASICs (application-specific integrated circuits), which are first implemented as programs and then transposed to logic gates on silicon. This transformational property of ICTs is a consequence of their being formal systems ultimately equivalent to the same abstract machine (the most general being the Turing machine).

If we turn the media stack on its side we can arrange different technologies from most concrete to most abstract right to left, culminating with formal languages. As we approach natural languages two interesting things happen: we encounter a boundary beyond which we cannot develop a formal model, and the medium and content converge. Furthermore, as we approach natural language it becomes increasingly difficult to commoditise the technology. This becomes clear through the simple observation that society could not function if every spoken utterance were copyrighted and money were exchanged between listener and speaker. In this context it becomes clearer how copyright law, for written content, becomes a more “socially friendly” or benign form of IPR protection than patents. This will therefore be one of the starting points for our investigation of F/OS from the point of view of language. Fig. 3 tries to capture some of the conceptual relationships involved, but it is too early in the research and analysis effort to place F/OS unambiguously in this picture.

Fig. 3 also highlights how difficult it is to separate the factors underpinning the co-evolution of technology with socio-economic systems. For example, it is far from clear whether principles such as decentralised architectures or P2P networks were derived from a particular social theory, or whether instead the converse applies. In general, it seems more accurate to state that socio-economic and technical systems are interdependent and tightly intertwined, that socio-technical and socio-economic phenomena appear to emerge spontaneously from their interaction, and that social theory then tries to explain them. This state of affairs can be interpreted as evidence that it is not so easy to make a clear separation between the “objective” technology we build and our “subjective” or “intersubjective” human experience (Ciborra and Hanseth, 1998).

As discussed in Feenberg (2005), in Heidegger’s early writings “Aristotle’s conception of being in general is derived from the Greek practice of technical making, from *τεχνέ*”. *τεχνέ* realises the inherent potentialities of things rather than violating them as does modern technology” (ibid, xiv). Compatibly with this position, according to Marcuse “...the task of a post-Heideggerian philosophy is to conceive a technology based on respect for nature and incorporating life-affirming values in its very structure, the machines themselves” (ibid, 4). This utopian demand can be understood as “an implicit recovery of Aristotle’s idea of *τεχνέ* in a modern context,

freed from the limitations of ancient Greek thought and available as a basis for a reconstructed modernity” (ibid, 4). Making things (i.e. engineering) can then be recovered as a life-affirming, deeply human activity, as long as we are not blinded by the myth of the neutrality of technology in an objective world. Feenberg’s critical theory of technology shows how technology embodies our cultural values and is in fact an extension of our human languages that necessarily generalises the concept of symbol. It then contributes to the construction of our understanding of reality and in particular of our social reality.

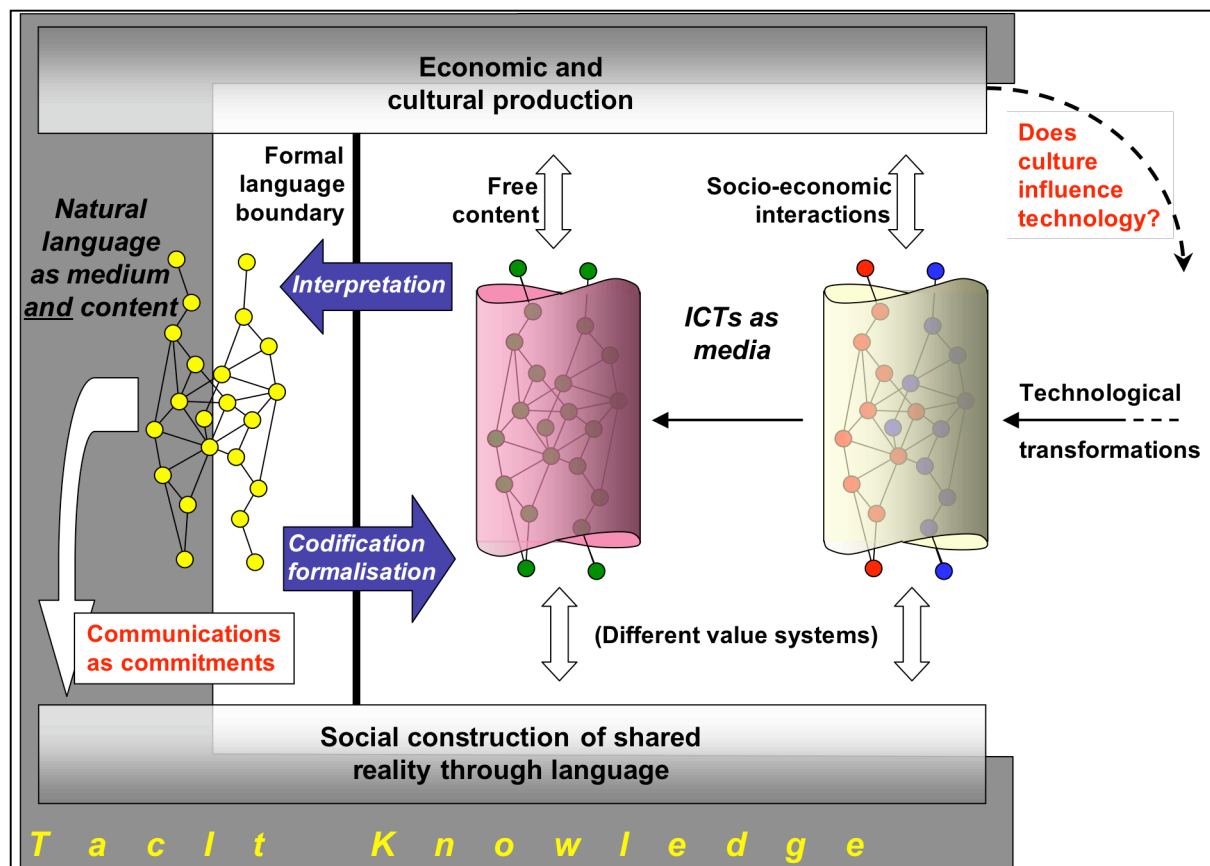


Fig. 3 Media, content, language and tacit knowledge

In this panorama of technology recast as an extension of human cultures and languages ICTs play a unique role because, not only do they share with other kinds of technology this cultural and expressive valence, they *mediate* the very communications that construct the social and cultural systems that created them. It is not clear what the effect of this tight feedback loop might be, but it is pretty clear that it is likely to be a strong one, and perhaps not so easy to control. When looked at through a social science “lens”, therefore, the hybrid role of computer science is perhaps best captured by Winograd and Flores’ view of computers as communication media (1985). Because communications, in turn, carry commitments (Austin, 1962; Flores and Spinoza, 1998; Searle, 1979), it becomes easier to accept that ICT has the potential to become a catalyst of social constructivist processes. For example, we can point to the role played by the Web in the formation of the identity of social groups, as discussed by Flores and Spinoza. Also relevant to Austin’s Speech Act theory, and similar to

it, is a precursor originally proposed by Thomas Reid in the Eighteenth century and further developed by Adolf Reinach in 1913 [Schumann and Smith, 1990; Reinach, 1913], which distinguishes between logical statements (true/false propositions) and other types of utterances (performatives, questions, etc) that are referred to as “social acts”. The importance of language and communications in the formation of social systems is therefore undeniable, although the complexity of the discussion is such that it can only begin in this report and be developed further in the next report. Fig. 4 completes the thought process around the concept of mediation developed in the previous three figures and gives a high-level Escher-like graphical rendition of the feedback loops generated by the interaction of ICTs and media content.

In summary, in this report we begin to examine under what conditions ICTs can best facilitate communication across different communities and networks of practice through their function as media of shared processes of formalisation and codification of knowledge. From this point of view, we see language as a constitutive element of social and economic spaces, ICT as a potential catalyst of this process, and our role to understand how the constructive power of language can influence the design of ICTs by taking into account the dynamics of power and collaboration. These insights will help us understand the potential role of F/OS in this constructive dynamic, leading to more informed policy recommendations in our final report.

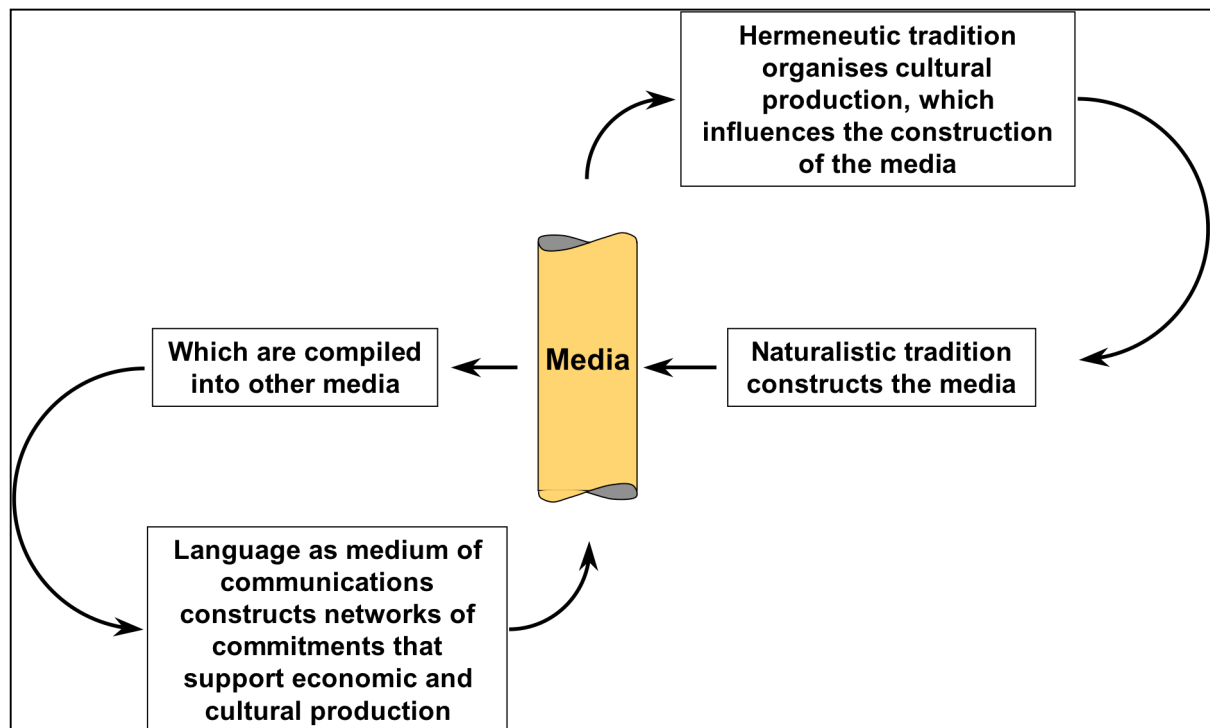


Fig. 4 Where is the boundary between technology and people?

