The challenge of building public technology infrastructure: issues of governance and sustainability in a digital business ecosystem

Mary Darking  
*The London School of Economics and Political Science, M.L.Darking@lse.ac.uk*

P Dini  
*London School of Economics and Political Science, p.dini@lse.ac.uk*

E. A. Whitley  
*London School of Economics and Political Science, e.a.whitley@lse.ac.uk*

Follow this and additional works at: [http://aisel.aisnet.org/ecis2006](http://aisel.aisnet.org/ecis2006)
THE CHALLENGE OF BUILDING PUBLIC TECHNOLOGY INFRASTRUCTURE: ISSUES OF GOVERNANCE AND SUSTAINABILITY IN A DIGITAL BUSINESS ECOSYSTEM

Darking, Mary, London School of Economics and Political Science, Houghton Street, London, UK, m.l.darking@lse.ac.uk

Dini, Paolo, London School of Economics and Political Science, Houghton Street, London, UK, p.dini@lse.ac.uk

Whitley, Edgar, London School of Economics and Political Science, Houghton Street, London, UK, e.a.whitley@lse.ac.uk

Abstract

The digital business ecosystem (DBE) is an infrastructure that is being designed to support the flexible development and composition of business services. Operating under open source licensing and designed according to open standards principles, the DBE is currently funded by the European Commission. The issue facing DBE project partners who include research institutions, large technology companies and small and medium-sized enterprises (SMEs) is how to sustain the momentum of the project once funding ceases. Responsibility for maintaining the infrastructure and ensuring that it remains open will fall to a governing body. However, the legal and organisational requirements of that body have yet to be defined. This paper provides details of research in progress which is being carried out into questions of governance and sustainability of the DBE infrastructure.

Data collection will take the form of a ground-up process of consultation in which participating SMEs will be asked for their views on what form of governance the nascent DBE community should adopt. Early feedback suggests three areas of governance will take precedence during this transition phase: the constitution of a governing body; governance necessary to maintain the DBE infrastructure; and governance to support SME participation.
1 INTRODUCTION

The Digital Business Ecosystem (DBE) is a project funded by the European Commission whose objective is to produce a pan-European infrastructure for the flexible composition and development of business services. The infrastructure is being built to support growth and collaboration among small and medium-sized enterprises (SMEs) and is being developed under open source legislation and according to open standards principles. Currently comprised of over around 40 individual but inter-related software projects, one of the main concerns of the DBE is how to maintain the interest of contributors once the project ceases to be funded in October 2006. For some, taking part in the DBE is a purely commercial venture and their interest will only be maintained if there is a clear business case for staying involved. For others, there is potential to see the open source idea of software as a ‘public good’ extended to large-scale technological infrastructure so that it too can be developed and exist as a public good. Maintaining the commitment of community members after the initial launch of a project is a common concern among open source communities and sustaining the interest of a developer community long enough to establish a large scale infrastructure is a central concern of the DBE project.

One of the key factors upon which community sustainability hinges is governance (Weber, 2004). Reliable systems of governance have the potential to safeguard the interests of contributors and could assist the DBE in its transition from funded project to open community. Early empirical research into this question has identified 3 building blocks of governance that require further investigation. These include: the formation of a DBE governing body; governance relating to the maintenance of the DBE infrastructure; and governance pertaining to SME developer participation. The primary objectives of a DBE governing body will be to instate the necessary constitutional apparatus to support technological developments and formulate a basic framework for community decision making. These apparatus will have implications for the software development methodologies that are used as well as for the way power and influence will be distributed among developers and other interested parties.

This paper describes research in progress that is being carried out into issues of governance and the DBE. Following a description of the DBE project and technology, a discussion of potential governance framework requirements based on the open source literature is provided. This part of the paper also draws upon empirical research findings derived from a set of preliminary interviews carried out with 14 SMEs who are taking part in DBE testing (Darking, 2005). Research into questions of governance will require a further stage of data collection which has not yet taken place. The theoretical foundation and design for this additional stage of data collection are described before some initial implications regarding DBE governance are discussed.

