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Beyond Interoperability to Digital Ecosystems: Regional Innovation and Socio-Economic Development Led by SMEs

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Abstract

This paper shows the early results of new research on how the Digital Ecosystems can promote new modes of sustainable e-business practices, for small and medium-sized enterprises (SMEs), using an open architecture for content sharing and B2B interactions in the knowledge economy, and within a framework of open standards. The current e-Business practices and technologies do not always encourage openness but instead tend to promote established models of proprietary e-business development based on centralized network and service infrastructure. Governments can promote open developments by supporting opportunities for new entry through supporting and augmenting a market environment for the productive coexistence of large and small companies in the B2B e-commerce domain.

1. Introduction

This paper is being written in the middle of a visible transformation of the Web from a distributed and interconnected information repository to a platform for social networking and content sharing and technologies that are collectively referred to as 'Web 2.0'. The paper considers this phenomenon as a symptom of the direction in which e-Business practices and technologies are moving.

The paper argues how a decentralized and flexible socio-technical approach can support the formation and growth of global production and innovation networks. This is premised on a perspective that originated with the economic sociology field and with the embeddedness concept in economic decision-making (Granovetter, 1985), of which Web 2.0 could be seen as a recent manifestation. It is also premised on the need for more sophisticated technology that can support the distributed coordination of loosely coupled business-to-business (B2B) transactions in reconfigurable value networks, thereby preserving local autonomy and avoiding dependence on centralized transaction servers.

The digital ecosystems initiative is funded by the European Commission but we believe that its aspects are centrally important in development contexts: the local autonomy, because it is about social constructivist understandings of self-determination and the independence, because, by empowering individual players, no matter how small, to play in the B2B market at the same level of multinational corporations, it reaches in the electronic B2B space a similar flattening and democratizing effect to what the Web has already reached in the content sharing space.

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Section two briefly looks at the Web 2.0 phenomenon and argues how traditional conceptualizations of the exchange of tangible goods and services can be greatly enriched in the knowledge economy by loosening the topology of the business interconnections, by extending the notion of 'value', and by opening up the interoperability standards. Section three summarizes the economics of online B2B transactions, with attention to SMEs, to provide an assessment of the market context. This is followed by an in-depth discussion of the University of Surrey's distributed transaction model and the implications for the next generation of the underlying peer-to-peer (P2P) network architecture. Section four discusses the role of government in promoting an environment that supports innovation and growth in the new spaces of the knowledge economy and Section six concludes.

2. Knowledge, value, social ties and interoperability standards

Fig. 1 shows how developments in the semantics of information and in the semantics of social networks appear to be progressing at an ever-increasing pace, mediated by sophisticated technologies. Such trends can be altered by unexpected developments, but in this paper we assume a progression along the lines depicted here.

This figure is interesting because it suggests that there will be a move from Web 2.0 to Web 3.0 to Web 4.0. Assuming this linear path of development, this move will happen in the US, India, China, and Brazil and the like. The question is whether Europe wants to ride the wave(s) of innovation or follow in their wake. These waves of online innovation are influenced by a powerful connection between media technology and people, reminiscent of the success of text messaging in mobile phones. The Google advertising model was among the first examples to take advantage of this coupling and showed how free content sharing and social relations could be leveraged to drive sustainable business models in the traditional sense. But the figure also implies the emerging business models that are innovative in their reliance on the value generated by social relations *directly*. These are characterized as falling on the boundary between the Exchange Economy and the Gift Economy, such as Open Source, without which most of the Web servers now in operation would not be running.

Fig. 1 and the future of the Web are more concerned about what is referred to as 'content sharing'. This tends to involve the interactions between individual users and, the business-to-consumer (B2C) domain. As information and communication technology (ICT) literacy rises in different countries, sectors and among people, we are likely to see a convergence between content sharing and the exchange economy, further strengthening the tendency of the service economy to rely on knowledge-intensive services mediated by ICTs.

This trend is strengthened by Open Source and similar phenomena (Creative Commons,[2] sharing of unused capital (Benkler, 2004), Community Currencies,[3] and so on.), which predate Web 2.0 by at least 10 years but are based on a similar blending of the social and the economic dimensions. Such trends are in the end connected to debates on intellectual property right protection, digital rights management, and software patents that are part of conceptualizing new value systems as the basis of new business models and as enablers of innovation in the emerging environments of the knowledge economy. Let us see how current understandings of the market for digital services measure up to these emerging trends.