1.5 Conceptual Framework

The report conceptualizes as members of distinctive communities and networks of practice the three main groups of stakeholders involved in the F/OS process: community developers, business people, and public administrations and policy makers. This view provides a set of theoretical tools that enable us to examine the dynamics of cooperation between the principal actors of the open source process by taking into account the **embedded character of knowledge**, the idea that practices of different communities are highly localized and that knowledge is inextricably connected to the social processes that create and maintain it. In the following sections this view underlies the challenges involved in knowledge exchange across these communities and the difficulties created by the loss of context that the process of translation of knowledge entails when we try, for example, to apply the lessons learned at the level of communities to the level of businesses, public organizations, and policy.

These ideas are of wider interest for Digital Business Ecosystems research, which is largely concerned with how knowledge codification and language formalization through the use of ICTs can support regional development by empowering the communities involved, especially SMEs, to specify their needs and requirements within a framework that reflects the localized character of their knowledge and practices. In this deliverable we begin to develop a functionalist framework that places **language** at the centre of Digital Business Ecosystem research and aims to answer the question of how we can design tools through an awareness that ICTs are mediating language but at the same time they are language: as channels of communication they facilitate information exchange and business interaction through the use of specific codes and conventions, and as technologies they embody specific ideas and ideals that shift the balance of power between users and designers, large players and small players, technically proficient and less technically sophisticated users. . This unique and hybrid role of ICTs relates in fact to a larger the discussion on computers as tools or reality creating artefacts and on the possibilities regarding the mechanization of rationality.⁶

In addition to the **embeddedness of knowledge** another idea that is central to the analysis of the socio-economic dynamics of F/OS is the notion of the **embeddedness of economic action**. Whereas the idea of the embeddedness of knowledge argues in essence in favour of localization and distinctiveness, Granovetter's argument about the embeddedness of economic relations in social relations draws attention to the overlapping character of networks and communities of practice. At an analytical level this will help trace the complex interdependencies that develop between the networks of practice examined in the following sections, which intersect the boundaries between the exchange and the gift economy. These two notions of embeddedness are leveraged within the context of this report in order:

⁶ These ideas are explored in Terry Winograd's article on 'Thinking machines: Can there be? Are we? (1991) in which he considers computers as "language machines".

- to provide a critical examination of the points of tension and convergence between the principal stakeholders of F/OS.
- to arrive at some practical recommendations about the deployment of the DBE, through suggesting for example strategies for connecting with volunteer F/OS communities.

This more critical perspective is supplemented by a more systemic view of F/OS that examines the structural elements of its success as mode of production, namely the way in which F/OS successfully mediates the social and economic value systems inscribed in the exchange and the gift economy. Although this perspective is not directly supported by the analytical sections of the report, it provides a normative framework for understanding the importance of F/OS as an example of a sustainable socio-technical system whose constitutive elements the DBE should aim to transpose to a business environment.

2 .THE COMMUNITY PERSPECTIVE: THE DYNAMICS OF VOLUNTEER COMMUNITY DEVELOPMENT IN F/OS

The F/OS movement and its successes seem to be inextricably linked to the idea of 'community' which is often identified with a new way of organizing production and knowledge exchange. Indeed, in many cases, F/OS appears to have become emblematic of the changes associated with new information and communication technologies that appear to enhance the importance of communities as cradles of knowledge and innovation. This section focuses on the dynamics of community development, traces their socio-economic relationships with the offline world and makes some recommendations with respect to the challenges of cooperation within and between F/OS communities.

The first subsection presents perspectives that have been used in examining F/OS and its principal development characteristics. These are often used to explain the reasons for the success of the F/OS movement. The second subsection focuses on the dynamics of community development and draws attention to the multiple connections between the gift and the exchange economy. The third subsection draws attention to some of the implications of the practices of F/OS development for a strategy that aims to strengthen the interfaces of different stakeholders with the F/OS communities.

2.1 Free/open source and its development characteristics

Free/Open source is an evolving and increasingly ambiguous phenomenon. This is reflected in the multitude of perspectives through which it has been examined. It is possible that as the F/OS movement matures, some of its aspects will become more prominent and that others, after having been tested, will be revised, fade away or

become absorbed in different processes and institutions. For the moment, however, F/OS is emblematic of the processes that appear in what is perceived as the 'network economy' (Castells, 2001)

To be more precise, free/open source has been regarded as:

- A revolutionary method of software development that could potentially provide the solution, the 'silver bullet', to the problem of software productivity which has led to the software 'crisis' (Bauer and Pizka, 2003;Bezroukov, 1999;Feller and Fitzgerald, 2002;Raymond, 2001MC;Raymond, 2001MC).
- A platform for a novel innovation process, a distributed, user-driven innovation process, which appears to bridge the gap between consumers and producers of information and which allows for a new, decentralised, model of authority, control and organizing labour (Garcia and Steinmueller, 2003;von Hippel, 2002;von Hippel and von Krogh, 2003;Weber, 2004).
- A movement that has led to the emergence of a new commercial actor, community-driven open source projects, that indicates an evolution in the relationship between community, culture and commerce and which is associated with novel governance structures that introduce new ways of resolving tensions between the individual and the collective and between the community and commercial world (O'Mahony, 2003;O'Mahony, 2002;Weber, 2004).
- A generator of new business models that have the potential of changing the structure of the software industry. For example, the model of indirect revenue capture has been linked with and undergoing a paradigm shift from a commodity- based model to a service model.
- An engine for development and for the empowerment of the public sector (Dravis, 2003;Schmidt and Schnitzer, 2002).
- An alternative to the 'rationality' of the exchange economy, i.e., the gift economy, which expresses the essence of community, promotes the idea of intangible goods such as software as a public or quasi-public good and is based on the principle of anticipated reciprocity and peer-to-peer exchange. This rationality is often associated with a new model of production, i.e. peer-to-peer production, that is based on the notion of property which is configured, not around excludability, but around distribution and is articulated within the framework of special copyright licenses. (Berguist and Ljungberg, 2001;Kollock, 1999;Newmarch, 2001;Raymond, 2000;Raymond, 2001MC;Raymond, 2001MC;Weber, 2004).
- A paradigm for online, collaborative, distributed work, a model of organization, governance and knowledge production structure that is characteristic of the network society and which is potentially transferable to other domains of knowledge and areas of production (Bezroukov, 1999;Dafermos, 2001;Feller and Fitzgerald, 2002;Garcia and Steinmueller, 2003;Ljungdberg, 2000;Moon and Sproull, 2002;Stalder and Hirsh, 2002).

In their book *Understanding Open Source Development* Joseph Feller and Brian Fitzgerald (2002:84) provide a very useful list of the generic characteristics of open source. The F/OS process is:

- "Parallel, rather than linear;

- involves large communities of globally distributed developers;
- utilizes truly independent peer review;
- provides prompt feedback to user and developer contributions;
- includes the participation of highly talented, highly motivated developers;
- includes increased levels of user involvement;
- makes use of extremely rapid release schedules". (ibid: 84)

As the next section indicates, the realization of these aspects of F/OS is much more complicated than is often assumed.

2.2 Overview of the socio-economic literature on Free/Open Source

This overview presents the main socio-economic contributions associated with F/OS as a collective, distributed mode of production. Most examinations of the F/OS phenomenon rely entirely upon or adapt a combination of arguments drawn from three major frameworks:

- a) The cultural, ideological perspective. This approach argues that the success of the F/OS is largely founded on the values of the hacker culture.
- b) The socio-technical perspective. Proponents of this approach view F/OS projects as systems whose technical and social aspects are intricately connected through a dual, recursive process of technology and social shaping.
- c) Organizational studies, labour economics and the economics of innovation. Although only a few studies adopt formal models, many researchers frame their explanations in frameworks that combine elements from these three areas of research.

Research in these traditions examines issues concerning motivation, coordination and cooperation, conflict management, labour divisions, governance and integration. The trend in the recent literature is to complement explanations drawn from cultural studies and analysis of contributors' motivations with empirical studies that question some of the early assumptions about the F/OS model, such as its meritocratic or collective basis. In the following we assess the arguments of some of these studies and highlight some important characteristics of F/OS development.

Many contributions that concentrate on the dynamics of F/OS community development adopt a cultural perspective where the success of the F/OS movement is assumed to be founded on the values of the hacker culture which emphasize access and freedom of information, reciprocity and meritocracy. With a few exceptions, such contributions support the primacy of the integrative role of hacker beliefs over other coordinating factors. (Elliot and Scacchi, 2003; Hemetsberger, 2004; Stewart and Gosain, 2003). One exception is a study by Magnus

Bergquist and Jan Ljungberg (2001) who view the F/OS movement as an attention economy, with members leveraging their reputations in order to attract participants to their projects,

Increasing attention is being given in research to how coordination and consensus are achieved through the technical design of the F/OS platform. For example, Baldwin and Clark (2004) suggest that the *modular architecture of open source mitigates free-riding, reduces the costs of communication, provides rewards, and encourages repeated interactions*. Research also indicates that modularity and *frequent, incremental releases are essential factors in the integration process of new contributors, as they facilitate the learning process* (Berdou, 2004). Although Steven Weber (2000) agrees with Baldwin and Clark that it is the architecture of the technical system that drives the organization, Joseph Reagle (2004) argues that bug tracking tools embody the values of how a community should come to agree or disagree. Maha Shaikh and Tony Cornford have examined how the debate over version tracking tools reflects governance and decision making in the community of the Linux Kernel project as well as *how these tools create a learning environment* (Shaikh and Cornford, 2003; Shaikh and Cornford, 2004). Studies of this kind, many of which have been informed by a social construction of technology research agenda,⁷ suggest that the socio-technical interdependencies of F/OS deserve more attention.