2 BUILDING PUBLIC TECHNOLOGY INFRASTRUCTURE

2.1 The DBE Project and technology

The DBE is the name of both a European project and a technology (Nachira, 2002; Dini et al, 2005). As a project, the DBE is funded under the European Commission’s 6th Framework Programme for Research and Technological Development. There are 22 different partner organisations involved including IBM, SUN, Intel, a number of SME organisations and various Universities and research centres across Europe. Early stages of implementation and SME engagement have focused on 3 ‘DBE regions’: the Tampere region of Finland, the region of Aragon in Spain and the West Midlands in the UK. The DBE currently exists as a distributed development made up of around 40 individual software projects which are gradually being integrated with one another. Each stage of integration is being tested by a group of small software companies from the DBE regions who have elected to be early participants in the project. Comprised of both small and large technology companies and drawing on
research from a range of research disciplines the DBE faces some serious challenges when it comes to balancing political and epistemological interests represented in the project.

As a technology, the DBE aims to provide a flexible, distributed infrastructure to underpin regional economic growth, supporting local trade and industry through the composition and development of software. The intention is that local ecosystems will gradually federate creating inter-regional cooperation by fostering nodes of innovation and integrating pan-European, national and local initiatives (Nachira, 2002). The project has drawn inspiration from physical and biological concepts of self–organisation and evolution to produce a technological platform that will facilitate the flexible composition of software services in a similar way to Microsoft’s .Net or SAP’s forthcoming business process ‘appli-structure’. One of the key differences between the DBE and these infrastructures is the fact that the DBE has been designed as a non–proprietary ‘public’ technology infrastructure.

The DBE can be regarded as a distributed middleware comprised of a ‘studio’ of tools, a run-time environment and an ‘optimisation’ environment (see Table 1). The DBE Studio provides a range of tools that allow the SME user to search for and develop new software services according to their business needs. The run-time environment consists of a collection of server-clients. Since the DBE controls both ‘end-points’, it can rely on a variety of different transport protocols. For example, although SOAP has been used in the first instance, there is nothing to stop a more efficient binary protocol from being introduced by enterprising community developers at a later date. The evolutionary environment optimises the results that are achieved when searching for a service by drawing on the local context or ‘habitat’ of the individual or organisation making the request.

As the table below shows, depending on the point of view, the DBE can be understood as three dynamic and distributed environments or as three sets of local components that allow the individual user to create/describe services, expose or consume services, and issue service search requests.

<table>
<thead>
<tr>
<th>Development</th>
<th>Local component</th>
<th>Distributed Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run-time</td>
<td>SERVENT = SERV[er] + [cli]ENT</td>
<td>Execution Environment (ExE)</td>
</tr>
<tr>
<td>Optimisation</td>
<td>Habitat</td>
<td>Evolutionary Environment (EvE)</td>
</tr>
</tbody>
</table>

Table 1. Relationship between local components and distributed environments in the DBE

This whole area of the infrastructure is open source and the overall architecture is designed according to the principles of open standards, thereby maximising the capacity that exists for being able to couple and uncouple component parts. The high degree of abstraction in the overall architecture with its emphasis on ‘meta–level’ design has been a strong selling point with SMEs for whom the infrastructure is being principally designed. In early interviews, small software houses described how difficult they find it to produce services at a cost point their customers are able to consider due to the uncompetitive conditions in the software industry created by closed standards. In this respect, the DBE aims to generate an advantage for smaller companies by encouraging cross–regional collaboration, supporting the development of niche markets and reducing the number of development silos that exist across Europe.

2.2 Creating a framework of governance: safeguarding incentives

One of the responsibilities of any organising body seeking to create a framework for governance is to put in place the mechanisms necessary to support the interests of the community (Weber, 2004). In the case of the DBE, creating a framework for governance refers to the need to establish an organising body which is trusted by all members of community. In order to exist as an open community of developers, this organising body will need to put in place necessary legal institutions such as the General Public License known to support the development of non-proprietary software. In addition,
there are specific citation and signalling (or voting systems) required that are necessary to safeguard contribution incentives.