[2] http://creativecommons.org/
[3] www.openmoney.org

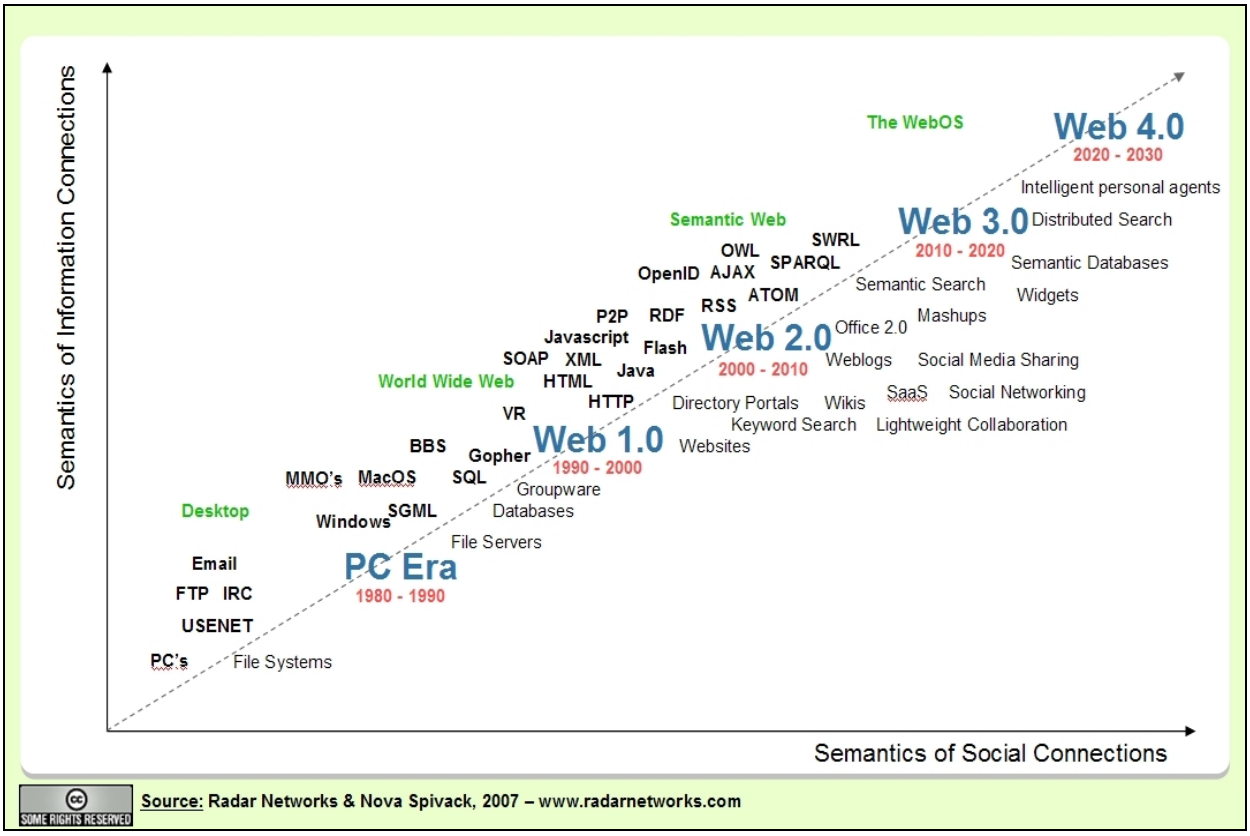

Fig. 1: Constructive interference between information semantics and social semantics

Fig. 2 shows a view of the digital market that is more concerned with the provision of services as a business model for the provider.[4] From this viewpoint economies of scale and technological efficiency call for a well-integrated and interoperable platform, for which there is not much difference between citizens as consumers (B2C) and companies as purchasers (B2B). The figure also includes Government as one of three typologies of 'end-user'. The difficulty in such a framework is that it does not leave room for interactions that do not participate in economic production processes in the traditional sense, i.e. based on revenue. This well understood model of economic exchange that was well suited to the material economy does not fit the knowledge economy so well. Notice also the fairly linear and synchronous character of the 'value chain' depicted.

The first step in a 'constructive deconstruction' of this more traditional model is to distribute the source of value from the consumer and the value chain to the whole 'value network' (Allee, 2000):

> It is no longer enough to think of a firm as a member of a closed system subject to uncontrollable outside shocks. It is part of a network that produces its own change. So, in analyzing the network all aspects of the network must be included: customers, suppliers, competitors, allies, regulators, complementors and any other network players whose presence in the network can influence value creation of the firm. (Peppard and Rylander, 2006)

The second step is to recognize the value of 'intangibles' in business transactions:

[4] From Ovum study for the UK DTI, 2005, www.ovum.com

> Interest in intangibles and corporate transparency has increased as business thinking evolves from bureaucratic and mechanistic models to more organic perspectives emerging from biology and living systems theory. … the basic pattern of organization for business is that of a network of tangible and intangibles exchanges. Tangible exchanges equate to flows of energy and matter [in living systems]. Intangible exchanges, such as knowledge, point to cognitive processes and intelligence. … [There] are serious attempts to develop new indexes, equations, measures, and analytical approaches for calculating knowledge assets and for understanding intangible value creation. All this adds up to a serious attack on traditional accounting and enterprise models that regard only revenue and physical assets as "valuable," and that regard people as liabilities rather than important resources and investments. (Allee, 2002)