Research on the social and technical dynamics of F/OS development include studies that use data from CVS (Concurrent Version Systems) code repositories. CVS are software tools that allow developers to keep track of their changes in the code and are usually organised around the project's modules. Their structure is akin to a tree and it provides programmers with the unique advantage of retrieving, when necessary, older versions of the programs they are working on. CVS is also used by non-programming groups of projects. For instance, translators and documenters also use them as a means of coordinating their work.

Studies that have adopted this methodology include Ghosh and David's work on the nature and composition of the Linux kernel (Ghosh and David, 2003), Koch and Schneider's examination of cooperation and coordination in Gnome (Koch and Schneider, 2002) and Fernandez et al.'s application of Social Network Analysis to the information in the Apache, KDE and Gnome code repositories (Fernandez, Robles and Gonzalez-Borahona, 2004). Although they have considerable methodological weaknesses these studies offer interesting insights that challenge established ideas about open source development. For example, in contrast to the well-established idea that open source development is a strongly collective endeavour, Ghosh and David's (2003) study *indicates that development actually takes place in small groups*. The idea that developers usually work in small groups is also supported by Milchmayr and Hill's study on "Quality and Reliance of Individuals in Open Source Projects" (2003). Whereas they embrace Raymond's view that "given enough eyeballs all bugs are shallow" *they do not*

⁷ See (Bijker, Hughes and Trevor, 1987) Also (Bijker and Law, c1992)

argue that the actual development of software benefits from parallelization in exactly the same way as debugging does.

These findings are consistent with Koch and Schneider's (2002) study on effort and cooperation in the Gnome project which demonstrated that *individual developers work more or less in relative isolation on different modules, and shows that there is a relatively small group of inner developers who are responsible for most of the output*. Finally, the collective character of F/OS is contested in another way. After examining 100 open source projects on SourceForge, Sandeep Krishnamurti (2002) concluded that many F/OS programs are not produced by a community but by a handful of developers.

The findings of these studies complement larger scale studies of F/OS development communities helping us to form a clearer understanding of the make-up of contributors (David, Waterman and Arora, 2003; Ghosh, Glott, Krieger and Robles, 2002; Lakhami and Wolf, 2002). The OSDN Hacker survey, based on 684 responses obtained through a web survey on SourceForge, one of the most active foundries of F/OS projects, *indicates that projects are driven by the contributions of seasoned IT professionals, who have on average over 10 years of programming experience and that the most important contribution of the project leader is creating the initial code base for the project*. The initial code base seems to be a significant attractor of contributions and one of the main preconditions for projects to take off (Lakhami and Wolf, 2002). Another large survey, the Free/Libre and Open Source Software Survey and Study, funded by the European Commission *confirms the importance of the mix of IT professionals and amateurs, mostly students, but indicates that project leadership and performance are primarily issues for professionals* (Ghosh, Glott, Krieger and Robles, 2002).

In addition to the insights regarding the structure and make-up of F/OS development communities, there are several studies that point to the structural and institutional factors of F/OS community membership and participation. Similar to studies that challenge the collective basis of open source, some of these studies challenge the idea that the social organization of F/OS projects is founded exclusively on meritocratic principles. New understandings are being developed about the more formal structures that communities develop in order to interact with the commercial world.

O'Mahony and Ferraros' (2004) study of membership in the Debian community indicates that changes in the social structure of the project affected the evolution of membership mechanisms and the determination of gatekeepers. The factor that catalysed this development was the institutionalisation of membership, the constitution of specific criteria that defined whether someone could be considered a member of the community by being given a CVS and email account. This was deemed necessary in order to control the increasing flow of new developers and to assure the quality of contributions. The new membership process required identity verification through face-to-face exchange (key-signing), sponsorship by an existing member, demonstrated understanding of the community's philosophy and procedures, demonstrated technical capability and a written

recommendation by an application manager. After having studied the participants' key signing networks it was concluded *that two of these factors, meeting people face-to-face (required for key signing) and acquiring a central position in the network through attachment to a core developer (sponsorship), enhanced the possibility of attaining a gatekeeper position more than the number of packages maintained and therefore introduced a significant bias in the validation of membership.* At the same time O'Mahony's(2002) research on "The Emergence of a New Commercial Actor: Community Managed Software Projects" *showed how communities develop governance mechanisms in the form of specially designed organizational bodies to mediate between the communities and the companies and to handle issues such as licenses and donations.*

The issue of F/OS contributor motivations raises many additional questions about which it is beyond the scope of this section to provide a detailed account. However, it is important to outline some of the more recent insights in this area. Researchers have moved on from arguments suggesting that developers participate for fun, for "scratching an itch", or for learning and to pay greater attention to the economic significance of the contributors' reputational assets and the way that they are managed. These studies draw primarily from labour economics and organizational studies and they point to the signaling of competence and expertise as one of the primary motives for participation in open source development.

In one of the most frequently cited early articles on F/OS, Lerner and Tirole (2002) suggested that the reputational benefits that accrue to successful contributors of open source often translate into higher and better paid positions within companies involved in OS development and improved access to venture capital. They illustrate this by pointing to the case of high ranking Apache developers. Lerner and Tirole's arguments are substantiated by studies like the FLOSS-US/The Free/Libre/Open Source Software Survey which points to the different ways that volunteers benefit financially from their participation in free/open source projects (David, Waterman and Arora, 2003). Some of them create their own spin-off companies, provide consultancy services or are hired by other companies with an interest in the development of the project.

In a more recent article Lerner and Tirole (2005) suggest that with regard to the effect it has on salary, a higher ranking position in the Apache organization is more important than the sheer volume of contributions to the Apache project. They also indicate that long-term incentives for contributions are strongest under three conditions: a) the more visible the performance to the relevant audience "strategic complementarities"; b) the higher the impact of effort on performance; and c) the more informative the performance about talent. Dalle et al. (1997) point to the 'economy of regard' as a system of reciprocated exchanges that is situated between the market and the gift economy. This provides us with a framework for understanding recurring voluntary transactions. In this 'economy of regard', an appreciation of the relative importance of contributing to different projects and to different modules within these projects is said to significantly shape the behaviour of F/OS contributors.

Unpublished research by Berdou examines the impact that the involvement of employed developers has on the dynamics of F/OS development. Research on the commercialization of mature F/OS communities indicates that companies frequently employ developers who are on a 'critical path' of development, contributing to crucial aspects and modules of the project. In several cases it appears that the role of these hired developers becomes even more important as they can work full-time on the project.

It has often been argued, both by practitioners and by academics, that the motivations of developers contributing to open source projects are significantly different from the ones that underlie proprietary software development (Elliot and Scacchi, 2003; Lakhami and Worf, 2003; Raymond, 2001MC). This view has been interpreted as suggesting a contrast between two kinds of economic rationality; the gift economy and the exchange economy. Whereas the first is based on the principle of reciprocity, upholds the idea of software as a public good and is often associated with abundance, the second relies predominantly on monetary flows, market transactions and is organised around a scarcity of resources. This idea is being challenged on several fronts by researchers who draw attention to the interconnections between the two spheres of activity.

At the same time, thanks to more empirically-grounded studies, we are starting to develop a better understanding of the processes that facilitate cooperation and coordination within F/OS projects. Through these studies certain patterns emerge that render the F/OS process at once distinctive and mundane. On the one hand, it seems that F/OS projects are structured in ways that remind us of more traditional processes of software development (discussing processes and goals, editing, reviewing). On the other, F/OS projects are informed by their own dynamics that render the development process unique in terms of the involvement of users, parallelization of the debugging process, intensive modularization of tasks, and the organization of the community in a centre-periphery structure.

The following subsection draws out some of the implications of the characteristics and processes of F/OS community development for the DBE.

2.3 Designing for distinctiveness: strategies for involving free/open source communities in the DBE

In order to tap into the resources of the F/OS community the DBE faces two interrelated challenges: how does the project create its own community and how does it connect with existing ones? This section outlines the initial elements of a strategy for engaging with F/OS communities which takes into account their embeddedness in the exchange economy, on the one hand, and the distinctive characteristics of the open source development process, on the other. We concentrate on the strategy of creating an architecture of cooperation (O'Reilly, 2003⁸) based on the requirements of the F/OS process of development, while also considering some of the

⁸ Posting made at <http://www.oreillynet.com/pub/wlg/3017>, last accessed 07.05

institutional requirements of the DBE⁹. We draw from ongoing research into the commercialization of F/OS projects (Berdou, 2004) and some observations on the dynamics of sponsored F/OS projects as opposed to the community founded ones (West and O'Mahony, 2004).

The first point in this strategy concerns the way that the DBE will be able to communicate its aims and its vision to the F/OS communities of volunteers. In addition to the online presence of the project on websites such as Source Forge, it might be advisable for representatives of the DBE to present the project, especially with regard to its technical characteristics and the way it differs from existing initiatives, in major commercial and community F/OS events such as FOSDEM in Brussels, Linux Tag in Germany and Linux World Expo. As we have seen, face-to-face interactions are crucial in sustaining relationships and forging new partnerships (O'Mahony and Ferraro, 2004). Besides providing a good opportunity for networking, such events also provide valuable insights and feedback.

One of the main issues with regard to the open source process of development concerns the extent to which the community succeeds in facilitating the learning process and lowering barriers to participation. The modular architecture of F/OS projects is crucial in this respect. However, the facilitation of the learning process is even more important in the case of the DBE which, with its commercial orientation, is likely reduce its appeal to some members of the F/OS communities. There are two major ways in which learning is facilitated within the context of communities.