What constitutes a contribution incentive is an important question and the issue of why people choose to contribute to open source developments is widely debated in the open source literature (Raymond, 1999). The question has a tendency to be narrowly conceived, with open source developers described as either hobbyists, altruists or as motivated by ideologies which focus on ‘the public good’ (Lakhani & von Hippel, 2003). At the heart of these questions is an attempt to rationalise why someone would contribute their unpaid time and effort to a software development project. The question of motivation is often framed in terms of what incentives, other than financial ones, exist for contributing to an open source project. Some have argued that instead of financial reward, there is a reputation incentive that inspires individual contributors (Feller & Fitzgerald, 2002) whilst others attribute this to the notion of gifts (Bergquist & Ljungberg, 2001).

The idea of reputation incentive is a useful one for understanding the organisational and governance requirements of a new open source community such as the DBE. However, early empirical research carried out for the DBE project shows that there are many more incentives for individual firms to commit time and resources to open source developments. Findings from this data suggest that it is not only personal incentive that plays a part in the desire to contribute to open sources projects. For some the issue is a practical one where software ‘bugs’ are easier to resolve when there are lots of people working on the same problem. For others open source communities provide an opportunity to learn and remain up to date with the latest developments within a particular field. As well as a pronounced incentive to learn about new developments some very clear business incentives are also involved. Business ideas and learning carry over from open source projects into the work of small software houses, enabling them to discover new niche markets and develop innovative solutions for their clients which make use of the latest technologies. Not having to wait for commercial companies to release new versions of software is another incentive which allows SME developers to work with bugs and address client concerns according to their own timescales.

As well as licensing, two other important factors need to be accounted for in the governance of an open source community; these are citation and signalling. Reliable citation and signalling mechanisms are fundamental to establishing a foundation of trust within a developer community. If contributions are not clearly authored then the whole basis for ‘voting through’ software alterations is open to question. Similarly, if voting systems appear inefficient or non–representative then there are also grounds for contributors to lose faith in basic community processes. The problem arises for new open source communities where these mechanisms have not yet been established and where a particular project or concept has yet to become viable as a commercial product.

Valid signalling mechanisms and market success infers that reputation incentives can only be gained from open source projects that are up and running but this begs the question, how does and open source project get up and running in the first place. Possible explanation could be down to ideological superstructures (Franck & Jungworth, 2002:15)

By ideological superstructures, these authors refer to other kinds of incentives that developers might find in being part of a particular project. For example, the concept of establishing technical infrastructures as non–proprietary public goods is a powerful one which has the potential to interest and motivate. However, in order to mobilise contributors motivated by these ends, clear indicators need to be established that the project is not going to ‘go proprietary’.

In early interviews, discussions with SMEs concerning the question of membership and having contributors from big technology companies involved in the community was generally not seen as a problem. One reason for this is that contributions to open source software projects usually give citation details that refer to the individual and exclude details of the company for which that individual works. The boundary crossing nature of open source contributions where traditional models of ‘the firm’ are replaced by notions of ‘the individual’ and ‘the community’ have been shown to cut across hierarchy (Grand et al, 2002). In this respect, individual contributors from large technology
companies were judged on their ability ‘to be a good citizen’ in the same way as anyone else (SME Interview 03.05.05). For the purposes of analysis it is important to bear in mind that although individual contributors might be able to align their interests with those of an open source project, this is different to saying that an entire company – or for example, it’s Board or Managing Director - might also be capable of such alignment.

The case of the DBE raises important questions about how to study community in order to take into account these differences in perspective. However, methodologically, a further challenge is presented by the particular requirements that the study of infrastructural technologies makes. These requirements are discussed in the following section.

3 RESEARCH METHOD

3.1 Studying infrastructure: theoretical perspectives

The concept of infrastructure is addressed by both IS and STS authors (Ciborra, 2002; Hanseth & Braa, 2000; Star & Ruhleder, 1996; Bowker & Star, 2000). Whilst Ciborra theorises infrastructure from a phenomenological perspective, Star comes from a tradition of grounded theory. The emphasis of both authors is that the relations that information infrastructures enact are dense and diffuse and that knowledge of any infrastructure as a ‘totality’ is virtually impossible. In this sense, infrastructure is always something that is locally achieved through the textured ‘knitting together’ of practices. Both Ciborra (2002) and Star & Ruhleder (1996) use the term ‘ecology’ with reference to infrastructure to depict the inherent heterogeneity and complex interconnectedness of information infrastructures, which tend to fade into the background except at times of ‘breakdown’.