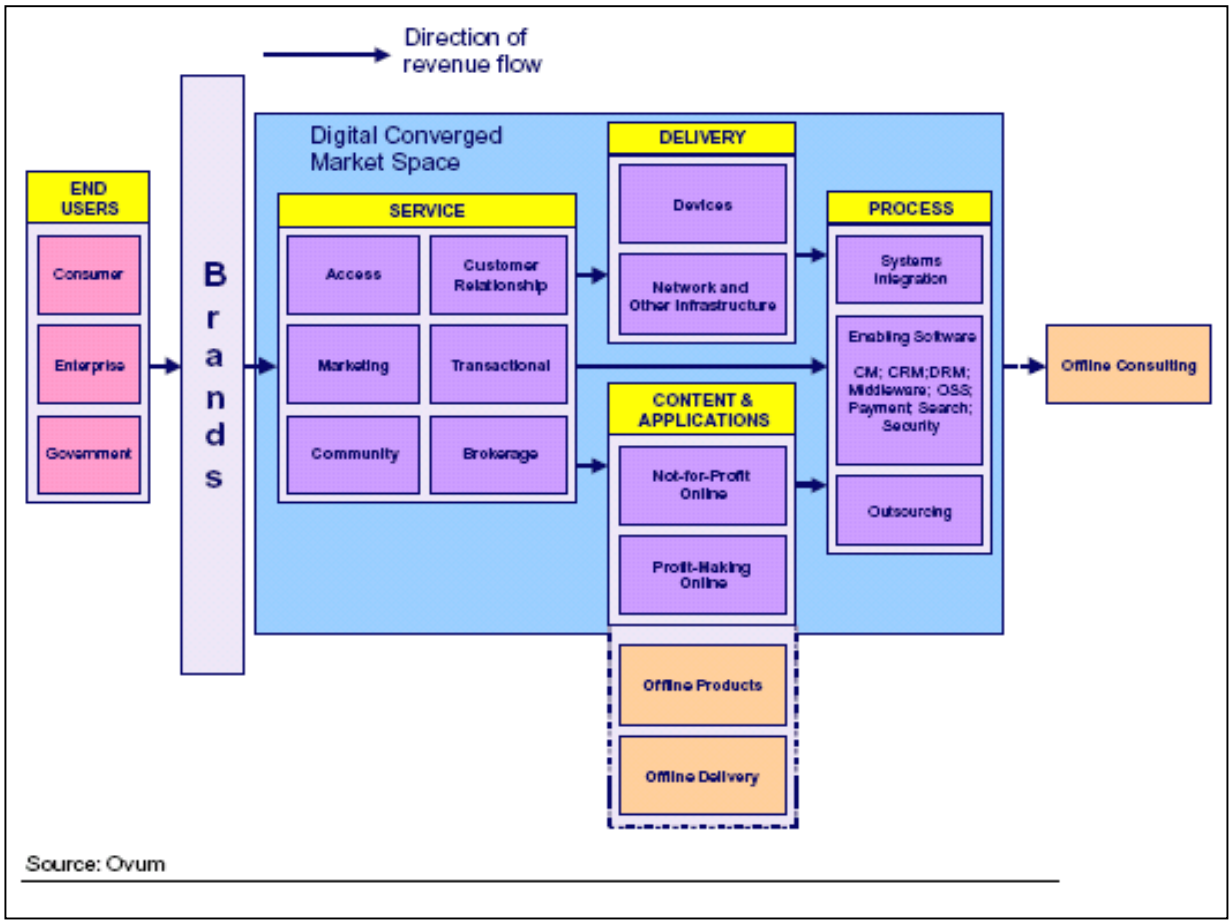

Fig. 2: Integrated B2C and B2B service provision framework

The third step is to come to terms with the fact that, as shown in the perhaps too much simplistic and linear depiction of Web evolution in Fig. 1, in the content sharing space of the Web it is difficult to set a price for the direct exchange of information because of the many different social interactions.

The most successful response so far was indirect revenue models, which predate Web 2.0, also known as "related revenue models" (Mansell and Steinmueller, 2000: 304). For example, the Google advertising model is successful precisely because it does not try to charge directly for the information being exchanged. The Google model creates a coupling with other services that are semantically about the information that is being viewed or shared for free. Revenue is generated from *micro*-payments between third parties that do not involve the end-user directly. Even giving due credit to this model, clearly the huge popularity of the new Web 2.0 phenomena such as Facebook, Flickr, and the like points to the need to generalize our thinking about value systems toward the social space.

Though the strength of social interactions that the architecture of the Web has enabled is contributing to transforming the content sharing landscape and to a healthy rate of innovation in the B2C space, the same cannot be said of the B2B space. Although if we measure innovation by market size this statement would appear erroneous, given the much greater volume of B2B relative to B2C, we mean innovation here in the sense of organizational and cultural change. Willingness and ability to change often lead to significant growth in volume in any sector. For example, Sassen (2006) argues that the ability of financial markets to embrace global electronic networks in the early 1990s led to their impressive growth since then, which she contrasts to the damping effect of the strict accountability constraints imposed on NGOs by funding bodies which prevent them from creating cross-country networks of shared knowledge and resources, and therefore also from benefiting from economies of scale. We see the barriers to organizational and cultural change in the B2B sector as arising mainly from three factors:

- *Convergence leads to lock-in*. The challenge to support business interactions in a distributed and heterogeneous environment of differing syntactical service interfaces, semantic service description languages, and messaging protocols is motivating the larger infrastructure and ICT providers, at all layers of the stack, to make as large a share of the market as possible 'interoperable'. Where the market must be shared between a few players, industry standards are developed to promote the kind of convergence shown in Fig. 2 (for example Bluetooth). When convergence is coupled too tightly to business models and market share it leads to lock-in, even though lock-in is not a characteristic that emerges only in competitive markets, and slows innovation.
- *Branding formalises lock-in in the public consciousness*. When premature lock-in occurs, which comes from the lag of what current ICT can support relative to the more dynamic demands of business interactions, this leads early entrants in the digital marketplace to protect market share by promoting proprietary standards and recognizable brands. Open standards can offer the consumer an alternative to these well-established brands, thereby creating new market entry opportunities for new players. Adopting open standards may be fostered by some form of government intervention (for example the involvement of United Nations Organisations in business modelling frameworks). In the content sharing space, the Semantic Web initiative is about these two points.
- *Intermediators constitute barriers to emergent and socially-driven business activity*. B2B interactions may be strongly influenced and motivated by social phenomena such as small-world networks, family ties, and geographical proximity. In some cases, the need to rely on third-party platforms can limit the formation, range, and complexity of new value chains, business collaborations, and business transactions. The ability to support a 'Web 2.0 for Business' could be beneficial to SMEs. In this segment of the market, government has the opportunity to foster opportunities for *many* open standards to emerge, which may provide a basis for socio-economic developments that are not aligned with the short-term business incentives of dominant market incumbents.

Though common standards can protect the ability of new entrants to compete with established brands, and government can help in this regard, the maximum possible theoretical interoperability level could be defined as making interoperability independent of standards altogether. Although this is an unrealistic goal in practical terms and undesirable from the view of socially constructed shared languages and technologies, it sets a useful limiting case for the more technical aspects of the interoperability debate. As discussed below, this was addressed first through the loose coupling of the Service Oriented Architecture (SOA) of ICT environments and more recently through Digital Business Ecosystems (DBE) research. DBE research has raised the awareness of the challenge that

also the Semantic Web programme has posed. But the goal of interoperability at all levels, business interactions, content, or anything else, remains worth pursuing. Our research challenges the means by which this goal may be gained by encouraging wider interdisciplinary debate that encompasses social constructivist perspectives on the role of language as a medium of power relationships, and functionalist arguments and models, which are inspired by how biology has solved this problem.

This paper, therefore, is concerned with the barriers and opportunities for innovation and economic growth faced by SMEs in the context of the potential available for 'constructive' and synchronous B2B interactions, besides those best characterized as 'defensive' moves by dominant players to promote asynchronous measures aimed at intellectual property protection. We leave this to a broader discussion of (open) knowledge and innovation networks (and of the extensive research literature in this area). In this paper we look at some of the implications for the B2B environment of open architectural and design choices for an ICT infrastructure that supports e-Business transactions specifically for SMEs. Though the paper starts to integrate a social science perspective with technical architecture considerations, it does not discuss or address the influence of biological solutions on the second.

The Digital Ecosystems initiative[5] offers an interesting view of new modes of economic organization that aim to leverage loose and dynamic business networks in the online B2B interaction space in a way that is similar to the Web 2.0 content sharing environment. This view places a premium on the contribution of SMEs to economic growth by their flexibility and ability to form loose and dynamic business partnerships in response to changing market conditions. Before discussing the implications for the technology of such flexible business behaviour we discuss some economic data on the online B2B space.

3. Basic Economics of Online B2B Transaction Environments

B2B online transactions or e-commerce have moved out of the early adoption phase and its long-term prospects are strong. In the EU-27, the percentage of enterprises' total turnover from e-commerce via Internet doubled between 2004 and 2007, passing from 2.1 percent (2004) to 4.2 percent (2007) of total turnover (Eurostat, 2007). On average, 15 percent of EU enterprises received online orders in 2007, up from 9 percent in 2003. Also, online sales by EU enterprises grew on average from 13 percent in 2003 to 27 percent in 2007 (UNCTAD, 2007). In the United States, total e-commerce sales for 2007 were estimated at USD 136.4 billion representing a rise of 19 percent from 2006 (U.S. Census Bureau, 2008). In 2005, B2B explained 92 percent of total e-commerce in the US (U.S. Census Bureau, 2007), while the volume of European B2B online trade raised to almost half of firms' purchases occurring online (European Commission, 2005).

Most B2B applications of e-commerce are in three areas relative to the different phases and related business processes. Transaction preparation applications (pre-sale/pre-purchase phase) include advertising, catalogues and stock lists, price comparisons, information services/information about offers, and negotiation between seller and buyer. Transaction completion applications (sale/purchase phase) include ordering, billing and payment, finance and delivery. And transaction support applications (after sale/purchase phase) include information capture, information management, market analysis, market development, guarantee management, credit administration and handling returns (EC, 2007; OECD, 2002).

[5] www.digital-ecosystems.org

But e-business is more than just e-commerce. Although higher efficiency of business processes, internally and between trading partners in the value chain, continues to be one of the most important promises of e-business because of its direct impact on cost cuts, it is argued that innovative firms see e-business as an opportunity to deliver against key business objectives such as the delivery of high quality goods and services, high quality management, and marketing for improving customer service (EC, 2007). E-business thus involves business processes in the entire value chain, or value network. Firm size matters when talking about e-business. The continuing challenge is to promote adapting e-business by SMEs. According to the E-business Watch Survey in 2006 (EC, 2007b), there are roughly 50 SMEs engaged in e-business for every 100 large enterprises. Nordic SMEs are the most engaged but other differences among countries like France, Germany, Italy, Spain and the UK are not clear because of the uncertainty in the data.