The first is related to the incremental character of releases, which gives developers time to familiarise themselves with new features and other additions to the code base. The DBE project had no definitive release plan from the beginning and initial discussions suggested releasing the code base in one go. Although this might be seen as an advantage since the communities of volunteers would have a large and solid base for their work, it may create difficulties since it will require considerable effort to become familiar with the code base. Good quality documentation can remedy this to some extent. The decision to release the DBE code base in one go was largely dictated by internal project dynamics, the processes of negotiating the technical characteristics of the platform and the time consuming process of building consensus among the various teams. In practice the principal components are being released as they are completed. So far three major components of the project have been released on SourceForge¹⁰: FADA (June 2005) <http://sourceforge.net/projects/fada/> and Swallow (August 2005) <http://sourceforge.net/projects/swallow/> and DBE Studio (October 2005) <http://sourceforge.net/projects/dbestudio>.

⁹ We have chosen to omit from this discussion questions regarding the legal framework of the DBE mainly because the issue seems to have been settled in favour of GPL. It is sufficient to note that licensing is extremely important for the communities. Lerner and Tirole (2005) suggest that permissive licenses, such as the BSD, where the user retains the right to use the code as s/he sees fit, will be more common in cases where the project has a strong community appeal, projects that have great value for developers, whereas restrictive licenses such as the GPL will be more common when such appeals are more fragile.

¹⁰ SourceForge is a repository of free/open source projects <http://sourceforge.net/>

It is also the case that releasing early and frequently can sometimes clash with the framework and objectives of projects such as the DBE that aim to establish new computing paradigms. Releasing early in the life of the project could relinquish control over the evolution of fundamental aspects of the technical platform. But it is important to take into account the implications of accountability and quality that can be influenced by F/OS developers and volunteer communities from the early stages of a project.

Secondly, F/OS code maintainers can create opportunities for new contributors to get involved in a project by maintaining an active list of tasks and providing support and guidance through the projects' mailing lists and IRC channels. One of the greatest difficulties for new open source developers is knowing where to start and how to get involved (Berdou, 2004). Defining tasks and maintaining open lines of communication with senior developers (in the case of the DBE the programmers involved in the development of the project) are key elements of a strategy to cultivate a high level of involvement and motivation among F/OS communities. This would require a commitment on the part of the main DBE developers over a time-frame beyond the funded life-time of the DBE project. Community building is a long-term process that requires financial, and more importantly, human resources.

3. THE BUSINESS PERSPECTIVE: THE BUSINESS COMMUNITY AND BUSINESS CASE FOR F/OS

This section focuses on F/OS as a business strategy. It examines some of the complications of building viable business models that take advantage of the innovative potential of F/OS communities and taps into the volunteer resources of these communities. The first subsection provides an overview of the literature on the models that companies have developed to appropriate returns from F/OS and considers some issues involved in the symbiosis between companies and communities. We argue that questions about the business appropriation of F/OS cannot be viewed separately from questions regarding the economic viability of software business models in general. The trend appears to be towards business models that try to combine the best of the proprietary and the F/OS worlds.

The second subsection considers the issue of business strategy from the perspective of SMEs in the light of the findings of a study that examined the practices and assumptions of early SME drivers in relation to the DBE and its open source foundations. Their concerns echo those observed in other studies and also indicate a gap between the rhetoric about the business potential of F/OS and the barriers to formulating and implementing strategies that leverage it. The third subsection considers how the DBE project can be connected with the F/OS

community by taking advantage of the relations of companies that are involved in F/OS development with the F/OS communities.

3.1 Companies and the gift economy: business models and the appropriation of public goods

This subsection reviews contributions to the literature on the way open source is leveraged within the business world and maps some of the main strategies and business models associated with its adoption and use. It draws attention to: a) the reasons why companies release some of their code/products under an OS license; b) how they attempt to appropriate returns from programs and applications developed by F/OS communities; and c) the strategies they employ to handle issues such as the conflict between the requirements of viral OS licenses, such as the GPL, to protect their intellectual property.

Compared to the literature examining processes internal to F/OS communities and the production of code, the literature on the business potential of F/OS is less extensive. There are several reasons for this. The first is that with the exception of a few dedicated F/OS distributors and companies like RedHat, Novell and Suse and the much publicised examples of big corporations releasing some of their products under F/OS licenses, F/OS appears to be less readily available for commercial exploitation than the rhetoric would suggest. The second is that it is frequently hard to identify what a F/OS business is; what its boundaries are and how it derives its revenue streams. Should the definition encompass, for example, the significant number of F/OS developers who provide their services on a freelance basis? We have little evidence on the extent to which F/OS is being adopted by various segments of the software producing and using industries or on the practices of companies appropriating F/OS in terms of revealing the code and in relation to their connections with F/OS communities.

We concentrate here on two interrelated frames of action. The first is the leverage of F/OS by large corporations who use it as part of their strategy to retain a prominent position in the market. The second is the adoption of F/OS software by SMEs that aim to take advantage of community managed or sponsored code repositories and open standards in order to create their own proprietary add-ons and niche services. The first frame is illustrated by the strategies of companies like Sun and IBM that have combined F/OS and proprietary platforms in a bid to gain competitive advantage, especially over Microsoft.

West (2003) who studied the evolution of the platform strategies of IBM, Sun and Apple indicates that when these companies have tried to leverage open standards they have done so in one of two ways: a) the first, *opening parts*, consists of waiving control of the commodity layers of the platform “while retaining full control of other layers that presumably offer greater opportunities for differentiation” (2003:1279); b) the second, *partly open*, tactic consists of “disclosing technology under such restrictions that it provides value to customers, while at the same time making it difficult for it to be directly employed by competitors.” (ibid) The Darwin based Mac

OS X (Apple), Solaris, Java and StarOffice (Sun), the adoption of Linux as a server operating system and Eclipse (IBM) are examples of these strategies. These approaches aimed to establish de facto standards by creating a virtuous circle of direct and indirect network effects, including a larger user base, improved interoperability with other, potentially proprietary, products of the vendor and the further development and maintenance of open sourced parts by a dedicated community of users and developers. Eclipse, which is also used by DBE developers, illustrates this strategy. Eclipse is an open source Integrated Development Environment and platform for developing rich client applications that was developed by IBM and which is now managed by a non-profit consortium of industry vendors. The open source architecture has allowed third-party developers to extend the functionality of the platform to support various programming languages and products, while IBM merged some of the features of the project into one of its commercial products. Furthermore, IBM has capitalized on its knowledge of F/OS by making it one of the main foci of its consulting business.

The conditions under which these approaches are seen as the optimal courses of action vary. As Lerner and Tirole (2005, 14) point out: "the temptation to go open source is particularly strong when the product is lagging behind the leader and making few profits, but the firm sees the possibility that if the released code becomes the centre of an open source project and is utilized more widely, the profitability of the complementary segment will increase". This explains the case of Netscape which open sourced a portion of its browser and created the Mozilla project as an answer to Internet Explorer's increasing dominance in the market. Furthermore, the choice to release F/OS under a F/OS license may be part of a tactic aimed at reaping first mover advantage and at acquiring superior sources and capabilities through early entry into a market. Lastly, as in the case of the adoption of Linux on servers by IBM, code may be released when it is not perceived as a primary source of competitive advantage as in the server market. Firms may benefit substantially from lower maintenance and development costs of drivers and other supporting software when they are taken up by the F/OS community.

An examination of the strategies of large firms can provide the DBE project with some useful insights into possible revenue streams and governance frameworks. However, they are not representative of the strategies of the SME players that attempt to appropriate returns from the F/OS community with somewhat more modest aims, more limited resources and a shorter timeframe for the recovery of costs than the larger firms. Smaller firms usually try to take advantage of the momentum of an evolving open standard, reaping the benefits of the network effects created by its proliferation and the lower development and maintenance costs, a greater proportion of which can be borne by the volunteer community. Dahlander (2004) studied the F/OS strategies of five medium-sized firms in Sweden and Finland, finding that they adopted five approaches: licensing, blackboxing, consultancy, education and support.

Licensing refers to the dual licensing model. It consists of having a commercially oriented license for additional features and add-ons developed for a F/OS program licensed under a viral and, hence, restrictive in terms of commercial exploitation, OSS license such as the GPL. The dual licensing scheme is believed to be particularly

attractive because: a) it allows a company to protect its intellectual property and does not oblige licensees to publish subsequent amendments they make to the code; and b) it helps sustain lines of communication and avenues of cooperation with the external development community and benefits from their work. Blackboxing refers to combining several pieces of F/OS software in a hardware solution, following the same logic as that pursued by the bigger players. Consultancy, education and support are all parts of business models that are geared to service provision. In Dahlander's study:

- all five firms pursued a variety of approaches which changed over time. The firms experimented with different schemes of licensing and service provision, tried different mixes of F/OS and proprietary software solutions, and adjusted their business plans according to the changing dynamics of the market and their efforts to differentiate themselves from their competitors.
- Three of the five firms opted to close source and retain the copyright on the software.
- The two remaining firms released the code and created development communities around the projects, but only one released the entire code base under the GPL. The other retained the copyright to its product.
- Four of the five firms chose to retain the traditional form of copyright on most of their products, thereby retaining control over the software.

Free/Open Source software as a foundation of, or as part of, a business strategy does not necessarily involve building or cultivating a sustainable relationship with F/OS communities. In many cases it does not imply revealing the code. Joachim Henkel (2004) has shown that this can be avoided even when companies license their software under the most viral of all F/OS software licenses, the GPL, which makes it obligatory for all derived works to be made publicly available. His study examined patterns of revealing code for a sample of companies dealing with embedded Linux¹¹ and documented the following ways that companies circumvent the requirements of the GPL:

- a. Since the GPL stipulates that the source code needs only to be made available to the users of the software, companies supply the code only to their customers. If they are not interested in revealing the code, the source remains effectively hidden.
- b. If the device including the GPL'd code is distributed in the mass market, the companies can delay the diffusion of the code by providing the code on demand only and without active support.
- c. Companies use the time between the development and market launch to delay revealing the code.
- d. 53% of the 268 companies admitted that they usually make the code available in binary mode and not as source code.