Bowker & Star (2000) suggest several techniques for overcoming this tendency and eliciting the richness of infrastructural ecology. They suggest a focus on the classifications, standards and categories upon which the interconnectivity of infrastructure depends, as well as on the spaces between categories and classifications (the unclassifiable, that which is outside categorisation) as a basis for understanding how interconnectivity is locally achieved and what the historical conditions for that interconnectivity are. They argue that standards, categories and classifications play a significant role in affording interconnectivity, but that there is a tendency to overlook them because they are frequently embedded in apparently mundane objects such as lists, programming code or document layouts and, as such, are seldom understood as a basis for compelling narrative or insightful research. However, Bowker & Star argue that “standards are material as well as symbolic” (2000:39) and hence that, “systems of classification (and of standardization) form a juncture of social organisation, moral order, and layers of technical integration.” (2000:33).

Similarly, Ciborra also sees infrastructures as both material and symbolic. He uses the term ‘formative context’ to describe infrastructure

not just as sets of hardware and software but as sets of the pre-existing institutional arrangements, cognitive frames, and imageries that actors bring to and routinely enact in, a situation of action. (Ciborra, 2002:70)

In this sense Ciborra sees local engagement with infrastructure as an occasion that “triggers reflexivity” and can lead to innovation. He cites the open source movement and the development of the Linux operating system as manifestations of this kind of innovation.

Actor-network theory has proven to be helpful to the study of infrastructure (Monteiro, 2000: Monteiro & Hanseth, 1996). Authors who use ANT to describe infrastructure and the adoption of standards use the technique of ‘following the actor’ where the emergence, design and adoption of a technology or standard is traced through detailed empirical research (Hanseth & Braa, 2000). The
complex character of associations formed appears as surprising and unpredictable when they are described ‘as they happen’ and not purely from the standpoint of intention or post hoc analysis.

As regards constructing a theoretical basis for collecting data on DBE governance this is an important point. It is possible that the debate over what governance framework to adopt will be comprised of a number of different groups offering a number of differing perspectives. ANT-influenced studies focus on how human, symbolic and material resources become enrolled within a network. They also focus on how the interests of human and non-human stakeholders, or actors, become translated and inscribed as networks are formed. In the planning of research, it is thought that the concept of the actor and processes of enrolment, translation and inscription will all be relevant to the study of DBE governance. Underpinning debates surrounding governance will be arguments concerning individual technological components and the circumstances and rationale surrounding their integration. Being able to treat the DBE as a socio-technical network where social and technological arguments can be both discrete and convergent will form an important part of the process of data collection.

3.2 Methodology for data collection and analysis

Empirical data will be collected as part of an ongoing process of discussion and consultation among DBE partners, early SME adopters and other interested parties including the European Commission and other projects within the Digital Ecosystem cluster of projects. Participant observer research will be carried out at relevant project meetings and data gathered from e-mail communications. There are also a number of public discussion forums concerning DBE governance and related topics such as sustainability which will act as valuable sources of data. In addition, a selection of interviews will be carried out with early SME adopters. The exact number and cross-section of interviews will depend upon which of the SME adopters remain involved in the project. On the basis of early interviews with SMEs, it is clear that governance constitutes an area that it is difficult for participants to think about as an abstract concern. Therefore interviews will be scheduled to coincide with early implementation activities where SMEs attempt to attach one of their existing software services to the infrastructure as a ‘legacy’ application. Carrying out interviews whilst interviewees are still working through the implementation process should help to draw out details and requirements relevant to discussions regarding DBE governance.

The data collected will be mainly comprised of e-mail and discussion forum excerpts, interview transcripts and research notes taken from meetings. These data will be submitted to a process of analysis according to Grounded Theory principles (Glaser & Strauss, 1966). Grounded theory and actor-network theory are complimentary to one another since they are both theories that advocate an empirically grounded approach to looking at research data. However, a grounded theory approach demands that data are not submitted to a theoretical framework prior to analysis. Therefore, this study makes a ‘light’ use of ANT literature and concepts which are used as sensitising devices rather than theoretical constraints or criteria. Taking a ‘ground-up’ view of governance is significant because it underpins a process of SME consultation through which SME views and concerns are systematically fed back to the project. The concepts generated from the process of data collection and analysis will be used as resources capable of informing the process of developing a framework for governance. The implications drawn will form a useful starting point for considering what model of governance will be best suited to the task of ensuring that the DBE makes a successful transition from European project to sustainable community.