For B2B transactions among SMEs, on average only about 11% of SMEs use software solutions or internet-based services for e-procurement. Moreover, there is a massive gap between the percentage of SMEs placing at least some orders online (53% of total) and those that use special software for this (only 11% of total). SMEs without special software place orders mainly through websites or extranets of suppliers (EC, 2007b). The result is a lack of digital back-office integration of procurement-related processes among European SMEs. Despite this, the E-business Watch survey also showed that 84% of small companies consider that E-business is an important feature of their business operations as compared with 81% of large enterprises that report that this is an important feature.

Estimating the share of the economy that e-Business explains is difficult because the intensity, focus, and the impact of e-Business vary by business sector and by specific value chain in which an enterprise operates. Even so, according to the Eurostat Community Survey on ICT usage in enterprises (2007), in most European countries the volume of Internet and other e-commerce transactions[6] is rising as a share of total turnover. In 2006, Denmark, the UK, Ireland and France were reported to have the highest shares in Europe, with 17% of enterprise total turnover coming from e-commerce in Denmark and the UK; and 16% of the total in Ireland and France.

For enterprises to have an incentive to adopt e-Business and e-commerce strategies and tools, the benefits must be larger than the investment and maintenance costs of the tools. Public policy is directed to promoting e-business and e-commerce readiness and connectivity, but it also needs to promote more mature e-business strategies that integrate internal and external processes. Analysis has shown that technology neutrality is important in fostering these developments (OECD, 2004). Research has shown that cutting the barriers to e-business adoption by promoting interoperable systems, the extension of network infrastructure, and related support services, offers a means of raising incentives for adoption. For B2B transactions across European countries (cross-border), it is also clear that reliable trust systems and an adequate legal and regulatory framework are needed.

The characteristics of B2B transactions suggest the need for an open infrastructure, that is interoperable and allows enterprises to move freely in the market, thereby avoiding lock-in from 'principal-agent problems,'[7] which may arise from market failures like information asymmetries, uncertainty and high risk. Policies can encourage these developments, by creating incentives for new entrants in the market through fostering competition and investment in innovative technology infrastructures. The OECD Recommendations of the Council of Broadband Development in 2004

[6] Including proprietary electronic data interchange (EDI).

[7] The principal-agent problem in economics arises under conditions of incomplete and asymmetric information when a 'principal' hires an 'agent'. Various mechanisms may be used to try to align the interests of the agent with those of the principal, causing the agent to be 'locked in' to the principal.

suggested that public financing to expand coverage of infrastructure networks to under-served groups (i.e. SMEs), though with little negative effect on competitive market forces, is needed.

Although the above argument was hugely controversial at the time and was not supported by clear evidence, if adopting a perspective of 'global public goods' for the provision of ICTs and infrastructure networks as suggested during the United Nations' World Summit on the Information Society (Geneva, December 2003), negative externalities arising from public action can be internalised (Binger, 2003). As explained by Binger (2003), "if the cost associated with a negative externality is effectively attributed to the responsible agent the externality is regarded as internalised". This approach suggests that governments have to assume responsibility for the negative effects that their own actions might generate and correct them accordingly (Kaul et al., 1999).

The next section presents the latest technological advances developed as part of the digital ecosystems initiative specifically to support dynamic B2B transactions between SMEs interacting through global production networks.

4. Digital Business Ecosystems built on open-standards infrastructure and dynamic P2P architecture with local autonomy

The Digital Business Ecosystem (DBE) is unique because it offers a new approach to modelling business standards. Rather than assuming service offerings will converge to a common standard or promoting compliance with a centralized data model or architecture, the DBE supports an evolutionary approach that helps the dynamic service chains formation to match the business partnerships' flexibility, which can be formed through Web-enabled communication and Web 2.0 environments. The technical implications of such a vision are considerable, but they offer the potential for the Digital Ecosystems approach to deliver a disruptive innovation that could challenge the leading players in the market.

Current implementations of Service-Oriented Architectures (SOA) for addressing B2B requirements tend to underestimate the negative impact of the new unique proprietary functional models. In many cases efforts to ask competing businesses to use a unique data schema, or service model, proved unsuccessful, as competing standards cannot be enforced even when they were defined by a government or by a standards body. There are complex mechanisms that motivate ICT and business communities to adopt some standards that may become de-facto standards. 'Good' standards do not always emerge from competition and current implementations of SOA are unsatisfactory because they can be shown to violate important principles.

For example, the goal of Service-Oriented Computing (SOC) is to enable applications from different providers to be offered as services that can be used, composed and coordinated in a *loosely-coupled* way (Papazoglou, 2003). This is the predominant computing paradigm in a digital business ecosystem. In this paradigm each participant in the B2B space does not need to expose the details of its internal workflows and business models as this model requires only that it present a service interface. The architectural approach of SOC is called SOA (Papazoglou et al., 2006) and it is applicable when many distributed applications are running on various technologies and when different platforms need to communicate with each other. SOA offers the promise of keeping full local autonomy for participants (i.e. loosely coupled such that their local state is invisible).