These tactics are used in order to enable companies to maximize profits from their investment, by prolonging the period during which the software can be sold, denying its use by their competitors, and retaining some degree of control over the evolution of the software.

¹¹ The term "embedded Linux" refers to versions of Linux that are used in devices such as mobile phones, VCRs and machine controls.

One of the primary motives for companies to reveal their code is marketing (Henkel, 2004). Many representatives of firms associate revealing good code with the potential to improve to their visibility and their technical reputation within the firm and in the F/OS software community. One of the main reasons that early SME drivers are interested in joining the DBE is the perceived benefits in terms of networking and visibility.

F/OS is used both to appropriate returns from the F/OS community and to increase the market share of proprietary products and services and/or block competitors. Some of the most prominent business models are based on combinations of F/OS and proprietary code. The difficulty in assessing the business potential of F/OS is that it is frequently coupled with the quest for effective business models for software in general. Another difficulty is related to questions of appropriability and adoption and the need to maximize profits and take advantage of the network externalities created by an extended user/client base. This applies when the software is regarded as a primary source of competitive advantage and when it is not. The picture is one of heterogeneity and hybridity. The need to achieve systems interoperability has led to hybrid strategies in many cases historically (West, 2003). In the case of the DBE platform the dynamics of this mix are particularly important for its sustainability, since it appears that a successful combination of both strategies can be beneficial both to companies and communities.

3.2 Strategies and practices of early SME drivers in the DBE: contextualizing open source within the horizon of perceived benefits from the ecosystem

The findings presented in this section are drawn from a study conducted for the DBE titled: “In the Cocoon: Translating Complexity Across Communities and Networks of Practice in a Collaborative Open Source Project”. The research focused on the implicit decision processes that underlie the actions of three different groups of stakeholders within the DBE as they sought to realize the project’s objectives in its early phase: early SME drivers (Software Developers), Regional Catalysts and BML designers. The 10 interviews conducted with SME representatives examined how SME software producers communicate their needs and requirements within the context of the expected benefits of the DBE project. One of main aims was to assess the value that early SMEs place on the project’s priorities such as the importance of F/OS for knowledge sharing and building of networks of practice. The results are consistent with the observations in the previous section about the attitudes of company representatives regarding their intellectual property and its protection and with the concerns of key industrial stakeholders documented elsewhere (Ägerfalk, Deverell, Fitzgerald and Morgan, 2005).

We can think of SMEs as belonging to overlapping networks of practice. Although companies are comprised of different groups of employees and are therefore not homogeneous in their perceptions, our research has

focused on the perceptions and practices of software producers¹². One of the main findings is that SME representatives focus primarily on the networking opportunities afforded by the DBE, both in terms of potential partnerships with DBE partners and with the other SME drivers.

Given the relatively small amount of information about the technical characteristics of the DBE project that was available during the early stages of the project, it is not surprising the SME representatives appeared to focus more on “match-making” than on the productive/integrative capacity of the DBE. The relatively high risk associated with the development of a cutting-edge F/OS platform led the respondents to concentrate on the opportunities for collaboration and networking that the process of DBE development seemed to promise.

The DBE platform was primarily perceived as a ‘push’ or marketing mechanism for the respondents’ existing products and services. Most of the respondents viewed their engagement as a way of expanding beyond their niche and of pursuing opportunities in new business domains. An employee in a company specializing in event-management suggested, for example, that the DBE could sustain their efforts to break out of organizing technical conferences, something that they had been doing because of the company owner’s connections. A software developer was seeking to test and apply his systems development toolkit in domains other than in the specialised area of environmental management. In fact, marketing and networking seemed to be closely interdependent in SME practices. This observation is consistent with the literature which suggests that the main reason for this close interdependence is the limited resources that SMEs have at their disposal (Gilmore, Carson and Grant, 2001).

There is, however, an alternative explanation that relates to the extent to which business relations are mixed up with social relations. The embeddedness of SME economic behaviour within institutions and social relations is evident in the way they perceive the relationship between technology and business. In most cases, the interview discussions concerning the technological capabilities of the DBE platform and its F/OS basis led to a consideration of its business potential. Technology was more frequently judged, not on the basis of its technical excellence, but in terms the difficulties and the challenges associated with the realization of its potential as business opportunities and partnerships. This is how one of the interviewees framed the issue:

“You have to have more than knowledge, because you have to know people and you have to know how the things should be done and who are you, who you are discussing to. This is not IT and the beginning maybe be somewhere in here <<points to the sketch he had made>>. It has to be, the business has to be translated into IT and when it is strictly IT, then you can develop some open source platforms and I don’t see...it is a good idea to have open source, but they are more or less modules, for example, Internet here

¹² In addition to their capacity as developers of software, SME practices are also largely shaped by their activities in their specific domains of development. However, for the purposes of this study we emphasize the more generic aspects of the practices of SMEs as they are expressed by their representatives.

it's the lowest level, because it is a network..."

(Interview, 02/06/04: 9)

Responding to the question of whether they would be willing to share and publish their business models, another interviewee suggested that business models are not important in themselves. It is the way that they are realized and implemented through the company's network of relations that provides the real value to the business (Interview 02/06/04). Given the value of their network of partners, however, it would be worthwhile to consider the extent to which companies would be willing to share this knowledge through the system. The BML designers have taken this into account by allowing SMEs to specify how transparent their networks and processes are to different kinds of actors.

The interviewees' attitudes towards open source were governed by similar considerations about the limitations and the opportunities that this underlying feature of the platform would set up for them. The emphasis placed on the regulatory framework of the DBE is characteristic here of their concerns in relation to the protection of their intellectual property. The fact that most company representatives who participated in the study had very limited or no experience with F/OS software and its associated business models may be one reason for their conservative attitudes towards F/OS. This viewpoint is associated with their overall perception of the DBE as a system where the choices made about regulatory, scientific and technical issues shape a space for doing business for sharing and developing software that complements and extends their established practices and networks.

Some of these concerns are echoed in Ågerfalk's et al.'s (2005) study on the views of some key players in the European secondary software sector regarding the business potential of OS and OS development. The data were gathered during a workshop organized by the authors. Although the industry representatives acknowledged the opportunities afforded by F/OS, they also indicated the following weaknesses:

- Issues surrounding intellectual property rights and patents 'who do I sue and who's going to sue me' as one of the industry representatives put it.
- The lack of clear business models.
- Issues related to the standardization of OS.
- The lack of relevant social and technical skills in utilizing open source code and supporting F/OS projects.

How do these empirical insights add to our understanding about the attitudes of representatives of SMEs and larger firms with regard to open source development? On the one hand, they clearly indicate concerns about experimenting with business models in a context of software development they know little about. In contrast to the firms involved in F/OS development that have developed the necessary knowledge to take advantage of its potential and, in some cases, even to manipulate the legal, technical and social framework, more traditional

software companies view F/OS as a potentially lucrative but also risky business. In the Cocoon study it seems that one of the primary barriers to SMEs getting involved in F/OS development may be associated with the lack of opportunities for cooperating with firms' experience in F/OS development, both technically and socially. The embeddedness of SMEs in socio-economic networks of relationships is a source of support and business opportunity but it can also limit their horizon, i.e., the potential for forming partnerships that would allow them to extend beyond the context of their existing partnerships.

The following section makes some suggestions about how the DBE could create the conditions for a network horizon that would encompass both the proprietary and the F/OS worlds. It is argued that, although it is not necessary that all early DBE adopters have experience in F/OS development, it is important that some of them do. This is because companies with know-how in these processes can help to create links with open source communities whose involvement in the development of the DBE platform is vital for the its long-term sustainability.

3.3 SMEs and F/OS communities in the DBE: leveraging embeddedness and broadening network horizons

Section 2 on the community dynamics of F/OS development concluded by outlining the basic challenges for a strategy aiming at involving F/OS communities in the process of maintaining and further evolving the DBE platform after the conclusion of the project. One of the main difficulties is the limited time that the DBE project has to establish the relationships required to ensure the take-up of the platform by the F/OS community. However, if the DBE Foundation, the institution that could potentially act as the caretaker of the project, has the resources to pursue this strategy after the end of the project, it may be feasible to continue to build the necessary relationships.

In this section we propose a strategy based on leveraging the embeddedness of F/OS in the commercial world that takes advantage of the overlapping networks of contacts and partnerships between companies and volunteer communities. This strategy would prioritize the involvement of companies that have a proven track record in F/OS development and that have cultivated synergistic relations with the F/OS communities. This would ensure a mix in the ecosystem in terms of companies providing products and services that could ensure the inclusion of skills and networks of contacts that span the proprietary and the open source worlds.

A good example of such a strategy is provided by a tender for a Free software groupware server and client for the German Government. The bid was won by three companies with extensive experience in F/OS software - Erfrakon, Intevation and Klarälvdalens Datakonsult AB. Some of the people involved in these companies include Bernhard Reiter, a F/OS developer and leading member of Free Software Foundation Europe (Intevation) and Matthias Kalle Dalheimer, one of the founders of the KDE project (Klarälvdalens Datakonsult AB). The

groupware server is intended to extend the functionality of existing free software applications and, in particular, KDE components such as KMail and KOrganizer¹³. This is how the project was announced and elicited the participation of the KDE community on the KDE mailing lists:

"Preannouncement: Kroupware Project for KDE (KMail, KOrganizer) starting

This is a note to developers that a new project has been started to significantly enhance the available groupware functionality for KDE and Free software in general. The working name of the project is Kroupware. Because of the tight schedule of the project, we send this email to inform the developers as fast as possible. More details will be made available as soon as we can publish them.