Early research findings have suggested that there are three areas of governance that will require consideration: the constitution of a governing body; the maintenance and governance of the infrastructure itself and governance to support the participation of SMEs. Potential implications relating to these three areas are described below.
4 POTENTIAL CONCERNS AND IMPLICATIONS

4.1 Establishing a Governing Body

Whether the project elects to create a foundation (such as the Apache foundation), a ‘democratic model’ based on voting rights, or a benign dictatorship (such as the Linux kernel), leadership will be an extremely important aspect of the ecosystem’s development. At the level of code development, the DBE currently consists of around 40 individual components which have been developed among a fixed group of developers from various project partners. Individual technical components are of sufficient technical interest that they could be established as individual projects, however, the danger of forking or dissipation presents itself. A governing body has the potential to disseminate and market the underlying principles of the DBE architecture and demonstrate how individual projects are designed as interconnected units. The technical cohesion of the project as a whole depends upon this issue and as such it is an important concern for any governing body.

4.2 Governing the DBE infrastructure

The distributed nature of the DBE infrastructure means that ‘hosting’ and providing secure repositories for sensitive data and information are key concerns of SMEs. Hosting raises issues of trust, security and consumer protection. These are issues that SMEs have raised as potential barriers to their being able to integrate their existing applications and services with the DBE infrastructure and are therefore issues that need to be addressed by a governing body. Whilst it would be counter-intuitive to the distributed design of the DBE to provide centralised security or hosting services, a governing body may be able to gain access to security accreditation and certification standards that individual SMEs might find difficult to access.

4.3 Governance to support SME participation

As a new open source project, the DBE is faced with the problem that the benefits to small software houses are still in the process of being fully realised. Whilst the project has been successful at securing the interest and enthusiasm of smaller companies in the first stage, there are a number of crucial issues to be addressed that will determine whether that enthusiasm is maintained. Many of these issues focus around the question of trust. Contributors to the DBE project are searching for reassurance that, firstly, the DBE community will continue beyond the end of the project and that secondly, the project will remain open and their contributions will not be lost. If the project is ‘taken over’ by a single company or organisation, then it is clear that SMEs will feel that their contribution will be ‘carried off’ to serve that company’s ends. Constituting a governing body founded on democratic principles with appropriate voting mechanisms and legal powers should guard against this eventuality.

Interest in the overall architecture of the DBE was one of the primary reasons why participating SMEs elected to become involved in the project and why they have remained involved up to this point. A significant number of SMEs (just over half) currently participating in the project were drawn to the DBE as a project / technology that sought to address social inequalities. From a business point of view, this was argued in terms of SMEs feeling ‘squeezed out of the market’ by larger technology companies through the monopolisation of standards. In discussions, the concepts of collaboration and community were routinely contrasted with concepts of competition and pure business. In some cases, the ‘levelling’ aspects of the DBE were interpreted in explicitly social terms and associated with values about social equality as an intrinsically good end to strive for.
5 CONCLUSIONS

In designing a framework for governance, the DBE faces a number of challenges, not least of which is the intrinsic paradox of trying to establish governance of a socio-technical infrastructure that has been designed as inherently distributed and self-organising (Gallivan, 2001). Strong leadership could be a solution to this issue but early consultation with SMEs has shown that the unique character of the DBE architecture offers another solution. Perception of the DBE as a public infrastructure is growing and the idea of building a platform that is not owned by any one body or organisation has strong appeal. The question of whether the DBE will be able to stay true to these aims beyond the funded phase of the project remains to be seen. What is clear is that decisions taken regarding what kind of governance framework should be aimed for will have consequences for the sustainability of the DBE as both technology and nascent community.

References


http://opensource.mit.edu/papers/flemingwaguespack.pdf Last accessed 12.08.05

Franck, E. and Jungworth, C. (2002) Reconciling investors and donators – the governance structure of open source, Working paper series, No.8, University of Zurich
http://opensource.mit.edu/papers/jungworth.pdf Last accessed 8.08.05