But, current Web Service protocols violate the SOA principle. This violation was justified as

providing for safe recovery of aborted transactions (WS-BusinessActivity, 2004), but it is also the case that, until recently, the technology was unavailable to support a loosely coupled architecture. Digital Ecosystems research shows that loose coupling is now within reach (Razavi et al., 2007b,c), although further research is needed to consolidate work in this area and to develop proper standards that will have a strong chance of being adopted. We argue that this chance will be strengthened if the potential for spontaneous adoption is complemented by government intervention aimed at promoting this alternative market interaction mechanism.

Business transactions in a B2B context usually involve interactions between many partners, either service providers, or service consumers, or both. These interactions require partners to behave to some extent in a coordinated way—partners must follow an agreed protocol to execute transactions (Razavi et al., 2007a). A B2B transaction between SMEs in a digital ecosystem may involve simple usage of a web service or composition of several services from various service providers. A business transaction may be finished over a period of minutes, hours, or even days—thus the term long-lived or *long-running* transaction. Executing a long-running transaction corresponds to conducting a business and often comprises several *sub-transactions* that involve many underlying services.

Current implementations of transaction support in distributed e-Business environments rely on a centralized transaction server. This is mainly because the orchestration and composition of separate services that cooperate in the delivery of a complex workflow is difficult to reach, so a centralized solution was the only possibility until recently. In contrast, Digital Ecosystems research is developing the concept, formal model, architecture, and implementation for a *distributed* transaction management system. This system relies on Local Coordinators, one for each service, with a specification derived from a workflow model. The Local Coordinators act independently of one another to guarantee (local) consistency and recovery support across all the transactions in a complex workflow representing a business process.

A Digital Ecosystem is able to ensure local autonomy and loose coupling because it relies on a distributed rather than on a centralized transaction manager. It is important to realize that in the Digital Ecosystems distributed transaction model rollback recovery does *not* imply that the model is stateful.[8] Since there is no central server, the information about the previous state can *only* be stored on the servers of the participating SMEs, who own this information. The Local Coordinators can only flag a failed step in the transaction and roll back to the previous stage (not state), where the information about the previous state is requested *again* from the same participating SMEs. So, the Digital Ecosystems distributed transaction model is stateless and compatible with the SOA principles. A Digital Ecosystem integrates a distributed agent architecture with a distributed Web Service architecture, thereby reaching a true SOA. Figure 3 shows the complexity of a DBE, suggesting how the dynamic system services in the Digital Ecosystem mirrors the dynamic system of social networks and business partnerships.

A business network enables networked firms to engage in distributed business transactions and to realize their business goals. The Digital Ecosystem provides support for B2B interactions between SMEs in a fully distributed way (no central point of control for transaction or network operations), and offers a consistent model for performing transactions. The model must be highly resistant to *fragmentation*—a situation where the network gets divided into smaller isolated networks—as this may inhibit collaborative business interactions. It must also be designed to cut the risk of failure at

[8] In computer science, 'stateless' refers to a system or protocol that does not keep a persistent state between transactions. A stateless server is a server that treats each request as an independent transaction that is unrelated to any previous request. 'Stateful' is the opposite of stateless. http://en.wikipedia.org/wiki/Stateless_server

the transaction level. Transaction recovery must be supported by a procedure and must be helped by the underlying network that must support the choice of alternative paths/scenarios of transaction execution.

In the DBE, rather than having one service provider (like Google), there are thousands of them. In contrast to Google that has many regular servers around the world (which are not transaction servers), the DBE supports B2B transactions while respecting SOA principles and the local autonomy of businesses engaged in transactions. The aim of DBE research is to develop a distributed coordination framework for long-lived transactions using a P2P architecture.

In the DBE architecture, not only does the network propagate traffic smartly, but also each 'virtual server' or 'virtual super-peer' is formed by a *collection* of servers cooperating to provide the functionality of one server in a reliable and flexible way that is not feasible when a centralized server is used. Servers in the P2P network are elected to become members of a virtual super-peer cluster by their availability to share resources and by their recent history of reliability. By the same token, they can be downgraded to regular peers if their reliability or availability decreases. In either case, it is foundational in the architecture that *the peer remains unaware that a change in its status has occurred*; similarly, the members of a virtual super-peer cannot belong to the same organization. In this way the functional concerns for quality and reliability of service, which require a hierarchical network topology, were decoupled from any aggregation or centralization of power or control, which an architecture that is merely functionally optimized could (wittingly or unwittingly) support. It is also relevant to point out that a centralized solution cannot easily compete with a decentralized or distributed solution on a cost basis. A centralized solution cannot be regionally customized and cannot adapt to peak-time traffic congestion by using localized propagation models—because it is centralized.