Erfrakon, Intevation and Klarälvdalens Datakonsult AB have won a bid to write a Free software groupware server and client for the German "Bundesamt für Sicherheit in der Informationstechnik" (Federal Agency for IT Security, BSI). It aims to work in a heterogenous environment and provide email, contacts, appointments and tasks lists. Server components will be OpenLDAP, Cyrus IMAP, Postfix, and more. The KDE client side will be implemented by using and extending KMail, KOrganizer and other KDE components.

We plan to do the development in an open manner appropriate for Free software projects. We want to handle the project in a way that will leverage and add to the work of other developers and want to win your collaboration; you are cordially invited to participate in this endeavour. We have an open mailing list for technical discussions, please see <http://mail.kde.org/mailman/listinfo/kroupware>. Of course, we will also follow - and participate in - the discussions on kde-pim@kde.org and kmail@kde.org.

The project deadline forbids us to follow the normal KDE development schedule, and we are also concerned about introducing instability into KMail and KOrganizer at this point in the KDE 3.1 release cycle. We will therefore create our own branch called `kroupware_branch` in the modules `kdelibs`, `kdebase`, `kdenetwork` and `kdepim`. We aim to retrofit the changes on this branch as timely as possible back into the HEAD branch; this will happen in close collaboration with the maintainers of the affected projects, and following the KDE release cycle.

More information will be made available from the following website. kroupware.kde.org (Note: Website basically empty at the time of writing.) We will also post requirements documents, design specifications, etc. there.

10.9.2002

Bernhard Reiter Kalle Dalheimer

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Matthias Kalle Dalheimer

President&CEO/VD

Klarälvdalens Datakonsult AB

Platform-independent software solutions

(<http://mail.kde.org/pipermail/kroupware/2002-September/000003.html>)"

¹³ KDE is a free software graphical desktop environment for Linux and Unix workstations.

The successful outcome of the contract, KroupWare, became a free software server called Kolab that is commercially exploited by the Kolab Consortium, a group founded by companies that won the initial bid, which provides support, consultancy and development services for Kolab. The success of the project was largely the result of active F/OS community involvement in the process of development which, in turn, depended on the extensive network of relations and contacts of employees of the companies with the F/OS communities. Furthermore, KroupWare was set up from the beginning as a Free/Open Source project. It was based on transparent processes and used tools already familiar to F/OS developers. In addition, it was seen as an extension of existing projects and aimed to include any major improvements in the original code branches.

If the DBE is to develop similar links with F/OS communities, it will need to involve companies such as the three firms mentioned above. The creation of relationships with F/OS communities and SMEs is only one way of reaching out to them. It is possible that this could also be accomplished in the long-run through the networks of contacts of other stakeholders within the project such as Regional Catalysts, or through F/OS communities that have been established through the projects of some of the large corporations that are involved in the DBE project, like Sun and IBM. However, the take-up of the DBE by F/OS communities is more likely if the project creates links at many levels of interaction. This is important because the technical excellence of the DBE platform may not be sufficient to attract the interest of, or to leverage the participation of, F/OS communities. The involvement of companies with experience in open source processes, on the other hand, could help establish an important interface between the DBE platform and the F/OS communities through the networks of contacts between commercial actors and volunteer communities.

By taking advantage of already established networks of contacts between companies and F/OS communities, the DBE project should be able to create multiple entry points for the communities to become involved in various aspects of the development, both at the level of applications and at the level of the platform. The recruitment of companies with experience in Web Services that has been the priority so far is also crucial since it would help to populate the ecosystem with services and products that are necessary for its initial bootstrapping. In specifying the selection criteria for the recruitment of early drivers and adopters, however, DBE partners need to take into account both the long and the short-term requirements of the project. The engagement of F/OS communities will become increasingly difficult if the DBE is developed at the level of applications using proprietary standards.

4. THE POLICY PERSPECTIVE: REGULATION , PUBLIC INSTITUTIONS AND F/OS

This section highlights the main public policy issues with regard to F/OS software, provides some examples of policy interventions that aim to leverage the potential of F/OS and draws out the implications for the DBE. Debates on these issues reflect the divergent interests shaping the policy intervention framework for software. Although public institutions are recognizable stakeholders in the F/OS world, their role is less clear than it is with

respect to the business and volunteer communities. Debates about public support for F/OS are a reflection of more general concerns about the role of public policy in promoting economic development and in protecting the 'public interest'.

The issue of the appropriate public policies with respect to F/OS is related to the impact of F/OS developments on economic and social welfare and whether its further development will stifle or promote innovation. In most cases this issue is framed in economic terms and policy intervention in favour of F/OS development is often seen as having the potential to distort the software market (Tuomi, 2005)). This framing of the issue does not take account of broader public interest considerations. In the software area, public policy is not neutral since patent legislation and legislation with respect to reverse engineering already influence software markets.

After noting some of the main policy areas affecting F/OS development, the first subsection focuses on the arguments for and against policy intervention to promote F/OS. The second subsection gives some examples of initiatives associated with F/OS at different levels of intervention: from regional and national policies to initiatives funded by the European Commission and projects in specific organizations. The picture that emerges reflects the inconclusiveness of the debate on the role of public policy and F/OS source. Policy interventions are fragmented and the interfaces between public administrations and the F/OS world are relatively underdeveloped. The last subsection draws out the implications for the DBE.

4.1 Free/Open Source and public policy: an overview of arguments and interventions affecting Free/Open Source Software

This section begins by outlining some of the main areas of policy that have an impact on the sustainability and scaling of F/OS. These include high-level issues that affect the legal basis of F/OS and its potential to scale such as legislation regarding software patents and reverse software engineering, and also policy interventions favouring F/OS software development through subsidies and public procurement.

The effect of patenting on F/OS software and on software innovation generally is the subject of intense debate. In contrast to copyright legislation that protects the form of expression of an idea (but not the idea itself), conferring certain exclusive rights on the author or creator, patent legislation allows the granting of an exclusive right of ownership to a 'person' for a fixed period of time in exchange for the public disclosure of certain details about a device, method, process or substance (known as an invention) which is new, inventive and useful. Patents can affect F/OS in two ways:

- a) As technologies become more complex and firms file for patents, some applications begin to infringe on other patents. This may occur especially when an application concerns abstract algorithms or high level concepts or processes that are difficult to reverse-engineer. However, even if the F/OS community side-stepped their concerns about ethical objections to acquiring patent licenses for software, it is unlikely

that the community would have the resources to develop a successful patenting strategy given its reliance mainly on volunteer labour.

- b) In contrast to their theoretical aim which is to stimulate innovation, patents are often leveraged to block competitors or to negotiate cross-licensing agreements between large players that have the resources to build up large patent portfolios. These patent portfolios or “patent thickets” constitute barriers to innovation not only for the F/OS community, but also for SME software developers (Bessen, 2003). To assist SMEs and the F/OS community, some large firms, like IBM, Nokia and Sun Microsystems, have opened parts of their patent portfolios to F/OS developers¹⁴. The Open Source Development Lab (OSDL) has announced the creation of a patent commons which is meant to provide a central location for OS-friendly software patents and patent pledges.

Whereas software patenting has become well-established in the US, the European Parliament approved in 2003 amendments on the patentability of computer-implemented inventions directive proposed by the European Commission. The amendments restate the position that in Europe software is not subject to patenting. The original proposal before the European Parliament was to expand the patent legislation to include it. In July 2005 the European Parliament rejected one more time the directive on software patentability.

Legislation on reverse engineering is another area that has an effect on software development and F/OS (Samuelson and Schotchmer, 2002). Reverse engineering is a long-standing practice among software developers and it signifies the process of abstracting information from a lower level of abstraction to a higher one, usually from the machine-readable, object form of the code to the human-readable source code (Cifuentes and Fitzgerald, 2000). The process, which is difficult and time-consuming, allows developers to learn how a program has been developed. Programmers undertake reverse engineering for a variety of reasons, for example, to fix faults, to detect patent or copyright infringements and to learn from what others have done. One of its prominent uses, however, is gleaning information that is necessary to make a compatible program or to replicate the functionality of a platform or application. The development of Linux itself can be regarded as an effort to reverse engineer the Unix system.

The question of the legality of two common forms of software reverse engineering, decompilation and disassembly, has followed a course parallel to the expansion of software patent law. It is interesting to note that, in the US context, reverse engineering rights do not exist in patent law as, in principle, the patent specification provides all the necessary information regarding the invention. Reverse engineering is provided for, however, in trade secret and copyright law in the US (Samuelson and Schotchmer, 2002). In Europe reverse engineering is provided for under the Council Directive 91/250 on the Legal Protection of Computer Programs, art. 6(1), 1991

¹⁴ It is interesting to note that although these companies, IBM and Sun Microsystems in particular, have supported the free/open source community they are also vehemently in favour of software patents and have strongly lobbied the European Parliament for legislation that extends patents to software in Europe (see for example, <http://swpat.ffii.org/> accessed 11.05).

O.J. (L 122) 42, 45 [European Software Directive]. One of the greatest threats that reverse engineering poses is that it can undermine platform developers' non-interoperability strategies. This applies to software and hardware, and consists of keeping interfaces closed as a defensive measure against the platform becoming commoditized. This may also be adopted as an offensive strategy to capture a larger market share or to monopolize a market. As Samuelson and Scotchmer (2002:1620) indicate: "From the standpoint of the unlicensed application developer, reverse engineering offers the means of achieving compatibility between its products and the large installed base of a successful system". One of the most famous legal cases in this area is *Sega Enterprises Ltd. v. Accolade, Inc* (2002). Accolade, a small US computer company, reverse engineered the Sega gaming platform in order to develop games that would run on it. Accolade chose to reverse engineer instead of buying the license for the Sega gaming interface because Sega insisted on exclusivity which would have prohibited Accolade from developing games for other platforms. The US court ruled in favour of Accolade recognizing that if it ruled that disassembling computer programs was unlawful it would imply that Sega had a de facto monopoly over the ideas and functional concepts in the program, something that could be done only under patent law.

A restrictive framework for reverse engineering can have a profound effect on the F/OS and the wider software community. It would affect their ability to develop applications that are compatible with proprietary programs and platforms. This is of great importance not just for F/OS, but for open information and communication technology systems in general.

In addition to the high-level policy and legal issues affecting the sustainability and scalability of F/OS development, we draw attention to other policy interventions promoting F/OS. One of the most prominent is the endorsement of F/OS in public procurement policies, especially in support of public administration, such as document and data processing for formats that are valid for more than 50 years.

As in the case of patent and reverse engineering legislation, opposition to F/OS software promotion through public policy comes primarily from large software publishers' lobbying organizations such as CompTIA (Computer Technology Industry Association) and BSA (Business Software Alliance). Their position is that procurement policies favouring F/OS software discriminate against proprietary solutions and violate requirements for transparent, nondiscriminatory, and competitive procedures in public procurement (Simon Forge, 2004).

It has also been argued that government support for F/OS is likely to have an ambiguous effect on social and economic welfare. Johnson (2002), for example, argues that whereas F/OS development can tap into a large pool of developers, some potentially valuable F/OS projects may not be developed under a F/OS system. However, Johnson does not take into account the observation that this may be a good opportunity for policy intervention to enable public institutions to sponsor the development of a required software application. Public institutions have often supported the development of infrastructures, platforms and standards that commercial players either did not have the resources to support or did not perceive a benefit to do so. Market signals may

also be such that demand fails to give priority to the needs of a minority such as, for example, the case of translation of programs into languages that are spoken only by small populations.

Schmidt and Schnitzer (2002) argue that F/OS software may enable user access to most types of software, but may also have a negative impact on innovation due to the thinness of revenue streams. This might demotivate developers from engaging in cutting-edge research. This argument cannot be easily dismissed and requires closer attention. Comino and Manetti (2003) modelled different forms of public support (mandatory adoption by public agencies, information campaigns, subsidies for consumers who adopt F/OS) and concluded that only the information campaign had a clear positive effect on social welfare. However, this study and others using modelling techniques examine either/or public support options. They do not examine the more complex potential benefits arising from the co-development and co-existence of proprietary and F/OS solutions.

One of the main challenges for public policy, as reflected in the patenting and reverse engineering debates, is to design a framework that protects intellectual property rights for information-rich products against destructive cloning while allowing large established firms, new entrant large firms and the smaller players to compete on a reasonably level 'playing field' and to be innovative. The key question is how to provide adequate incentives for innovation, without raising unreasonable barriers to entry to the market. Another challenge for public policy is the issue of open standards from the perspective of users, not only as consumers but also as citizens. Users may benefit from interoperability, not only because it encourages the development of a larger variety of software at competitive prices, but because it can facilitate their access to a wide range of public and commercial services. Proprietary standards are often used to skew markets in favour of particular products and services, especially in situations where there are only a few dominant suppliers in the market.

In the next section we review some of the European initiatives, such as the IDABC (Interoperable Delivery of European eGovernment Services to public Administrations, Business and Citizens) project that leverages F/OS and open standards as the means to achieve interoperability among public administrations in the Member States. At the national level, many countries are starting to mandate F/OS software in their procurement policies. In their report "Open source Software: Importance of Europe", the consulting group SCF Associates provides an overview of the way F/OS is being endorsed in different countries (Simon Forge, 2004). Such endorsements range from recommendations to consider F/OS software as an alternative to proprietary solutions and providing evaluation criteria for comparisons (UK), to the founding of F/OS projects (the Netherlands) and F/OS implementations in local and central governments under pilot schemes (in the Netherlands, Germany, Italy and Canada).

4.2 A glimpse of F/OS public initiatives and interventions

This section highlights public F/OS initiatives at the national, European and regional levels and in specific organizations and considers the perceived disadvantages and weaknesses of F/OS. Although these initiatives reflect the fragmented character of policies, there are some trends. F/OS software is being appropriated as a means to complement and correct the deficiencies of proprietary software, especially in cases where access and interoperability are of great importance and where the aim is to stimulate economic development. As in the case of the commercial appropriation of F/OS software its leverage within the public domain is being achieved through different models. The main areas where F/OS is being deployed are in education, healthcare, eGovernment services and public administration. We begin by giving a brief overview of the characteristics and the strategies of some representative F/OS projects. This subsection concludes by examining the project outcomes and draws some critical points in connection with the deployment of F/OS at a national, regional, sectoral and European level.

a. Project description and strategies

F/OS as an instrument of National Industrial Policy

F/OS software is increasingly being treated as an instrument of economic development policy both at the regional and national levels. Countries like Brazil and South Africa have openly embraced F/OS as the preferred platform for public administration, education and e-government services, while regions like Extremadura in Spain¹⁵ are directly engaged in F/OS development. The reasons given for these initiatives are that F/OS:

- Provides an environment for skills development and has the potential of allowing economically disadvantaged countries and regions to become involved in cutting-edge innovation. This appears to be especially important for educational/research institutions and SMEs.
- Although F/OS software is not costless, especially when we consider costs associated with support, training and other issues, the costs of procuring and maintaining it seem to be considerably lower than the costs incurred to maintain proprietary software licenses.
- Provides a degree of control and security over platforms and data that is essential for the deployment of services, such as e-government and management of sensitive personal data records that are essential for public administrations, especially with regard to interoperability.
- It helps avoid proprietary lock-in to specific software solutions.
- It allows for a degree of localization that is especially important for regions and countries where the translation of programs and applications is deemed unprofitable by the larger commercial providers of proprietary software.

¹⁵ The region has initiated LinEx (Linux in Extremadura), a project that aims to create a fully functional IT infrastructure based on F/OS providing universal access to IT tools for all citizens.

F/OS as an instrument for Regional Development

One of the most well-known initiatives at a regional level is the case of Extremadura in Spain. The LinEx project was developed through a two-fold strategy:

- as part of an educational initiative that aimed to provide, through the implementation of an Educational Technological Network, one computer for every two students in all the schools in the region;
- to achieve wider social and economic goals through the Technological Literacy Plan which spreads the adoption of F/OS software in education, local administration, local business and SMEs, and to all citizens through access to the LinEx facilities.

The LinEx project connected with the wider F/OS community by adopting a widely used Linux distribution and was initially developed by a local company which was hired by the local government to develop the localized version of the distribution. The project led eventually to a local community of developers. Although Extremadura's approach appears to be highly successful, little is known about the challenges that the initiative faced, how these were addressed and the degree of penetration of F/OS within the region. The absence of empirical studies of the deployment of F/OS in the public domain makes it hard to elicit lessons for designing improved policy interventions.

Another example with a strong business focus is the Open Source Region Stuttgart Initiative (<http://opensource.region-stuttgart.de/english.php>). The region has a thriving F/OS community. Stuttgart is the birthplace of the KDE project and many students are involved in F/OS development. The project provides support and coordination among the different communities with an emphasis on the business aspects of F/OS software. The region appears to provide a good example of the virtuous circle of support, development and cooperation between volunteers, businesses and government. This virtual circle is important for the success and sustainability of F/OS, including the DBE project. It also illustrates a different model of intervention than that of the Extremadura region since it is based on different needs and conditions. Whereas the region of Extremadura emphasized migration, education and the building of ICT capabilities, the Open Source Region Stuttgart Initiative aims to extend and coordinate a well-developed F/OS ecosystem.

F/OS at the level of sectoral interventions

Another well-publicised study of F/OS adoption is the case of the Beaumont hospital, the largest public hospital in Dublin. The hospital's move to F/OS was initially estimated to result in cost savings of €13 million. It involved the deployment of a wide range of F/OS applications including infrastructure systems to office productivity applications and specialized health care applications such as x-ray imaging. The hospital also created a number of applications that it offers on an open source basis to other healthcare agencies.

F/OS at the European Level

The European Community has a number of F/OS projects, many of which are related to eGovernment. One of these is the IDABC project. IDABC stands for Interoperable Delivery of European eGovernment Services to public Administrations, Businesses and Citizens. The project aims to “encourage and support the delivery of cross-border public sector services to citizens and enterprises in Europe, to improve efficiency and collaboration between European public administrations and to contribute to making Europe an attractive place to live, work and invest.” (<http://europa.eu.int/idabc/>). The project provides recommendations, conducts research and develops solutions, such as the eLink platform, middleware for secure transactions between administrations and their partners and eServices, an application that facilitates the implementation of multilingual tasks. Project Evaluation and Critical Points. Another project that would be of interest for the DBE is Calibre, a project of DG Information Society and Media that focuses on F/OS in businesses (<http://www.calibre.ie/>).

b. Project evaluation and critical points

As stated in the ‘Final Report on Open Source Software: Trials in government’ prepared by the UK Office for Government Commerce (2004) some of the main drawbacks for F/OS include:

- “Fear that support can be fragmented or difficult to obtain, particularly for niche products. [...]
- Misunderstanding of the licensing and IPR implications of using or purchasing OSS. [...]
- Difficulties in identifying appropriate OSS applications for particular business problems [...]
- Documentation can be idiosyncratic or nonexistent. [...]
- Lack of real world experience and support for migration from closed proprietary software installations to OSS. [...]
- OSS often lags behind proprietary software in support for new hardware.[...]” (ibid, p.7)

Although these drawbacks create significant problems in F/OS implementation within the public and the commercial sector, F/OS adoption has substantially increased over the last 5 years.

The LinEx project in Extremadura, for example, has created a localized version of GNU/Debian Linux distribution. The main applications distributed through LinEx include some basic desktop applications and office productivity and Internet tools, such as OpenOffice and Mozilla. At the same time, the project funds a development centre that has created some specialized applications, including accounting software, hospital and agricultural applications. The Stuttgart region on the other hand, has over 120 companies involved in F/OS, an Open Source Solution park and numerous active local Linux groups. Although as we have seen the two regions differ significantly with regard to their strategy of connecting with the F/OS community, they may be similar if we consider their long-term viability. To consider this, we would need empirical studies of whether the success of LinEx in Extremadura, for example, has spilled over to the business community. And whether the Open Source Stuttgart project has had any impact on the number of volunteer developers in the region.