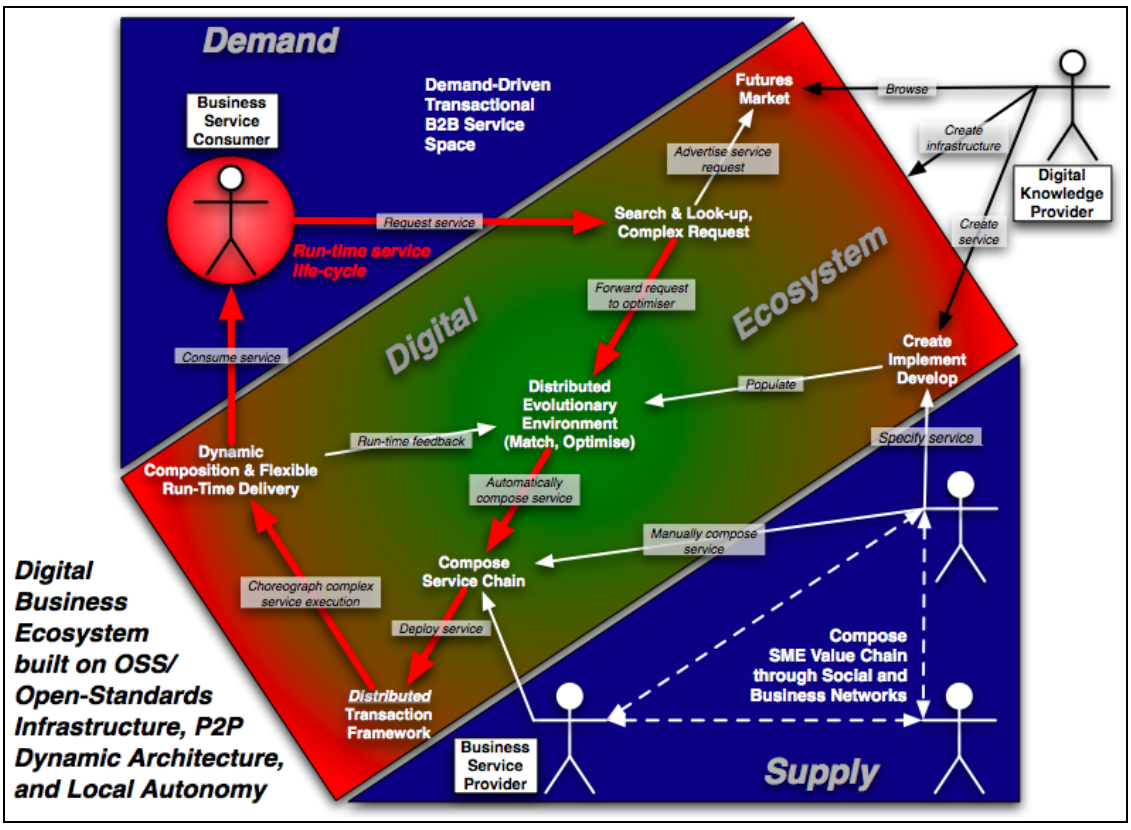

Fig. 3: Digital Business Ecosystem as a mediating SOA for e-Business

These discussions of network dynamics, topology, efficiency, and costs mirror the challenge of understanding the interaction between organizational forms, decentralized decision processes and information technology, and their effects on organizational performance, efficient operations, and decision-making in different business settings (Galbraith, 1977; Mintzberg, 1978; Burgelman, 1988; Huber, 1990). There are other considerations relevant to this discussion, such as decentralized organizational configurations (Galbraith: 1994, 1995), intense use of new communication technologies (Bettis and Hitt, 1995; Fulk and De Sanctis, 1995), and intensified competition across industries (D'Aveni, 1994; Thomas, 1996). The main point, however, is the greater ease with which smaller companies can react to changes in the economy, and the role ICTs can play in easing change. Andersen and Segars (2001) show that computer networks can provide decentralized decision makers with instantaneous access to relevant information, which will speed up the decision-making process, compared with formal approvals moving along several hierarchical layers authority, where information overload can inhibit timely decisions (Minzberg, 1992).

In this respect, SMEs do not suffer from centralized authority, and their flatter organizational structure offers flexibility for changing strategies in a short time, but the challenge is to enable them to interact through flexible and dynamic networks that can support business interactions. It is important to mention that any fragmentation of the ICT network can stop the organizational advantages of such dynamic, distributed, and loosely organized global production networks. These are precisely the concerns addressed by Digital Ecosystems research. So, the flexibility and resilience of Digital Ecosystems viewed as systems integrator of business, social and ICT networks would seem to enable the economy to benefit from the greater flexibility of SMEs without suffering from their greater vulnerability to market fluctuations and with lower transaction costs than experienced through 'state-of-the-art' centralized servers.

In short, in a Digital Business Ecosystem SMEs have the opportunity to:

- Maintain local autonomy
- Avoid dependence on a centralized server (provided by a large enterprise which is then likely to promote its own model or standard)
- Access a customized infrastructure that can cope with the dynamics of their local environment and adapt to changes quickly.
- Avoid network fragmentation and loss of partners because of hacker attacks, server failure, etc.
- Benefit from the diversity of their environment and avoid unexpected peaks in traffic (a risk for centralized super-peers). The dynamic and unpredictable character of the SME environment means that traffic propagation cannot easily be predicted and static super-peers cannot cope with unpredictable peaks in traffic loads without a wasteful investment in resources to ensure against unpredictable peaks and congestion.

As a continuation of the DBE work, the OPAALS project is investigating an integrated architecture for business interactions and content sharing that is consistent with the social science arguments and technical principles outlined above. Fig. 4 shows a high-level view of the open-standards architecture being developed and put into effect in the OPAALS project (www.opaals.org).

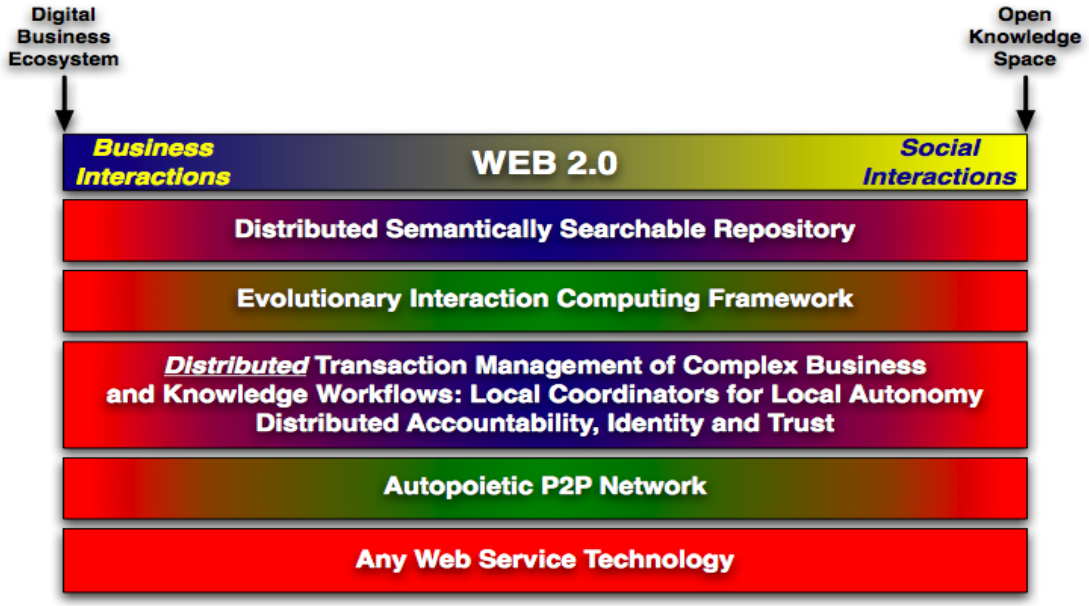

Fig. 4: Technology vision of Digital Ecosystems being pursued in the OPAALS project

The Role of Government

Lessig (2006) argues that as economies change from manufacturing to service and now knowledge economies, legislative frameworks are unable to keep up with these developments and that there is a need for new forms of market intervention. For example, the anti-trust proceedings in Europe against Microsoft have taken 10 years before requiring this player to pay a fine of 340m Euro for its unfair market dominance. During this time the online media industry has undergone a revolution with Google, My Space, Facebook, Skype, e-Bay, You Tube, and others emerging and reaching dominant market positions in various 'sectors' of the Web. Although it could be argued these developments signify healthy innovation in line with Schumpeterian forces of creative destruction in 'Fast-Forward' mode as large companies overtake each other in a frenzy of market expansion consistent with the emerging Knowledge Economy, it can also be argued that there are high risks for latecomers.

Historical evidence suggests that early entrants such as those referred above seek to claim as much territory or market share as possible through a variety of lock-in strategies, and then charge economic rents to the latecomers. Historically, this led to government intervention to foster minimum standards of fairness on competition in the marketplace. In interactive Web developments and P2P networks, social networks are enabling trust and reputation mechanisms to support content sharing spaces. But in the B2B space SMEs are disadvantaged by features of a digital divide, because of their small scale and the absence of incentives for coordinated action that would enable them to reach efficiency and competitiveness.

Alternatives to the present system of economic rents from technical knowledge asymmetries created by complex patenting and licensing systems which were put in place since the beginning of the PC revolution are difficult to develop. This is partly because the norms and precedents on proprietary standards have become so familiar: we are so used to digital technologies being owned by others that we do not notice to what extent how we work, think, and communicate is influenced by how these technologies are designed and regulated. The temptation is to regard the market arrangements for digital technologies and services, as a given.

In Digital Ecosystems research, technology is regarded as an extension of our language, and language as the medium of social construction. In this context, the structure and development of B2B e-commerce and e-business markets are not predetermined. This opens the possibility of raising the question about the best economic model that will be most advantageous for SMEs. In short, Digital Ecosystems research asks whether it is proper for someone, anyone, to own our language, and, therefore, a key aspect of constructing knowledge economies. So far as the answer is that open standards offer an alternative to the centralized server architectures that are available in the market, there is a case for government support for such an alternative.

Government support for open standards is an example of an indirect and light-touch way to strengthen the chances of success of new entrants in a market characterized by the dominance of large firms, thereby encouraging greater innovation potential. In the digital technology sector, there are some proprietary platforms through which SMEs must conduct all their online business transactions. Today in Europe this is the only entry point to the knowledge economy for millions of SMEs (20 million in the EU25). Clearly, there is a need to look at how this market environment operates and the extent to which SMEs are being disadvantaged.

5. Conclusion

The aim of the Digital Ecosystems approach is to develop structural, architectural, and regulatory measures that can enable new entry in the face of the advantages enjoyed by dominant large firms that can exploit substantial economies of scale and scope in the B2B e-business marketplace. The Digital Ecosystems approach offers a means for protecting open innovation environments and for enhancing the potential for greater inclusion of SMEs in the emerging knowledge economy with the expected benefit that these firms will contribute more effectively to a dynamic marketplace and to sustainable economic growth. In the setting of intensified globalization, we believe that this approach can support global production networks as a more inclusive and participatory industrial organization model, creating positive effects for innovation and economic growth.

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