As Fitzgerald and Kenny (2005) indicate in their study of the Beaumont deployment, the process was not unproblematic. There was considerable resistance from staff who feared that the use of the less popular F/OS applications would have a negative impact on their employability. In addition, the management was concerned that the operations staff who, during the process of migration had developed specialized skills and knowledge, might be lured away by other organizations. This situation has not been resolved. A July 2005 article in the *Irish Times* reveals an internal row between the hospital chief executive who supports a move back to a Microsoft system and the IT manager who believes that this decision is unjustified. The decision, according to the chief executive, was taken following representation from staff at all levels of the hospital who found that the F/OS software did not meet requirements and was giving rise to growing discontent. The case of the Beaumont hospital reveals the complexity of migration from proprietary to F/OS software especially in areas such as healthcare, that require specialized applications. It reveals interesting challenges that often go unnoticed such as user perceptions of their own employability.

As part of its ongoing projects, IDABC has elaborated a F/OS licence that is intended for use within the European public sector. The license is based on OSL (Open Source License) but takes into account the specificities of the European legislative framework and especially the European definition of intellectual property rights. For example EC 91/250 Directive on Copyright Law grants authors the right of communication to the public. In contrast to American law which distinguishes between the right to perform the work and display the work the public, but does not encompass the right to distribute copy of the work through the Internet, the European right of communication to the public grants authors the right to diffuse works through the air or networks (Dusollier, Laurent and Schmitz, 2004).

Notwithstanding the numerous projects initiated at different levels, there is the question of whether F/OS can meet its potential as a tool for social and economic change. This potential may be realised only if it is supported by a more cohesive policy framework that incorporates the lessons learned from the commercial and public implementations of F/OS as well as from the F/OS communities.

4.3 The fragmented space of public policy and implications for the DBE

Despite the numerous activities initiated at different levels of government, most public administrations are adopting a tentative approach towards F/OS and are promoting it as part of a strategy that promotes open standards. At the same time, despite the fact that F/OS has been adopted within public research institutions, other areas of the public sector have little experience in deploying F/OS solutions or in participating in the process of development. Although F/OS has increasing appeal in the context of education and in the provision of e-government services to citizens and businesses, the structures that would provide comprehensive support in

terms of technical, social and legal issues are underdeveloped. In many cases the success of deployment and migration projects seems to hinge on local networks of actors that create an ecosystem of development and support.

In spite of the potential importance of F/OS in the further evolution of the European information society, debate surrounding its support through public policy is framed mainly in economic terms. Emphasis is being given to how the F/OS movement could influence innovation and economic development and about the tensions existing between commercial copyright and community managed projects premised upon the idea of shared ownership. In the European Union, most initiatives promoting F/OS originate from the DG Information Society and Media whereas the most stringent opposition originates from DG Competition. The debate surrounding F/OS is indicative of wider issues of software governance that have been characterised by the same market liberalization forces that have underlied the development of the Internet.

The framing of F/OS software issues principally in economic terms has a strong impact on policy development and legislation in this area. As Ilkka Tuomi (2005: 450) indicates: "Policy intervention with a clear market impact has, therefore, often focused on the particular cases where theoretically accepted reasons allow policymakers to claim that markets have failed to operate as they should. As a consequence, much of the competition policy in free-market societies has centered on antitrust issues and monopolies". It is interesting that while the competition policy perspective favours proprietary software companies at present, it is a similar 'free-market' oriented argument that is used by F/OS proponents who are interested in public intervention to foster their projects, but only in public policy if it threatens to limit their own control over their domains of work.

What are the implications of the above for the DBE? The first implication concerns its deployment. The take-up of open standards and F/OS within the public sector provides a unique opportunity for the DBE to connect with public projects aiming to develop, for example, government-to-business (G2B) services. The term G2B refers here to two broad types of services associated with e-Government. The first relates to doing business with the government. This group of activities, that usually fall under the term e-procurement, involves selling products and services to the government and having the ability to learn about government procurement opportunities online. The second type of activities relates to the effort of integrating digital public sector services for businesses across the boundaries of public authorities such as reporting/taxation, obtaining licenses etc. In addition to its significance for gaining momentum, this strategy will provide opportunities for the system to incorporate a broader range of SME needs and activities and hence provide them with a more complete framework of integration and support.

The second implication concerns the role of the DBE in policy formulation. Although, as we have seen, there are already initiatives focusing on the study of F/OS in businesses from an industry and policy perspective (such as the Calibre project) the lessons learned during the project platform phase are invaluable in gaining a better

understanding of what the development and deployment of such a platform actually involves, about the possibilities of cooperation, the areas of contestation and the blindspots in a process involving a wide range of researchers and stakeholders. The participation of the DBE in the wider debate about the potential of F/OS at a policy level provides a unique opportunity to join forces with those who view it as an integral part of strategy to improve access to basic services for businesses and citizens.

5. CONCLUSIONS

In examining the sustainability of F/OS two different perspectives have been adopted in this report. The first is based on a functionalist perspective and considers the structural elements of the success of F/OS as a mode of production. The main question addressed within this framework is how these elements may come together in order to produce a sustainable and scalable system. This perspective is more in line with an engineering approach and provides a model view of F/OS whose constitutive elements the DBE should aim to transpose into a business environment. This view is premised on the working hypothesis that a social constructivist understanding of technology, with its emphasis on language, can provide a framework for understanding the relations between ICTs, creativity, and knowledge exchange as illustrated by the F/OS phenomenon.

The second perspective, which is extensively developed in this report, is concerned with a critical understanding of how F/OS is actually taking place. More specifically this report provides a framework for understanding the main socio-economic dynamics of F/OS from the perspective of the interrelated activities of three groups of stakeholders involved in the F/OS process of development, deployment and adoption: communities, businesses and public institutions. A nuanced account is provided regarding the points of convergence and departure between the practices and strategies of these three groups of actors as they move in and across their respective areas of activities.

More specifically the report indicates that:

- a. Volunteer communities display both mundane and unique characteristics of software development and social organization. Community managed F/OS projects are often structured in ways that remind us of traditional processes of software development in terms of use of technical tools, negotiating goals and priorities, editing and reviewing. However, they are also underlined by unique dynamics such as the intensive modularization of tasks, the parallelization of the debugging process and a highly developed sense of shared ownership and responsibility. At the same time, the social foundations of communities, such as their purely meritocratic basis, have been revised as a result of studies that develop more elaborate frameworks of membership and participation.

- b. The boundaries between the gift economy, the purview of communities, and the exchange economy, where proprietary development takes place, are more permeable than was originally assumed. The interconnections between the two value systems are intensified by the progressive commercialization of F/OS. Examples include companies contributing to community development and volunteer developers exchanging their reputational benefits for higher and better paid positions or improved access to venture capital.
- c. The business appropriation of F/OS broaches more general issues of software business models. More importantly, there seems to be a considerable gap between the rhetoric about the business potential of F/OS and the barriers to formulating and implementing strategies that leverage it. Copyright concerns and lack of know-how regarding social and technical aspects of F/OS development are considerable barriers to its adoption by SMEs. Some of the most prominent business models are based on combinations of F/OS and proprietary code. However, companies that appropriate F/OS often do so without contributing back to the communities and without revealing code. The virtuous cycle between business and F/OS code that is often envisaged within the discourse is therefore rarely realized in its idealized form, that of a synergistic relationship between companies and communities.
- d. The sustainability and scalability of F/OS are dependent on a wide range of policy issues that involve most prominently patents and reverse engineering legislation. At another level of policy intervention, public institutions have shown in recent years an increasing interest in F/OS and a commitment towards open standards, but lack in many cases the social, technical and legal know-how to participate fully in the F/OS process. F/OS is leveraged both as an instrument for industrial development and as an integral part of the provision of e-Government services for administration, businesses and citizens. However, the policy framework concerning public support of F/OS is considerably fragmented. This is largely due to how the issue is framed within the policy domain. On the one side, the debate concerning the welfare benefits of F/OS software is dominated by neoliberal arguments that consider public support as having the potential to distort the basis of competition in the software market. On the other, there are those who argue that the benefits of F/OS are not strictly economic, but are connected with the opportunities it offers for improved provision and access to products and services for businesses, administrations and citizens.

The sustainability and scalability of the DBE will largely depend on the take-up of its code base by volunteer communities. Based on the insights gained through examining current trends and practices within the community, the business, and the policy/public administration domains, a strategy for involving F/OS communities in the project is developed in this report. This strategy is founded on the distinctiveness of F/OS communities and their embeddedness in the exchange economy. In particular:

- a. The strategy, predicated on the distinctive characteristics of community development, argues that the DBE should aim to facilitate the learning process for volunteer developers, in order for them to become familiarized with the project's code base and to cultivate a sense of shared ownership. Since it has been impossible to involve communities from the early stages of the project, providing high quality documentation, maintaining active task lists and providing support on mailing lists and IRC channels can encourage the participation of volunteers.
- b. The strategy predicated on the embeddedness of F/OS in the commercial world takes advantage of the overlapping networks of contacts and partnerships between companies, public organizations and volunteer communities. Given the limited timeframe of the DBE project this strategy is likely to be the more viable of the two. The involvement of companies with ties in the F/OS world would additionally create multiple entry points for communities to become involved in various aspects of the DBE's development, both at the level of the applications and at the level of the platform.

The two main theoretical ideas that have guided the analysis of the socio-economic dynamics of F/OS, the idea of the embeddedness of knowledge and the argument regarding the embeddedness of economic relations in social relations, are of value in considering wider issues of communication and knowledge exchange between other groups of stakeholders within the DBE. The report, "In the Cocoon: Translating Complexity Across Communities and Networks of Practice in a Collaborative Open Source Project" was used to leverage these ideas to examine relationships between three groups of actors directly involved in the development of the project, BML designers, SME drivers and Regional Catalysts.

These two ideas also are relevant for understanding and for potentially providing solutions to two of the most challenging tasks of policy formulation and intervention, that of translating ideas and practices across different domains of activity and of transforming the insights gained at the level of specific communities of practice to viable policy recommendations at the level of institutions.

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